

# Drinking Water Quality: Radium Contaminant Levels

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| Type of EPHT Indicator | Hazard, Exposure                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Measures               | <p>Level of Contaminant in Finished Water</p> <ol style="list-style-type: none"> <li>1. Yearly distribution of number of Community Water Systems (CWS) by maximum Radium concentration (cut-points: &lt;3, &lt;5, &lt;10, &gt;10 pCi/L Radium).</li> <li>2. Yearly distribution of number of CWS by mean Radium concentration (cut-points: cut-points: &lt;3, &lt;5, &lt;10, &gt;10 pCi/L Radium).</li> <li>3. Average Concentration of Radium, by Year.</li> </ol> <p>Potential Population Exposure to Contaminants in Finished Water</p> <ol style="list-style-type: none"> <li>4. Yearly distribution of number of people served by CWS by maximum Radium concentration (cut-points: &lt;3, &lt;5, &lt;10, &gt;10 pCi/L Radium).</li> <li>5. Yearly distribution of number of people served by CWS by mean Radium concentration (cut-points: &lt;3, &lt;5, &lt;10, &gt;10 pCi/L Radium).</li> </ol> |
| Derivation of Measures | <p>Combined Radium-226 and -228 measures will be developed from water system attribute and water quality data stored in state Safe Drinking Water Act (SDWA) databases such as the Safe Drinking Water Information System (SDWIS/State). Data will be cleaned and transformed to a standard format. Analytical results of drinking water samples (usually taken at entry points to the distribution system or representative sampling points after treatment) will be used in conjunction with information about each CWS (such as service population and latitude and longitude of representative location of the CWS service area) to generate the measures.</p>                                                                                                                                                                                                                                     |
| Units                  | <b>pCi/L combined Radium-226 &amp; -228</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Geographic Scope       | State and Community Water System                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Geographic Scale       | The finest detail will be approximate point location of the community water distribution system represented by water withdrawal point, water distribution extents, principal county served, or principal city served.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Time Period            | 2000-Most Recent Year Available                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Time Scale             | Calendar year                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Rationale              | <p><b>Radium-226 and -228 and Public Health</b></p> <p>Radium is a naturally occurring silvery-white radioactive metal that can exist in several forms called isotopes. Radium is produced constantly by the radioactive decay of uranium and thorium. Uranium and thorium are found in small amounts in most rocks and soil. Some of the radiation from radium is being released constantly into the environment. It is this radioactive decay that causes concern about the safety of radium and all other radioactive substances. Two of the main radium isotopes found in the environment are radium-226 and radium-228. The decay of radium-226 results in the formation of radon which exists as a gas and is mobile in environmental media. Radium has been used as a radiation source for</p>                                                                                                  |

treating cancer, in radiography of metals, and combined with other metals as a neutron source for research and radiation instrument calibration. Until the 1960s, radium was a component of the luminous paints used for watch and clock dials, instrument panels in airplanes, military instruments, and compasses (ATSDR, 2010).

Everyone is exposed to low levels of radium in the air, water, and food. Higher levels may be found in the air near industries that burn coal or other fuels or near sites that mine or mill uranium. It also may be found at higher levels in drinking water from groundwater wells. Miners, particularly miners of uranium and hard rock, are exposed to higher levels of radium. It may also be found at radioactive waste disposal sites (ATSDR, 1990).

It is not known whether long-term exposure to radium at the levels that are normally present in the environment (for example, 1 pCi of radium per gram of soil) is likely to result in harmful health effects. However, exposure to higher levels of radium over a long period of time may result in harmful effects including anemia, cataracts, fractured teeth, cancer (especially bone cancer), and death. Patients who were injected with radium in Germany, from 1946 to 1950, for the treatment of certain diseases including tuberculosis were significantly shorter as adults than people who were not treated. Some of these health effects may take years to develop and mostly are due to gamma radiation. Radium gives off gamma radiation, which can travel fairly long distances through air. Therefore, just being near radium at the high levels that may be found at some hazardous waste sites may be dangerous to your health.

Exposure to high levels of radium results in an increased incidence of bone, liver, and breast cancer. The EPA and the National Academy of Sciences, Committee on Biological Effects of Ionizing Radiation, has stated that radium is a known human carcinogen.

#### **Biomonitoring Information**

Urine tests can determine if you have been exposed to radium. Another test measures the amount of radon (a breakdown product of radium) in exhaled air. Both types of tests require special equipment and cannot be done in a doctor's office. These tests cannot tell how much radium you were exposed to, nor can they be used to predict whether you will develop harmful health effects (ATSDR, 1990). Levels of radium in the U.S. population are unknown.

