567—41.9(455B) Sampling and analytical requirements for radionuclides.

41.9(1) *Analytical methods for radioactivity.*

a. Radionuclide analytical methodology. Analysis for the following contaminants shall be conducted to determine compliance with 41.8(1) in accordance with the methods in the following table, or their equivalent as determined by EPA.

RADIONUCLIDE ANALYTICAL METHODOLOGY

Contaminant	Methodology	Reference (method or page number)								
		EPA[1]	EPA[2]	EPA[3]	EPA[4]	SM[5]	ASTM[6]	USGS[7]	DOE[6]	
Naturally occurring:										
Gross alpha[11] & beta	Evaporation	900.0	p. 1	00-01	p. 1	302, 7110B		R-1120-76		
Gross alpha[11]	Co-precipitation			00-02		7110C				
Radium 226	Radon emanation	903.1	p. 16	Ra-04	p. 19	7500-Ra C	D 3454-91	R-1141-76	Ra-05	N
	Radiochemical	903.0	p. 13	Ra-03		304, 305, 7500-Ra B	D 2460-90	R-1140-76		
Radium 228	Radiochemical	904.0	p. 24	Ra-05	p. 19	304, 7500-Ra D		R-1142-76		N N
Uranium[12]	Radiochemical	908.0				7500-U B				
	Fluorometric	908.1				7500-U C[13]	D 2907-91	R-1180-76 R-1181-76	U-04	
	Alpha spectrometry			00-07	p. 33	7500-U C[14]	D 3972-90	R-1182-76	U-02	
	Laser phosphorimetry						D 5174-91			
Man-made:										
Radioactive Cesium	Radiochemical	901.0	p. 4			7500-Cs B	D 2459-72	R-1111-76		
	Gamma ray spectrometry	901.1			p. 92	7120[15]	D 3649-91	R-1110-76	4.5.2.3	
Radioactive Iodine	Radiochemical	902.0	p. 6 p. 9			7500-I B 7500-I C 7500-I D	D 3649-91			
	Gamma ray spectrometry	901.1			p. 92	7120[15]	D 4785-88		4.5.2.3	
Radioactive Strontium 89, 90	Radiochemical	905.0	p. 29	Sr-04	p. 65	303, 7500-Sr B		R-1160-76	Sr-01 Sr-02	
Tritium	Liquid scintillation	906.0	p. 34	H-02	p. 87	306, 7500-3H B	D 4107-91	R-1171-76		
Gamma emitters	Gamma ray spectrometry	901.1 902.0 901.0			p. 92	7120[15] 7500-Cs B 7500-I B	D 3649-91 D 4785-88	R-1110-76	4.5.2.3	

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, effective April 4, 1997. Copies of the documents may be obtained from the sources listed below. Contact the Safe Drinking Water Hotline at (800)426-4791 to obtain information about these documents. Documents may be inspected at EPA's Drinking Water Docket, 401 M Street SW, Washington, DC 20460 (telephone (202)260-3027); or at the Office of Federal Register, 800 North Capitol Street NW, Suite 700, Washington, DC.

[1] "Prescribed Procedures for Measurement of Radioactivity in Drinking Water," EPA 600/4-80-032, August 1980. Available at the US Department of Commerce, NTIS, 5285 Port Royal Road, Springfield, VA 22161 (telephone (800)553-6847) PB 80-224744.

[2] "Interim Radiochemical Methodology for Drinking Water," EPA 600/4-75-008(revised), March 1976. Available at NTIS, ibid. PB 253258.

[3] "Radiochemistry Procedures Manual," EPA 520/5-84-006, December 1987. Available at NTIS, ibid. PB 84-215581.

[4] "Radiochemical Analytical Procedures for Analysis of Environmental Samples." March 1979. Available at NTIS, ibid. EMSL LV 053917.

[5] Standard Methods for the Examination of Water and Wastewater, 13th, 17th, 18th, 19th editions, 1971, 1989, 1992, 1995. Available at American Public Health Association, 1015 Fifteenth Street NW, Washington, DC 20005. All methods are in the 17th, 18th, and 19th editions except 7500-U C Fluorimetric Uranium was discontinued after the 17th edition; 7120 Gamma Emitters is only in the 19th edition; and 302, 303, 304, 305, and 306 are only in the 13th edition.

