United States
Environmental Protection
Agency

Office of Water
WH-550

EPA

Radionuclides in Drinking Water

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National Primary Drinking Water Regulations for Radionuclides

Proposed Rule

June 1991

Office of Ground Water and Drinking Water
U.S. Environmental Protection Agency
Washington, DC

SUMMARY

These regulations will:

Propose Maximum Contaminant Level Goals (MCLGs) and Maximum Contaminant Levels (MCLs) for four radionuclide contaminants and two categories of radionuclides.

- The four radionuclide contaminants are: radium-226, radium-228, radon-222, and uranium.
- The two categories of radionuclides are adjusted gross alpha emitters, and beta and photon emitters.
  - The category of adjusted gross alpha emitters regulates alpha emitters and is gross alpha measurement less uranium and less radium-226.
  - The category of beta and photon emitters regulates total beta and photon emitters (mostly man-made).

When this proposed rulemaking is final:

- These rules will establish
  - Four revised radionuclide standards; and
  - Two new radionuclide standards (radon and uranium) for a total of six.

These proposed rules also include additional provisions for:

- Monitoring, analytic methods and laboratory requirements;
- Best Available Technologies (BATs) for compliance with the MCLs and for the purpose of issuing variances:
  - aeration
  - reverse osmosis
  - anion exchange
  - ion exchange
  - coagulation/filtration
- Mandatory health effects language to be used by systems when notifying the public of violations;
- State reporting, recordkeeping and primacy requirements; and
- Unregulated contaminant monitoring for lead-210, the first long-lived progeny of radon-222.

EPA is seeking comment from the public in this proposed rulemaking on:

- A number of alternative MCLs for radon, uranium, and radium; and
- A variety of technical and policy issues.

Key Dates	
June 1991	Standards for 4 radionuclide contaminants and 2 categories of radionuclides proposed
September 1991	Public hearings in Washington, D.C. and Chicago, IL
September 1991 (approximate)	Close of public comment period (90 days after Federal Register publication)
April 1993 (22 months after proposal)	Standards for 4 radionuclide contaminants and 2 categories of radionuclides promulgated
October 1994 (18 months after promulgation)	• Standards for 4 radionuclide contaminants and 2 categories of radionuclides effective • State adoption complete
January 1996	First monitoring compliance period begins

Regulatory Impact

As proposed, these regulations, when implemented, will reduce the exposure of 20 million consumers to the regulated contaminants and result in avoidance of an estimated 83 cancer cases per year.

- This includes:
  - Avoidance of an estimated 80 cancer cases per year due to reduced radon exposure of an estimated 17 million customers of public water systems served by ground-water sources;
  - Avoidance of an estimated 3 cancer cases per year due to radium; and
  - Reduced exposure of approximately 875,000 people to kidney toxicity risk.
- Regulation of radon is expected to result in the most violations, increased cost to public water systems, and provide the greatest health benefits.

National Costs of Proposed Radionuclide MCLs

	Rn-222	Ra-226	Ra-228	Uranium	AGA*	Beta Emitters	TOTAL
Proposed MCL**	300	20	20	20***	15	4****	
Systems Affected	26,000	70	40	1,500	130	0	28,000
Treatment Cost							
Total Capital ($M)	1,600	190	40	350	230	0	2,400
Annual O&M ($M)	70	20	3	30	20	0	140
Total Annual Cost ($M)	180	30	6	60	40	0	310
Monitoring ($K/Yr)***	5,000	3	860	3	640	250	6,800
State Implementation							
Initial ($M)	---------- NA ----------						15-28
Annual ($M)	---------- NA ----------						10-19
Annual Household Cost by System Size							
Very Small (25-500)	120	630	650	580	770	0	
Small (501-3,300)	30	150	150	180	340	0	
Medium (3,301-10,000)	6	90	90	80	200	0	
Large (over 10,000)	5	60	60	40	140	0	

** Adjusted Gross Alpha.*

*** MCLs are expressed in pCi/L unless otherwise noted.*

**** MCL for Uranium is expressed in µg/L.*

***** MCL for Beta Emitters is expressed in millirems effective dose equivalent per year (mrem ede/yr).*

****** Gross Alpha is used as a screen for Radium-226 and uranium.*

Total Costs

- Total costs to all public water systems will be approximately $317 million per year. Approximately 75% of these costs will be borne by systems serving fewer than 10,000 people.