#### **Sources of Radium**

Radium forms from the decay of uranium or thorium in the environment. Radium -226 is formed from the decay of uranium-238; Radium-228 is formed from the decay of thorium. Radium is abundant in low levels everywhere because it originates from uranium which is commonly found in all rocks, soil and water. (EPA, 2010)

#### **Radium Regulation and Monitoring**

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|                                           | <p>The EPA has set a drinking water limit of 5 picocuries per liter (5 pCi/L) for radium-226 and radium-228 (combined) (EPA, 2009). A gross alpha particle activity measurement may be substituted for the required radium-226 measurement provided that the measured gross alpha particle activity does not exceed 5 pCi/L. The EPA lifetime exposure cancer risk estimate for radium at the MCL, is approximately 1-2 cases per 10,000 people.</p> <p><b>Monitoring frequency</b></p> <p>Once a CWS has satisfied initial monitoring requirements (4 quarterly samples at every entry point to the distribution system within the first quarter after initiating the source); the required frequency for Combined Radium-226 and -228 monitoring is once every three years if the average of the initial monitoring results for the contaminant is greater than one-half the MCL but at or below the MCL. States may allow CWS to reduce the frequency of monitoring from once every three years to once every six or nine years at each sampling point, if the average of the initial monitoring results for each contaminant is below the detection limit. If a system has a monitoring result that exceeds the MCL while on reduced monitoring, the system must collect and analyze quarterly samples at that sampling point until the system has results from four consecutive quarters that are below the MCL, unless the system enters into another schedule as part of a formal compliance agreement with the State (CFR, 2002).</p> |
| <p><b>Use of Measure</b></p>              | <p>These measures can assist by addressing the following surveillance functions:</p> <ul style="list-style-type: none"> <li>• Distribution measures provide information on the number of CWS and the number of people potentially exposed to combined Radium-226 and -228 at different concentrations.</li> <li>• Maximum concentrations provide information on the peak potential exposure to combined Radium-226 and -228 at the state level.</li> <li>• Mean concentrations at the CWS level provide information on potential exposure at a smaller geographic scale.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <p><b>Limitations of The Measure</b></p>  | <p>The current measures are derived for CWS only. Private wells may be another source of population exposure to combined Radium-226 and -228. Transient non-community water systems, which are regulated by EPA, may also be an important source of combined Radium-226 and -228 exposure. Measures do not account for the variability in sampling, numbers of sampling repeats, and variability within systems. Concentrations in drinking water cannot be directly converted to exposure, because water consumption varies by climate, level of physical activity, and between people (EPA 2004). Due to errors in estimating populations, the measures may overestimate or underestimate the number of affected people.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <p><b>Data Sources</b></p>                | <p>Iowa Department of Natural Resources</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <p><b>Limitations of Data Sources</b></p> | <p>The required monitoring frequency for combined Radium-226 and -228 is infrequent and may be as intermittent as every nine years; therefore most states will have very little data on this contaminant.</p> <p>Ground water systems may have multiple wells with different combined</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |

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|                                  | <p>Radium-226 and -228 concentrations that serve different parts of the population. Compliance samples are taken at each entry point to the distribution system. In systems with separate wells serving some branches or sections of the distribution system, the system mean would tend to underestimate the combined Radium-226 and -228 concentrations of people served by wells with higher combined Radium-226 and -228 concentrations. Exposure may be higher or lower than estimated if data from multiple entry points for water with different combined Radium-226 and -228 levels are averaged to estimate levels for the PWS.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <p><b>Related Indicators</b></p> | <p>Public Water Use; Uranium</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <p><b>References</b></p>         | <ol style="list-style-type: none"> <li>1. Agency for Toxic Substances and Disease Registry (ATSDR). Toxic Substances Portal. Radium. 2010. Available at: <a href="http://www.atsdr.cdc.gov/substances/toxsubstance.asp?toxid=154">http://www.atsdr.cdc.gov/substances/toxsubstance.asp?toxid=154</a></li> <li>2. Agency for Toxic Substances and Disease Registry (ATSDR). 1990. Toxicological Profile for Radium. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service Available at: <a href="http://www.atsdr.cdc.gov/toxfaqs/TF.asp?id=790&amp;tid=154">http://www.atsdr.cdc.gov/toxfaqs/TF.asp?id=790&amp;tid=154</a></li> <li>3. Code of Federal Regulations (CFR), 2002. Title 40 Protection of the Environment Chapter I--Environmental Protection Agency Part 141--National Primary Drinking Water Regulations 141.26 Monitoring frequency and compliance requirements for radionuclides in community water systems. Available at: URL: <a href="http://www.access.gpo.gov/nara/cfr/waisidx_02/40cfr141_02.html">http://www.access.gpo.gov/nara/cfr/waisidx_02/40cfr141_02.html</a></li> <li>4. U.S. Environmental Protection Agency (U.S. EPA). Radiation Protection, Radium, 2010. Available at: <a href="http://www.epa.gov/radiation/radionuclides/radium.html">http://www.epa.gov/radiation/radionuclides/radium.html</a></li> <li>5. U.S. Environmental Protection Agency (U.S. EPA). The Analysis of Regulated Contaminant Occurrence Data from public Water Systems in Support of the Second Six-year Review of National Primary Drinking Water Regulations. EPA-815-B-09-006, October 2009.</li> </ol> |