

**567—41.8(455B) Radionuclides.****41.8(1) Radionuclides.***a. Applicability.*

(1) This rule applies to all CWSs and specifies radionuclide MCLs, analytical methodology requirements, and monitoring requirements. Radionuclide reporting requirements are listed in 567—subrule 40.8(1), PN requirements are in 567—40.5(455B), and BAT is in 567—subparagraph 43.3(10)“b”(3). All CWSs must comply with the requirements and MCLs for gross alpha particle activity, radium-226, radium-228, uranium, beta particle activity, and photon emitter radioactivity. Only those CWSs designated by the department to be vulnerable to man-made radioactivity contamination are required to monitor for beta particle activity and photon emitter radioactivity. To determine whether a system is vulnerable to man-made nuclear radioactivity, the department will evaluate proximity to a nuclear facility, source water, historical analytical data, ongoing surveillance data from the nuclear facility, and any other factor considered to be relevant.

(2) Compliance dates. CWS must comply with the MCLs in 41.8(1)“b”(1). Compliance shall be determined in accordance with 41.8(1)“c” through “f.” Compliance with the radionuclides reporting requirements is required. All CWSs must conduct initial monitoring to determine compliance with 41.8(1)“b”(1) by December 31, 2007.

*b. MCLs for radionuclides.*

(1) Gross alpha particle activity, radium-226, radium-228, and uranium MCLs are specified in the following table:

Contaminant	MCL
Gross alpha particle activity, including Radium-226 but excluding radon and uranium	15 pCi/L
Combined Radium-226 and Radium-228	5 pCi/L <sup>1</sup>
Uranium	30 µg/L

<sup>1</sup>Determine the combined radium-226 and radium-228 by the adding the results of analysis for radium-226 and radium-228.

*(2) Beta particle activity and photon radioactivity MCLs.*

1. The average annual concentration of beta particle and photon radioactivity from man-made radionuclides in drinking water must not produce an annual dose equivalent to the total body or any internal organ greater than 4 mrem/year.

2. Except for the radionuclides listed below, the concentration of man-made radionuclides causing 4 mrem total body or organ dose equivalents must be calculated on the basis of 2 liter per day drinking water intake, using the 168-hour data lists in “Maximum Permissible Body Burdens and Maximum Permissible Concentrations of Radionuclides in Air and in Water for Occupational Exposure,” National Bureau of Standards Handbook 69 as amended August 1963, U.S. Department of Commerce. If two or more radionuclides are present, the sum of their annual dose equivalent to the total body or to any organ shall not exceed 4 mrem/year.

**Average Annual Concentrations Assumed to Produce a  
Total Body or Organ Dose of 4 mrem/year**

Radionuclide	Critical Organ	Concentration
Strontium-90	Bone marrow	8 pCi/L
Tritium	Total body	20,000 pCi/L

*c. Detection limits and compliance determinations.* Compliance with the radionuclide MCLs will be determined based on the analytical results obtained at each sampling point. If one sampling point is in violation of an MCL, the system is in violation of the MCL. If a system is in violation of an MCL, the supplier of the water is required to give notice to the department in accordance with 567—subrule 40.8(1) and to provide PN as required by rule 567—40.5(455B).

(1) Detection limits. When monitoring gross alpha particle activity, radium-226, radium-228, uranium, and beta particle and photon radioactivity concentration in drinking water, the required sensitivity of the radioanalysis is defined in terms of a detection limit. The detection limit shall be that concentration which

can be counted with a precision of plus or minus 100 percent at the confidence level (1.960 sigma, where sigma is the standard deviation of the net counting rate of the sample).

1. To determine compliance with the specified radionuclide MCLs, the detection limit shall not exceed the following concentrations:

**Detection Limits for Gross Alpha Particle Activity,  
Radium-226, Radium-228, and Uranium**

Contaminant	Detection Limit
Gross alpha particle activity	3 pCi/L
Radium-226	1 pCi/L
Radium-228	1 pCi/L
Uranium	1 µg/L

2. To determine compliance with the specified radionuclide MCLs, the detection limits shall not exceed the following concentrations:

**Detection Limits for Man-Made  
Beta Particle and Photon Emitters**

Contaminant	Detection Limit
Gross beta	4 pCi/L
Cesium-134	10 pCi/L
Iodine-131	1 pCi/L
Strontium-89	10 pCi/L
Strontium-90	2 pCi/L
Tritium	1,000 pCi/L
Other radionuclides	1/10 of the applicable limit

(2) Compliance determination.