- State implementation costs will be $15-28 million initially and $10-19 million in future years.

Monitoring and Treatment

- Monitoring requirements will be standardized, with monitoring required every three, six, or nine years depending on the system's vulnerability to the particular contaminant.

- Nationally, it will cost approximately $7 million per year for systems to monitor.

- Nationally, monitoring for lead-210 will cost systems an addition $8 million one-time cost.

- Monitoring for radionuclides will be required for approximately 80,000 systems.

  Ground Water

  - Approximately 68,000 community and non-transient non-community public water systems with ground-water or mixed surface and ground-water sources must monitor for radon, radium-226, radium-228, uranium, and adjusted gross alpha emitters. Vulnerable systems also must monitor for beta and photon emitters.

  Surface Water

  - Approximately 12,000 community systems and non-transient non-community public water systems with surface water sources must monitor for radium-226, radium-228, uranium, and adjusted gross alpha emitters. Vulnerable systems also must monitor for beta and photon emitters.

- Nationally, approximately 28,000 or 35% of affected public water systems will be required to provide treatment or find an alternative source of water.

  - Treatment will cost approximately $3 to $800 per household annually depending upon system size, degree of contamination, and other factors.

  - It will cost systems $310 million per year to provide treatment.

  - At State's option, extendable exemptions based on costs may be allowed for systems with less than 500 service connections, as long as the level does not exceed unreasonable risk to health and alternative sources are not feasible.

Radionuclide National Primary Drinking Water Regulations

Contaminants	Drinking Water Health Effects	EPA Standards: Proposed MCLG	EPA Standards: Proposed MCL[1]	EPA Standards: Current MCL	Sources	Analytic Method	BAT[2]
Radium-226	cancer	zero	20 pCi/l	5 pCi/l combined with radium-228	naturally occurring	RE; RC	IE; LS; RO
Radium-228	cancer	zero	20 pCi/l	5 pCi/l combined with radium-226	naturally occurring	RC; LS	IE; LS; RO
Radon-222	cancer	zero	300 pCi/l	-	naturally occurring	LS; LC	AER
Uranium	kidney, cancer	zero	20 µg/l[3]	-	naturally occurring	RC; FL; AS	C/F; AE; LS; RO[4]
Adjusted gross alpha emitters	cancer	zero	15 pCi/l	15 pCi/l	naturally occurring and man-made	GA/B; GA	RO
Gross beta and photon emitters	cancer	zero	4 mrem ede/yr	4 mrem/yr any organ or whole body	man-made and naturally occurring		IE; RO
- radioactive cesium						PREC	
- radioactive iodine						PREC	
- radioactive strontium 89.90						PREC; RC	
- tilium						LS	
- gamma and photon emitters						GRS	

Analytic Methods Key:

RE	= Radon Emanation
RC	= Radiochemical
LS	= Liquid Scintilation
LC	= Lucas Cell
FL	= Fluorometric
AS	= Alpha Spectrometry
GA/B	= Gross alpha and/or beta activity
GA	= Gross alpha activity
PREC	= Precipitation
GRA	= Gamma Ray Spectrometry

Best Available Technology Key:

IE	= Ion Exchange
LS	= Lime Softening
RO	= Reverse Osmosis
AER	= Aeration
C/F	= Coagulation/Filtration
AE	= Anion Exchange

[1]pCi/l is an activity measurement of radioactive decay (1 pCi = 2.2 disintegrations per minute); µg/l is a mass measurement; mrem is measurement of effective radiation dose to organs).
[2]Except as noted, BAT for the purpose of issuing variances is the same as BAT for compliance.
[3]20 µg/l is based on kidney toxicity. 20 µg/l is the equivalent of 30 pCi/l.
[4]Coagulation/Filtration and Lime Softening are not BAT for small systems (those with less than 500 connections) for the purpose of granting variances.