[6] Annual Book of ASTM Standards, Vol. 11.02, 1994. Available at American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428.
[7] "Methods for Determination of Radioactive Substances in Water and Fluvial Sediments," Chapter A5 in Book 5 of Techniques of Water-Resources Investigations of the United States Geological Survey, 1977. Available at US Geological Survey (USGS) Information Services, Box 25286, Federal Center, Denver, CO 80225-0425.
[8] "EML Procedures Manual," 27th edition, Volume 1, 1990. Available at the Environmental Measurements Laboratory, US Department of Energy (DOE), 376 Hudson Street, New York, NY 10014-3621.
[9] "Determination of Ra-226 and Ra-228 (Ra-02)," January 1980, revised June 1982. Available at Radiological Sciences Institute Center for Laboratories and Research, New York State Department of Health, Empire State Plaza, Albany, NY 12201.
[10] "Determination of Ra-228 in Drinking Water," August 1980. Available at 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.
[11] 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.
[12] If uranium (U) is determined by mass, a 0.67 pCi/ug 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.
[13] Standard Methods for the Examination of Water and Wastewater, 17th edition, APHA, 1989.
[14] Standard Methods for the Examination of Water and Wastewater, 18th or 19th edition, APHA, 1992, 1995.
[15] Standard Methods for the Examination of Water and Wastewater, 19th edition, APHA, 1995.

b. Method references for other radionuclides. When the identification and measurement of radionuclides other than those listed in 41.9(2) are required, the following references are to be used, except in cases where alternative methods have been approved in accordance with 41.12(455B).

(1) "Procedures for Radiochemical Analysis of Nuclear Reactor Aqueous Solutions," H. L. Krieger and S. Gold, EPA-R4-73-014, Environmental Protection Agency, 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).

c. Radionuclide detection limits. For the purpose of monitoring 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 41.8(1)*"a,"* the detection limit shall not exceed 1 pCi/L. To determine compliance with 41.8(1)*"b,"* the detection limit shall not exceed 3 pCi/L.

(2) To determine compliance with 41.8(2), the detection limits shall not exceed the concentrations listed in the table below.

TABLE — Detection Limits for Man-Made Beta Particle and Photon Emitters

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

d. Calculating compliance with radionuclide MCLs. To determine compliance with the maximum contaminant levels listed in 41.8(1) and 41.8(2), averages of data shall be used and shall be rounded to the same number of significant figures as the maximum contaminant level for the substance in question.

41.9(2) *Monitoring frequency for radioactivity in community water systems.*

a. Monitoring requirements for gross alpha particle activity, radium-226 and radium-228.

(1) Initial monitoring requirement and period. Initial sampling to determine compliance with 41.8(1) shall begin by June 24, 1979, and the analysis shall be completed by June 24, 1980. Compliance shall be based on the analysis of an annual composite of four consecutive quarterly samples or the average of the analyses of four samples obtained at quarterly intervals.

A gross alpha particle activity measurement may be substituted for the required radium-226 and radium-228 analysis, provided that the measured gross alpha particle activity does not exceed 5 pCi/L at a confidence level of 95 percent (1.65 sigma where sigma is the standard deviation of the net counting rate of the sample). In localities where radium-228 may be present in drinking water,radium-226 or radium-228 analyses are required when the gross alpha particle activity exceeds 2 pCi/L.

When the gross alpha particle activity exceeds 5 pCi/L, the same or an equivalent sample shall be analyzed for radium-226. If the concentration of radium-226 exceeds 3 pCi/L, the same or an equivalent sample shall be analyzed for radium-228.

(2) Data substitution for initial requirement. For the initial analysis required by 41.9(2)*"a"*(1), data acquired on or after June 24, 1976, may be substituted at the discretion of the department.

(3) Monitoring requirements. Suppliers of water shall monitor at least once every four years following the procedure required by 41.9(2)*"a"*(1). At the discretion of the department, when an annual record taken in conformance with 41.9(2)*"a"*(1) has established that the average annual concentration is less than half the maximum contaminant levels established by 41.8(1), analysis of a single sample may be substituted for the quarterly sampling procedure required by 41.9(2)*"a"*(1).

More frequent monitoring shall be conducted when requested by the department in the vicinity of mining or other operations which may contribute alpha particle radioactivity to either surface or groundwater sources of drinking water.