1. For systems monitoring more than once per year, MCL compliance is determined by a running annual average (RAA) at each sampling point. If the average of any sampling point is greater than the MCL, the system is immediately in violation of the MCL. If any sample result causes the RAA to exceed the MCL at any sample point, the system is immediately in violation of the MCL.

2. Systems monitoring annually or less frequently whose sample result exceeds the MCL must revert to quarterly sampling for that contaminant during the next quarter. Systems are required to conduct quarterly monitoring only at the SEP at which the sample was collected and for the specific contaminant that triggered the increased monitoring frequency. Systems triggered into increased monitoring will not be considered in violation of the MCL until they have completed one year of quarterly sampling. If any sample result causes the RAA to exceed the MCL at any sample point, the system is immediately in violation of the MCL.

3. Systems must include all samples taken and analyzed under the provisions of this rule in determining compliance, even if that number is greater than the minimum required by the department.

4. If a system does not collect all required samples when compliance is based on an RAA of quarterly samples, compliance will be based on the running average of the samples collected.

5. If a sample result is less than the detection limit, use a value of zero to calculate the annual average.

6. The department may invalidate results of obvious sampling or analytical errors.

7. To judge compliance with the radionuclide MCLs, averages of data shall be used and shall be rounded to the same number of significant figures as the MCL for the contaminant in question.

(3) The department will determine compliance or initiate enforcement action based upon analytical results or other information compiled by department staff or the department's designee.

(4) The department may assign additional requirements deemed necessary to protect public health, including PN requirements.

d. *Radionuclide analytical methodology.* Analysis for radionuclides shall be conducted to determine compliance with the radionuclide MCLs in accordance with the methods in the following table, or equivalent methods determined in accordance with rule 567—41.10(455B).

(1) Radionuclide Analytical Methodology Table.

**Radionuclide Analytical Methodology**

Contaminant	Methodology	Reference (method or page number)								
		EPA <sup>1</sup>	EPA <sup>2</sup>	EPA <sup>3</sup>	EPA <sup>4</sup>	SM <sup>5</sup>	ASTM <sup>6</sup>	USGS <sup>7</sup>	DOE <sup>8</sup>	Other
<b>Naturally occurring:</b>										
Gross alpha <sup>11</sup> & beta	Evaporation	900.0	p. 1	00-01	p. 1	302, 7110B, 7110 B-00		R-1120-76		
Gross alpha <sup>11</sup>	Co-precipitation			00-02		7110C, 7110 C-00				
Radium-226	Radon emanation	903.1	p. 16	Ra-04	p. 19	305, 7500-Ra C, 7500Ra C-01	D 3454-97, 05	R-1141-76	Ra-04	NY <sup>9</sup>
	Radiochemical	903.0	p. 13	Ra-03		304, 7500-Ra B, 7500-Ra B-01	D 2460-97, 07	R-1140-76		GA <sup>14</sup>
Radium-228	Radiochemical	904.0	p. 24	Ra-05	p. 19	7500-Ra D, 7500-Ra D-01		R-1142-76		NY <sup>9</sup> NJ <sup>10</sup> GA <sup>14</sup>
Uranium <sup>12</sup>	Radiochemical	908.0				7500-U B, 7500-U B-00				
	Fluorometric	908.1				7500-U C (17th ed.)	D 2907-97	R-1180-76 R-1181-76	U-04	
	ICP-MS	200.8 <sup>13</sup>				3125	D 5673-03, 05, 10			
	Alpha spectrometry			00-07	p. 33	7500-U C, 7500-U C-00	D 3972-97, 02, 09	R-1182-76	U-02	
	Laser phosphorimetry						D 5174-97, 02, 07			
	Alpha liquid scintillation spectrometry						D 6239-09			
<b>Man-made:</b>										
Radioactive Cesium	Radiochemical	901.0	p. 4			7500-Cs B, 7500-Cs B-00	D 2459-72	R-1111-76		
	Gamma ray spectrometry	901.1			p. 92	7120, 7120-97	D 3649-91, 98a, 06	R-1110-76	4.5.2.3	
Radioactive Iodine	Radiochemical	902.0	p. 6 p. 9			7500-I B, 7500-I B-00 7500-I C, 7500-I C-00 7500-I D, 7500-I D-00	D 3649-91, 98a, 06			
	Gamma ray spectrometry	901.1			p. 92	7120, 7120-97	D 4785-93, 00a, 08		4.5.2.3	
Radioactive Strontium 89, 90	Radiochemical	905.0	p. 29	Sr-04	p. 65	303, 7500-Sr B, 7500-Sr B-01		R-1160-76	Sr-01 Sr-02	
Tritium	Liquid scintillation	906.0	p. 34	H-02	p. 87	306, 7500- <sup>3</sup> H B, 7500- <sup>3</sup> H B-00	D 4107-91, 98 (Reapproved 2002), 08	R-1171-76		
Gamma emitters	Gamma ray spectrometry	901.1 902.0 901.0			p. 92	7120 7500-Cs B, 7500-Cs B-00, 7500-I B, 7500-I B-00	D 3649-91, 98a, 06 D 4785-93, 00a, 08	R-1110-76	Ga-01-R	