Summary of Minimum Monitoring Frequencies for Radionuclides

Calendar Year [1]	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Framework Divisions	First 9-year cycle									Second 9-year cycle		
	Monitor for Current MCLs			Initial Period			Repeat period			Repeat period		
Base Monitoring Requirements [4] — *Gross Beta, H^3, SR-90 — GW/SW_2	New Monitoring Requirements Not Yet In Effect			4	4	4	4	4	4	4	4	4
				1	1	1	1	1	1	1	1	1
Radon — GW	New Monitoring Requirements Not Yet In Effect			4	1	1	1	1	1	1	1	1
Radon — GW/SW Waiver [3]				4	1	1	1			1		
**Gross Alpha, Ra-226, Ra-228, Uranium — GW/SW	New Monitoring Requirements Not Yet In Effect			1	1	1	1			1		
**Gross Alpha, Ra-226, Ra-228, Uranium — GW/SW Waiver [3]				1	1	1	State Discretion			1 / cycle		

1 Calendar to be adjusted to date of final regulations.
2 Vulnerable systems only (based on Vulnerability Assessment).
3 Waiver based on monitoring results.
4 Numbers shown in each monitoring period refer to number of samples per sampling point per year.
* Gross Beta is a screen for Ra-228 and an MCL standard.
** Gross Alpha is a screen for Ra-226 and uranium, and an MCL standard.

Summary of Proposed Monitoring Requirements for Radionuclides

Contaminant	Base Requirements		System is out of compliance IF:	Increased Frequency Triggered by Non-compliance	Waiver Conditions	Reduced Frequency (with waiver)
	Initial	Repeat				
Gross Beta* (Vulnerable systems)	Quarterly	Quarterly	Average of 1 sample + 1 mandatory confirmation sample > MCL	Monthly if out of compliance. Return to base when 3 mo. < MCL	None	None
Tritium, Strontium-90	Annually	Annually				
Radon - GW	YR . 1 - INITIAL PERIOD	Annually	YR . 1 - INITIAL PERIOD	YR . 1 - INITIAL PERIOD	State Discretion; Consistently Meeting MCL	Waiver reduces to 1 per 3-year period
	Quarterly		Annual average of quarterly samples > MCL	Continue quarterly if out of compliance. Annually when average of 4 quarters < MCL		
	YRS 2 & 3 - INIT. PER.		ALL OTHER YEARS	ALL OTHER YEARS		
	Annually		1 sample > MCL	Quarterly if out of compliance. Return to annually when average of 4 quarters < MCL		
Gross Alpha** Ra-226, Ra-228, Uranium (Compositing is permitted)	GW/SW- Annually	GW/SW - 1 per 3-year period	Average of 1 sample + 1 mandatory confirmation sample > MCL	GW/SW - Annually if out of compliance. Return to 1 per 3-year period when 3 years < MCL	State Discretion; Consistently Meeting MCL	Waiver reduces to 1 per 9-year period
Unregulated Contaminant Pb-210	One Sample	N/A	N/A	N/A	N/A	N/A

* Gross beta is a screen for Ra-228 and an MCL standard.

** Gross alpha is a screen for Ra-226 and uranium, and an MCL standard.

Radon in Water

The proposed radon regulation will provide a substantial public health benefit compared with other drinking water regulations and other environmental regulatory programs administered by EPA.

- The regulation will reduce the exposure to radon of 17 million consumers whose household water comes from a public water system served by ground-water sources.

- The regulation, when implemented, may result in an estimated avoidance of about 80 cancer cases per year.

Radon comes from the natural break-down of uranium in soil, rock and water.

- Radon is a volatile gas and is not a problem in drinking water from surface water sources.

- Radon may be present in drinking water from ground-water sources.

  - Public water supplies with ground-water or mixed ground and surface water sources would be required to monitor for radon and to provide treatment or find an alternative source of water if the radon MCL is exceeded.

  - Radon also may be present in drinking water from private wells not regulated by EPA.

The primary health hazard comes from breathing air containing radon.

- Breathing air containing radon can damage lung tissue and increase the risk of lung cancer.

  - Radon in water generally accounts for about 5% of the total indoor air concentration in homes with ground-water sources of drinking water.

  - EPA estimates that indoor radon may result in 8,000-40,000 lung cancer deaths annually.