A supplier of water shall monitor in conformance with 41.9(2)*"a"*(1) within one year of the introduction of a new water source for a community water system. More frequent monitoring shall be conducted when requested by the department in the event of possible contamination or when changes in the distribution system or treatment processing occur which may increase the concentration of radioactivity in finished water.

A community water system using two or more sources having different concentrations of radioactivity shall monitor source water, in addition to water from a free-flowing tap, when requested by the department.

Monitoring for compliance with 41.8(1) after the initial period need not include radium-228 except when required by the department, provided that the average annual concentration of radium-228 has been assayed at least once using the quarterly sampling procedure required by 41.9(2)*"a"*(1).

Suppliers of water shall conduct annual monitoring of any community water system in which the radium-226 concentration exceeds 3 pCi/L, when requested by the department.

(4) Exceedance of the MCL. If the average annual maximum contaminant level for gross alpha particle activity or total radium as set forth in 41.8(1) is exceeded, the supplier of a community water system shall notify the public as required by 567—42.1(455B). Monitoring at quarterly intervals shall be continued until the annual average concentration no longer exceeds the maximum contaminant level or until a monitoring schedule as a condition of an operation permit or enforcement action shall become effective.

b. Monitoring requirements for man-made radioactivity in community water systems.

(1) Applicability and initial monitoring requirements. Systems using surface water sources and serving more than 100,000 persons and such other community water systems as are designated by the department shall be monitored for compliance with 41.8(2) by analysis of a composite of four consecutive quarterly samples. Compliance with 41.8(2) may be assumed without further analysis if the average annual concentration of gross beta particle activity is less than 50 pCi/L and if the average annual concentrations of tritium and strontium-90 are less than those listed in the detection limits table, provided, that if both radionuclides are present, the sum of their annual dose equivalents to bone marrow shall not exceed 4 millirem/year.

If the gross beta particle activity exceeds 50 pCi/L, an analysis of the sample must be performed to identify the major radioactive constituents present, and the appropriate organ and total body doses shall be calculated to determine compliance with 41.8(2).

Suppliers of water shall conduct additional monitoring, as requested by the department, to determine the concentration of man-made radioactivity in principal watersheds designated by the department.

At the discretion of the department, suppliers of water utilizing only groundwaters may be required to monitor for man-made radioactivity.

(2) Data substitution for initial requirement. For the initial analysis required by 41.9(2)*"b"*(1), data acquired on or after June 24, 1976, may be substituted at the discretion of the department.

(3) Monitoring requirement. After the initial analysis required by 41.9(2)*"b"*(1), suppliers of water shall monitor at least every four years following the procedure given in 41.9(2)*"b"*(2).

(4) Monitoring requirements for PWSs receiving effluent from nuclear facilities. The supplier of any community water system designated by the department as utilizing water contaminated by effluents from nuclear facilities shall initiate quarterly monitoring for gross beta particle and iodine-131 radioactivity and annual monitoring for strontium-90 and tritium.

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. If the gross beta particle activity in a sample exceeds 15 pCi/L, the same or an equivalent sample shall be analyzed for strontium-89 and cesium-134. If the gross beta particle activity exceeds 50 pCi/L, an analysis of the sample must be performed to identify the major radioactive constituents present and the appropriate organ and total body doses shall be calculated to determine compliance with 41.8(2).

For iodine-131, a composite of five consecutive daily samples shall be analyzed once each quarter. As requested by the department, more frequent monitoring shall be conducted when iodine-131 is identified in the finished water.

Annual monitoring for strontium-90 and tritium shall be conducted by means of the analysis of a composite of four consecutive quarterly samples or analysis of four quarterly samples. The latter procedure is recommended.

The department may allow the substitution of environmental surveillance data taken in conjunction with a nuclear facility for direct monitoring of man-made radioactivity by the supplier of water where the department determines such data is applicable to a particular community water system.

(5) Exceedance of the MCL. If the average annual maximum contaminant level for man-made radioactivity set forth in 41.8(2) is exceeded, the operator of a community water system shall give notice to the public as required by 567—42.1(455B). Monitoring at monthly intervals shall be continued until the concentration no longer exceeds the maximum contaminant level or until a monitoring schedule as a condition of an operation permit or enforcement action becomes effective.