The procedures shall be done in accordance with the documents listed below. The incorporation by reference of documents 1 through 10 was approved by the Director of the Federal Register in accordance with 5 U.S.C. 552(a) and 1 CFR Part 51. Copies may be obtained from the sources listed below. Information regarding the documents can be obtained from the Safe Drinking Water Hotline at 800.426.4791. Documents may be inspected at EPA's Drinking Water Docket or at the Office of Federal Register.

<sup>1</sup>“Prescribed Procedures for Measurement of Radioactivity in Drinking Water,” EPA 600/4-80-032, August 1980. NTIS, PB 80-224744.

<sup>2</sup>“Interim Radiochemical Methodology for Drinking Water,” EPA 600/4-75-008(revised), March 1976. NTIS, *ibid.* PB 253258.

<sup>3</sup>“Radiochemistry Procedures Manual,” EPA 520/5-84-006, December 1987. NTIS, *ibid.* PB 84-215581.

<sup>4</sup>“Radiochemical Analytical Procedures for Analysis of Environmental Samples,” March 1979. NTIS, *ibid.* EMSL LV 053917.

<sup>5</sup>SM, 13th, 17th, 18th, 19th, 20th, 21st, and 22nd editions, 1971, 1989, 1992, 1995, 1998, 2005, and 2012. Methods 302, 303, 304, 305, and 306 are in the 13th edition. Methods 7110B, 7500-Ra B, 7500-Ra C, 7500-Ra D, 7500-U B, 7500-Cs B, 7500-I B, 7500-I C, 7500-I D, 7500-Sr B, 7500-3H B are in the 17th, 18th, 19th, 20th, 21st, and 22nd editions. Method 7110C and Method 7500-U C Alpha spectrometry are in the 18th, 19th, 20th, 21st, and 22nd editions. Method 7500-U C Fluorimetric Uranium is in the 17th and 21st editions. Method 7120 is in the 19th, 20th, 21st, and 22nd editions. Method 3125 is in the 20th edition. Methods 7110 B-00, 7110 C-00, 7500-Ra B-01, 7500-Ra C-01, 7500-Ra D-01, 7500-U B-00, 7500-U C-00, 7500-I B-00, 7500-I C-00, 7500-I D-00, 7120-97, 7500-Sr B-01, and 7500-3H B-00. The year that each method was approved is designated by the last two digits in the method number. The methods listed are the only online versions that may be used.

<sup>6</sup>ASTM, Volumes 11.01 and 11.02, 2002. Any year containing the cited version of the method may be used.

<sup>7</sup>“Methods for Determination of Radioactive Substances in Water and Fluvial Sediments,” Chapter A5 in Book 5 of Techniques of Water-Resources Investigations of the USGS, 1977. USGS Information Services, Box 25286, Federal Center, Denver, CO 80225-0425.

