HydraTech
of New Mexico
Since 1992
505•898•4343 800•944•9372 www.hydratechnm.org

Understanding the EPA Radionuclides Rule and Compliance Treatment Technologies

Overview

The United States Environmental Protection Agency (EPA) promulgated the **Radionuclides Rule** under the **Safe Drinking Water Act** (SDWA) in 1976 and revised it in December of 2000. The revised rule became law on December 8, 2003. The Radionuclide Rule established a mandate to begin initial monitoring under state regulated monitoring plans on December 8, 2003 and to complete initial monitoring by December 31, 2007. United States Community Water Systems (CWSs)—systems serving over 15 homes or 25 persons—are regulated by the rule. The purpose of the Radionuclide Rule is to improve public health by reducing the risk of various cancers caused by exposure to waterborne radionuclides.

The Radionuclide Rule creates four categories of regulated radionuclide contaminants along with their mandatory Maximum Contaminant Levels (MCL) and recommended Maximum Contaminant Level Goals (MCLG). The MCLG is the level at which no toxicity exists. It is always zero.

- **Radium**: Combined radium 226 and 228. **MCL 5 pCi/L. MCLG zero.**
  Radium 224 is listed as a prevalent contaminant but with no MCL.
- **Gross Alpha Emitters** (excluding uranium and radon): radium, thorium, plutonium.
  MCL 15 pCi/L. MCLG zero.
- **Gross Beta Emitters:** (formerly "Manmade Radionuclides") Radioisotopes that emit beta and photon particles: tritium, strontium 90, cesium 137, plutonium, cobalt 60
  MCL 4mrem/yr. MCLG zero.
- **Uranium:** A toxic heavy metal which also emits alpha particles.
  MCL 30 μg/L (0.03 mg/L. MCLG zero.

The Radionuclides Rule established regulatory radionuclide detection limits as follows: Gross Alpha 3 pCi/L, Radium 228 1 pCi/L, Uranium 1 μg/L (ppb).

Monitoring Requirements

Point of Entry Monitoring. Community Water Systems must now monitor at each entry point to the distribution system (EPTDS). This point-of-entry change from the 1976 Rule remedies situations in which a "representative point" in the distribution system yields an "average" acceptable standard, yet some homes are delivered contaminated water. Four consecutive quarters of monitoring at each entry point for each contaminant are required of all CWSs to establish a monitoring baseline.

Substituting Gross Alpha Results for Radium and Uranium Compliance. In certain instances the gross alpha test result may be substituted for radium 226 if previous gross alpha results are less than or equal to the radium MCL of 5 pCi/L. There is no gross alpha substitution allowable for radium 228. Gross alpha test results may also be substituted for uranium results if the gross alpha result is less than or equal to the gross alpha MCL of 15 pCi/L. This substitution may simplify monitoring and monitoring frequency.

The Calculation for Gross Alpha Substitution. If a uranium value is reported by a laboratory method that measures uranium activity (radioactivity), convert the activity to uranium mass (Umass) by dividing the activity in picoCuries (pCi/L) by the conversion factor of 0.67. This yields the Umass in micrograms per liter μg/L (the measurement units of the MCL). If this result is less than the uranium MCL of 30 μg/L you are in compliance. If the result exceeds the MCL, request that the certified laboratory analyze the Umass by a direct mass method. This result will yield a lower uranium value and may facilitate compliance. For further information contact your state drinking water division radiochemistry lab. See also the EPA website (www.epa.gov/safewater/rads/implement.html).

Gross Alpha Compliance. Remember that the MCL for gross alpha excludes radon and uranium. Therefore, if your gross alpha result exceeds the MCL, uranium (and radon if a non-evaporative method was used) should be analyzed. Subtract the resulting uranium value from the gross alpha value to determine the "adjusted gross alpha" value. Your analytical laboratory may not do this, leaving you with a gross alpha value that may incorrectly indicate an MCL exceedence. This adjusted value may then be used to determine compliance, avoid treatment costs and obtain a more favorable monitoring frequency. Consult with the radiochemistry division of your state's analytical laboratory or Drinking Water Bureau. Remember also that gross alpha treatment methods depend upon the specific gross alpha radionuclide, e.g., radium (cation exchange, RO), uranium (anion exchange, RO), radon (activated carbon, air stripping).

Gross Beta and Photon Emitters: Unless your system is vulnerable to contamination from a nuclear facility (nuclear power plant, nuclear research facility, hospital, university or industrial lab, pharmaceutical company) or is now contaminated, you are not required to monitor gross beta and photon emitters.

Should you be required to do so, remember that gross beta radionuclides have different concentrations of radiation that may result in an exceedence of the 4mrem MCL because the different radionuclides yield different energy levels of radioactivity. Your analytical laboratory will measure the nuclide concentrations in your samples as fractions and total them. If the result is greater than 1, the 4mrem/yr MCL is exceeded and a violation occurs. You must then monitor each month until a rolling average of 3 months is less than the gross beta MCL.

What Constitutes a Violation of the Radionuclide Rule?

- The running average of quarterly sample results for one year of any entry point to the distribution system (EPTDS) must not exceed any radionuclide MCL. If it does, you are in violation. Conversely, if the average is less than any radionuclide MCL, you are in compliance.
- No single sample result may exceed any radionuclide MCL by greater than four times.
- Any sample result that causes the running annual average of any EPTDS to exceed any MCL is a violation.
- Failure to collect and submit results of all requisite samples is a monitoring and reporting violation. Your state will then average the samples that you did submit to determine if there is also an MCL violation.