  - The higher the level of radon, the greater the risk of developing lung cancer.

  - Smokers exposed to radon may have up to ten times the risk of contracting lung cancer as never-smokers exposed to the same radon levels.

- Radon present in drinking water is released into indoor air during household water use such as showering and washing clothes.

- As an average, every 10,000 pCi/l radon in water contributes about 1 pCi/l radon to indoor air for an average house.

- On average, outdoor levels of radon range from 0.2 pCi/l to 0.7 pCi/l.

- Drinking water contaminated with radon may add some minor risk of developing stomach or other internal organ cancer. This risk is small compared to the risks from breathing indoor air containing radon.

EPA is taking action to protect public health from radon in air and radon in water to the highest degree possible, given existing mitigation technologies.

- Central water treatment for radon by public water systems is affordable and technologically feasible. Under the Safe Drinking Water Act, EPA is proposing to regulate radon at a level public water systems can achieve—300 pCi/l. Radon at this level contributes about 0.03 pCi/l of radon in air. This corresponds to an estimated lifetime cancer risk of approximately 2×10^{-4} (2 in 10,000) and is consistent with EPA's risk guidelines for regulating drinking water contaminants. This risk may vary for individuals.

- Concerning radon in air, EPA has proposed to keep its current action level of 4 pCi/l, corresponding to an estimated lifetime risk of $1\text{-}5 \times 10^{-2}$ (1-5 in 100) because the Agency believes that level can be achieved consistently and economically in homes, given current technology. The new *Citizen's Guide*, scheduled for publication in Fall 1991, also will provide information on testing methods to determine radon levels in homes.

All homes should be tested for radon in air.

- Most radon in household air comes from soil gas which seeps into the home through the foundation.

- Information about radon testing and mitigation of household air can be found in the following EPA publications:

  - *A Citizen's Guide to Radon: What It Is and What To Do About It*; and
  - *Radon Reduction Methods: A Homeowner's Guide.*

- Information about radon in air can be requested by calling 1-800-SOS-RADON or by contacting the State Radon office.

Some homes with private wells also should be tested for radon in water.

- After testing the air for radon and finding levels above EPA's current action guideline of 4 pCi/l, homeowners with private wells should consult with their State drinking water office to obtain information on laboratories to test for radon in water, and test the water. After testing, homeowners should select the mitigation strategy that is most cost-effective for reducing radon exposure for the individual home.

  - In the majority of cases, the appropriate mitigation strategy will be controlling the soil gas contribution to indoor air before treating the water to remove radon.

- If treatment of radon in private wells is appropriate, the most effective treatment is to remove the radon from the water before it enters the home. This is called point-of-entry (POE) treatment.

- Two basic types of POE water treatment are available.

  - **Aeration Systems**

    Forced air bubblers remove radon gas from the water.

  - **Granular Activated Carbon (GAC) Systems**

    Filters remove radon from the water. Homes with high levels of radon in water should not use GAC to remove radon.

- Treatment at the tap is called point-of-use (POU) treatment. POU treatment will fail to reduce the most important risk from radon in water, breathing radon in indoor air transferred from water.

- Information about radon in drinking water can be requested by calling the Safe Drinking Water Hotline (1-800-426-4791) or contacting the State Drinking Water Office.

FOR MORE INFORMATION ABOUT RADON IN INDOOR AIR

EPA Radon Information Hotline
☎ 1-800-SOS-RADON

EPA Regional Offices Radiation Program Managers

EPA Region 1
Pesticides and Toxic Substances Branch
JFK Federal Bldg., Rm. 2311
One Congress Street, 11th floor
Boston, MA 02203
(617) 565-4502

Connecticut, Massachusetts, Maine, New Hampshire, Rhode Island, Vermont

EPA Region 2
Air and Waste Management Division
26 Federal Plaza, Rm. 1137-L
New York, NY 10278
(212) 264-4110

New Jersey, New York, Puerto Rico, Virgin Islands

EPA Region 3
Air Programs Branch
Special Program Section
(3AM12)
841 Chestnut Street
Philadelphia, PA 19107
(215) 597-8320