<sup>8</sup>“EML Procedures Manual,” 28th (1997) or 27th (1990) edition, Volumes 1 and 2; either edition may be used. In the 27th edition, Method Ra-04 is listed as Ra-05, and Method Ga-01-R is listed as Sect. 4.5.2.3. Environmental Measurements Laboratory, U.S. Department of Energy, 376 Hudson Street, New York, NY 10014-3621.

<sup>9</sup>“Determination of Ra-226 and Ra-228 (Ra-02),” January 1980, revised June 1982. Radiological Sciences Institute Center for Laboratories and Research, New York State Department of Health, Empire State Plaza, Albany, NY 12201.

<sup>10</sup>“Determination of Radium-228 in Drinking Water,” August 1980. State of New Jersey, Department of Environmental Protection, Division of Environmental Quality, Bureau of Radiation and Inorganic Analytical Services, 9 Ewing Street, Trenton, NJ 08625.

<sup>11</sup>Natural uranium and thorium-230 are approved as gross alpha calibration standards for gross alpha with co-precipitation and evaporation methods; americium-241 is approved with co-precipitation methods.

<sup>12</sup>If uranium (U) is determined by mass, a 0.67 pCi/μg of uranium conversion factor must be used. This conversion factor is based on the 1:1 activity ratio of U-234 to U-238 that is characteristic of naturally occurring uranium.

<sup>13</sup>“Determination of Trace Elements in Waters and Wastes by Inductively Coupled Plasma-Mass Spectrometry,” Revision 5.4, published in “Methods for the Determination of Metals in Environmental Samples – Supplement 1,” EPA 600-R-94-111, May 1994. NTIS, PB 95-125472.

<sup>14</sup>“The Determination of Radium-226 and Radium-228 in Drinking Water by Gamma-Ray Spectrometry Using HPGW or Ge(Li) Detectors,” Revision 1.2, December 2004. Environmental Resources Center, Georgia Institute of Technology, 620 Cherry Street, Atlanta, GA 30332-0335.

(2) Method references for other radionuclides. When the identification and measurement of radionuclides other than those listed in 41.8(1)“b” are required, the following references shall be used, except in cases where alternative methods have been approved in accordance with 567—41.12(455B).

1. “Procedures for Radiochemical Analysis of Nuclear Reactor Aqueous Solutions,” H. L. Krieger and S. Gold, EPA-R4-73-014, EPA, Cincinnati, Ohio 45268 (May 1973).

2. “HASL Procedure Manual,” edited by John H. Harley. HASL 300, ERDA Health and Safety Laboratory, New York, NY (1973).

*e. Monitoring requirements for gross alpha, radium-226, radium-228, and uranium.*

(1) General.

1. Monitoring frequency and confirmation samples. The department may require more frequent monitoring than specified in this paragraph and may require confirmation samples at its discretion. The results of the initial and confirmation samples will be averaged for use in compliance determinations.

2. Monitoring period. Each PWS shall monitor during the time period specified in the operation permit.

(2) Applicability and sampling locations.

1. Existing systems and sources. All existing CWSs must sample at every SEP representative of all sources being used under normal operating conditions. Systems must take each sample at the same SEP sampling point, unless conditions make another alternate sampling point more representative of each source, or the department has designated a distribution system location, in accordance with this paragraph. The department must approve any alternate sampling point for radionuclides.

2. New systems and sources. All new CWSs or CWSs that use a new source of water must begin initial monitoring for the new system or source within the first calendar quarter after initiating use of the system or source. More frequent monitoring must be conducted by a CWS when required by the department, in the event of possible contamination, or when changes in the distribution system or treatment processes occur which may increase the concentration of radioactivity in finished water.

(3) Initial monitoring. Systems must conduct initial monitoring for gross alpha particle activity, radium-226, radium-228, and uranium as follows. If the average of the initial monitoring results for an SEP is above the MCL, a system must collect and analyze quarterly samples at that SEP until it has results from four consecutive quarters that are at or below the MCL unless it enters into another schedule as part of a formal compliance agreement with the department.

1. Systems without historical monitoring data. Systems without historical monitoring data must collect four consecutive quarterly samples at all SEP sampling points before December 31, 2007. The department may waive the final two quarters of initial monitoring from an SEP if the results of the samples from the previous two quarters are below the detection limit.