Compliance Technologies for Radionuclides

The EPA has approved the following Best Available Technologies (BATs) and Small System Compliance Technologies (SSCTs) for radionuclide removal from surface and ground water:

- Ion Exchange: cation, anion, or mixed bed (BAT, SSCT)
- Reverse Osmosis (BAT, SSCT)
- Lime Softening (BAT, SSCT)
- Enhanced Coagulation/Filtration (BAT, SSCT)
- Greensand Filtration (SSCT)
- Barium Sulfate Co-precipitation (SSCT)
- Electrodialysis/Electrodialysis Reversal (SSCT)
- Preformed Hydrous Manganese Oxide Filtration (SSCT)
- Activated Alumina (SSCT)
- Point-of-use (POU) Technologies: Includes POE (point-of-entry) ion exchange and POU and POE reverse osmosis devices. These SSCT point-of-use treatment strategies treat water in the home at

POE and at POU (at the tap). For very small Community Water Systems (CWS) POU/POE may be more cost effective than centralized strategies, but may yield higher monitoring and administrative costs, and possibly higher waste disposal costs. Consult with your state drinking water division.

The Radionuclide Rule does not require you to utilize a BAT or SSCT treatment technology. Any technology that is approved by your state primacy agency that accomplishes compliance with the MCL is allowed by the EPA. For example, iron based adsorptive media are very effective at removal of radium, uranium and arsenic. Other benefits are low cost and basic operator training level.

Treatment Technology Selection Considerations.

- Community Water System Size
- Specific radionuclide and level of contamination
- Operation and maintenance costs, capital
- Other state and local regulations
- Operator training level
- Waste disposal and residual management.

Which of these several BATs/SSCTs is right for your system? Each has its advantages and limits. Consult with a Professional Engineer (PE) and a certified specialist vendor with access to a laboratory computerized decision tree to determine which of these strategies is correct for your water system's unique geochemistry. Neither your state's drinking water division nor analytical laboratory will understand these technologies.

Now select your treatment strategy, strategy change or modification. Then consult with your state primacy agency to determine whether there are state or local restrictions that may preclude your selection. Request assistance on waste disposal regulations and other state and local regulations that may impact your treatment selection decision. Your state may require approval by a Professional Engineer (PE) if you are making treatment changes or selecting a new treatment strategy. Ask your PE to recommend a qualified, WQA certified vendor. Your vendor should know the treatment technologies better than your PE.

Non-Treatment Options. Consider blending your system's water with other community water systems in the area. Determine whether nearby geological water bearing zones can be isolated and tapped to improve your water quality.

Modification of Your Existing Treatment Technologies. If non-treatment options are not feasible, examine EPA SSCT treatment modifications to your current strategy. For example, consider point-of-entry (POE) in-home ion exchange water softeners to abate radium (cation exchange) and uranium (mixed bed cation/anion exchange). Point-of-use (POU), at the tap reverse osmosis (RO) devices and whole house POE RO is effective at removing all radionuclides at reductions that approach 99%. RO also removes arsenic at 98/99%. If you are utilizing lime softening to mitigate a radium or uranium MCL violation, **enhanced** lime softening will increase your efficacy from 50/70% to 90% and may also help with other contaminants such as arsenic, iron and manganese. Consult a certified vendor.

References

A Small Entity Compliance Guide www.epa.gov/rads
EPA Hotline 800-426-4791
National Drinking Water Regulations, www.hydatechnm.org
Radionuclides Rule (Final) Federal Register, Vol. 85
Radionuclides Rule Implementation www.epa.gov/rads/implement

HydraTech
of New Mexico
Since 1992
505•898•4343 800•944•9372 www.hydratechnm.org

Water Treatment Technologies for Radionuclide Removal©

Treatment Technology	Radionuclide Contaminant	EPA Treatment Designation	Source Water Efficacy	Operator Training Level	Treatment Considerations
Ion Exchange (cation, anion, mixed bed)	Radium (cation), uranium (anion), Gross Alpha *(c.f.* Radium, uranium), Gross Beta (mixed bed)	BAT/SSCT	Ground Water	Intermediate	Regenerate disposal, competing ions (sulfate, calcium), chromatographic peaking
Reverse Osmosis	Effective for all radionuclides, 99% removal (also arsenic)	BAT/SSCT	Surface Water Ground Water (small CWS)	Advanced	Disposal, pre-treatment, membrane scaling and failure
Lime Softening	Effective for all radionuclides	BAT/SSCT	All Waters	Advanced	Disposal, pre-treatment, low contaminant reductions
Enhanced Coagulation/filtration	Uranium, Gross Alpha,Gross Beta	BAT/SSCT	All Waters	Advanced	PH must exceed 10.6 for radium removal Complex monitoring
Greensand Filtration	Radium (small systems)	SSCT	All Waters	Basic	Low pH, Fe, Mn limit efficacy
Barium Sulfate co-precipitation	Radium	SSCT	Suitable ground water chemistry	Advanced	Too complex for small systems
Electro Dialysis/ Electro Dialysis reversal	Radium, Uranium, Gross Alpha, Gross Beta	SSCT (radium only)	All Ground Waters	Intermediate	High operating and disposal costs
Pre-formed Hydrous Manganese Oxide Filtration	Radium (also removes arsenic)	SSCT	All Ground Waters	Advanced	Competing ions (Fe, Mn)
Activated Alumina	Uranium	SSCT	All Ground Waters	Advanced	pH sensitive, disposal
Point-of-use POU RO Point-of-entry POE ion exchange	See Reverse Osmosis, Ion Exchange above	SSCT	Surface Water, Ground Water	Basic	In home treatment (see RO- above)
Iron based adsorptive media	Radium, Uranium, Gross Alpha (also arsenic)	None: Relatively new technology	Surface Water, Ground Water	Basic	Contaminant break-through. Monitor spent medium, low-cost benefit