2. Systems with historical monitoring data and one SEP. Systems with only one SEP may use historical monitoring data collected between January 1, 2000, and December 31, 2003, from either the representative point in the distribution system or the SEP to satisfy the initial monitoring requirement.

3. Systems with historical SEP monitoring data and multiple SEPs. Systems with multiple SEPs that also have appropriate historical monitoring data for each SEP may use the monitoring data collected between January 1, 2000, and December 31, 2003, to satisfy the initial monitoring requirement.

4. Systems with historical distribution system monitoring data and multiple SEPs. Systems with appropriate historical data for a representative point in the distribution system and multiple SEPs may use the monitoring data collected between January 1, 2000, and December 31, 2003, provided that the department determines that the historical data satisfactorily demonstrates that each SEP is expected to be in compliance based upon the historical data and reasonable assumptions about the variability of contaminant levels between SEPs. The department must make a written finding indicating how the data conforms to these requirements in order for the data to satisfy the initial monitoring requirements.

(4) Reduced monitoring. The department may allow a CWS to reduce the future monitoring frequency from once every three years to once every six or nine years at each SEP, based on the following criteria. The samples collected during the reduced monitoring period must be used to determine the monitoring frequency for subsequent monitoring periods. If a system has a monitoring result that exceeds an MCL while on reduced monitoring, the system must collect and analyze quarterly samples at that SEP until it has results from four consecutive quarters that are below the MCL unless it enters into another schedule as part of a formal compliance agreement with the department.

1. Nine-year frequency. If the average of the initial monitoring results for each contaminant is below the radionuclide detection limits specified in this subrule, a system must collect and analyze for that contaminant using at least one sample at that SEP every nine years.

2. Six-year frequency. If the average of the initial monitoring results for gross alpha particle activity, uranium, and combined radium-226 and radium-228 is at or above the detection limit and at or below half the MCL for a contaminant, a system must collect and analyze for that contaminant using at least one sample at that SEP every six years. The analytical results for radium-226 and radium-228 must be added together to yield the combined result.

3. Three-year frequency. If the average of the initial monitoring results for gross alpha particle activity, uranium, and combined radium-226 and radium-228 is above half of the MCL and at or below the MCL for a contaminant, a system must collect and analyze for that contaminant using at least one sample at that SEP every three years. The analytical results for radium-226 and radium-228 must be added together to yield the combined result.

(5) Composite samples. To fulfill quarterly monitoring requirements for gross alpha particle activity, radium-226, radium-228, or uranium, a system may composite up to four consecutive quarterly samples from a single entry point if analysis is done within one year of the first sample. The analytical results from the composited samples will be considered by the department as the average analytical result to determine MCL compliance and to determine the future monitoring frequency. If the analytical result from the

composited sample is greater than half of the MCL, the department may require additional quarterly samples from the system before the system will be allowed to sample under a reduced monitoring schedule.

(6) Data substitution using gross alpha particle activity results.

1. A gross alpha particle activity measurement may be substituted for the required uranium measurement provided that the measured gross alpha particle activity does not exceed 15 pCi/L.

2. The gross alpha particle activity measurement shall have a confidence interval of 95 percent (1.65 sigma, where sigma is the standard deviation of the net counting rate of the sample) for uranium. When a system uses a gross alpha particle activity measurement in lieu of a uranium measurement, the gross alpha particle activity analytical result will be used to determine the future monitoring frequency for uranium. If the gross alpha particle activity result is less than the detection limit, half the detection limit will be used to determine compliance and the future monitoring frequency.

*f. Monitoring requirements for beta particle and photon emitters.* To determine compliance with the radionuclide MCLs for beta particle and photon radioactivity, a system must monitor at a frequency specified in this paragraph.

(1) General.

1. Monitoring frequency and confirmation samples. The department may require more frequent monitoring than specified in this paragraph and may require confirmation samples at its discretion. The results of the initial and confirmation samples will be averaged for use in compliance determinations.

2. Monitoring period. Each PWS shall monitor during the time period designated by the department in the operation permit.

(2) Systems designated by the department as vulnerable to man-made radioactivity.

1. Initial monitoring. Systems that have been determined by the department to be vulnerable to man-made radioactivity must collect quarterly samples for beta emitters and annual samples for tritium and strontium-90 at each SEP, beginning within one quarter after being notified by the department of this requirement. Systems already required to conduct beta particle and photon radioactivity monitoring must continue to sample until the department removes the monitoring requirement.

2. Reduced monitoring. The department may reduce the monitoring frequency at that sampling point to once every three years, if the gross beta particle activity minus the naturally occurring potassium-40 beta particle activity at an SEP has an RAA (computed quarterly) of less than or equal to 50 pCi/L (screening level). Systems must collect all of the samples required in "1" of this subparagraph during the reduced monitoring period.

3. Data substitution. For a system in the vicinity of a nuclear facility, the department may allow the system to utilize environmental surveillance data collected by the nuclear facility in lieu of monitoring at its SEP(s), where the department determines such data is applicable. In the event that there is a release from a nuclear facility, systems using surveillance data must begin monitoring at its SEP(s) in accordance with this subparagraph.

(3) Systems determined to utilize waters contaminated by effluents from nuclear facilities.

1. Initial monitoring. Systems designated by the department as utilizing water contaminated by effluents from nuclear facilities must sample for beta particle and photon radioactivity. Systems must collect quarterly samples for beta emitters and iodine-131 and annual samples for tritium and strontium-90 at each SEP, beginning within one quarter after department notification. Systems already designated by the department as systems using waters contaminated by effluents from nuclear facilities must continue to sample until the department removes the sampling requirement.

- Gross beta particle activity. Quarterly monitoring for gross beta particle activity shall be based on the analysis of monthly samples or the analysis of a composite of three monthly samples. The former is recommended.

- Iodine-131. A composite of five consecutive daily samples shall be analyzed once each quarter for iodine-131. The department may require more frequent monitoring when iodine-131 is identified in the finished water.

- Strontium-90 and tritium. Annual monitoring for strontium-90 and tritium shall be conducted either by analyzing a composite of four consecutive quarterly samples or by analyzing four quarterly samples. The latter is recommended.

2. Reduced monitoring. If the gross beta particle activity minus the naturally occurring potassium-40 beta particle activity at a sampling point has an RAA (computed quarterly) less than or equal to 15 pCi/L (screening level), the department may reduce the monitoring frequency at that sampling point to every three years. Systems must collect all samples required in this subparagraph during the reduced monitoring period.

3. Data substitution. For systems in the vicinity of a nuclear facility, the department may allow a CWS to utilize environmental surveillance data collected by the nuclear facility in lieu of monitoring at the system's entry point(s), where the department determines such data is applicable. In the event that there is a release from a nuclear facility, systems that are using surveillance data must begin monitoring at the CWS SEP in accordance with 41.8(1) "f"(2) "1."

(4) Monitoring frequency waiver. A CWS designated by the department to monitor for beta particle and photon radioactivity cannot apply to the department for a waiver from the monitoring frequencies in 41.8(1) "f"(2) or (3).

(5) CWSs may analyze for naturally occurring potassium-40 beta particle activity from the same or an equivalent sample used for the gross beta particle activity analysis. Systems are allowed to subtract the potassium-40 beta particle activity value from the total gross beta particle activity value to determine if the screening level is exceeded. The potassium-40 beta particle activity must be calculated by multiplying elemental potassium concentrations (in mg/L) by a factor of 0.82.

(6) If the gross beta particle activity minus the naturally occurring potassium-40 beta particle activity exceeds the appropriate screening level, a sample analysis must be performed to identify the major radioactive constituents present in the sample, and the appropriate doses must be calculated and summed to determine compliance with 41.8(1) "b"(2) "1," using the formula in 41.8(1) "b"(2) "2." Doses must also be calculated and summed for measured levels of tritium and strontium to determine compliance.

(7) Monitoring after an MCL violation. Systems must monitor monthly at the sampling point(s) that exceed the MCL in 41.8(1) "b"(2) beginning the month after the exceedance occurs. Systems must continue monthly monitoring until a system has established, by a rolling average of three monthly samples, that the MCL is being met. Systems that establish that the MCL is being met must return to quarterly monitoring until they meet the requirements of 41.8(1) "f"(2) or 41.8(1) "f"(3) "2."

**41.8(2)** Reserved.

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