Delaware, Maryland, Pennsylvania, Virginia, West Virginia, District of Columbia

EPA Region 4
Air, Pesticides, and Toxics Management Division
245 Courtland Street, NE
Atlanta, GA 30365
(404) 347-3907

Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee

EPA Region 5
Air Toxics and Radiation Branch
(5AR26)
Chicago, IL 60604
(312) 353-2206

Illinois, Indiana, Michigan, Minnesota, Ohio, Wisconsin

EPA Region 6
Air Enforcement Branch
(6T-E)
1445 Ross Avenue
Dallas, TX 75202-2733
(214) 655-7223

Arkansas, Louisiana, New Mexico, Oklahoma, Texas

EPA Region 7
Air Branch
726 Minnesota Avenue
Kansas City, KS 66101
(913) 551-7020

Iowa, Kansas, Missouri, Nebraska

EPA Region 8
Radiation Programs Branch
999 18th Street, Suite 500
Denver, CO 80202-2405
(303) 293-1709

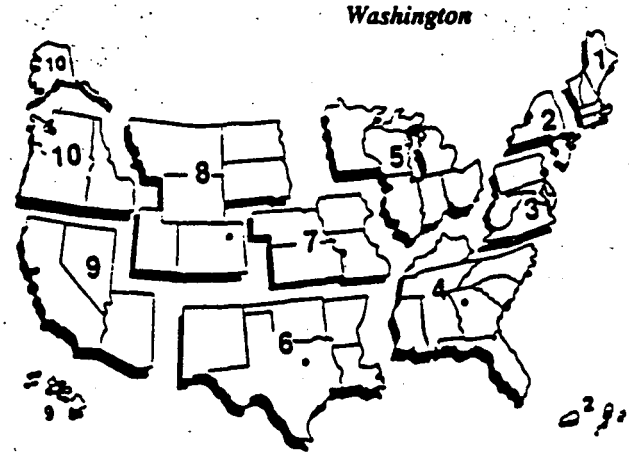
Colorado, Montana, North Dakota, Sourth Dakota, Utah, Wyoming

EPA Region 9
Office of Air Toxics and Radiation
(A1-1)
75 Hawthorne Street
San Francisco, CA 94105
(415) 744-1045

Arizona, California, Hawaii, Nevada, American Samoa, Guam, Trust Territories of the Pacific

EPA Region 10
Air Programs Branch
(AT-082)
1200 Sixth Avenue
Seattle, WA 98101
(206) 442-7660

Alaska, Idaho, Oregon, Washington



FOR MORE INFORMATION ABOUT RADIONUCLIDES AND RADON IN DRINKING WATER

EPA Regional Drinking Water Offices

EPA Region 1
Groundwater Management and Water Supply Branch
JFK Federal Bldg.
One Congress Street, 11th floor
Boston, MA 02203
(617) 565-3610

Connecticut, Massachusetts, Maine, New Hampshire, Rhode Island, Vermont

EPA Region 2
Drinking/Groundwater Protection Branch
26 Federal Plaza, Rm. 824
New York, NY 10278
(212) 264-1800

New Jersey, New York, Puerto Rico, Virgin Islands

EPA Region 3
Drinking/Groundwater Protection Branch
841 Chestnut Street
Philadelphia, PA 19107
(215) 597-8227

Delaware, Maryland, Pennsylvania, Virginia, West Virginia, District of Columbia

EPA Region 4
Municipal Facilities Branch
245 Courtland Street, NE
Atlanta, GA 30365
(404) 347-3633

Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee

EPA Region 5
Safe Drinking Water Branch
230 S. Dearborn Street
Chicago, IL 60604
(312) 353-2151

Illinois, Indiana, Michigan, Minnesota, Ohio, Wisconsin

EPA Region 6
Water Supply Branch
1445 Ross Avenue
Dallas, TX 75202
(214) 655-7155

Arkansas, Louisiana, New Mexico, Oklahoma, Texas

EPA Region 7
Drinking Water Branch
726 Minnesota Avenue
Kansas City, KS 66101
(913) 551-7032

Iowa, Kansas, Missouri, Nebraska

EPA Region 8
Drinking Water Branch
999 18th Street, Suite 1300
Denver, CO 80202-2413
(303) 293-1713

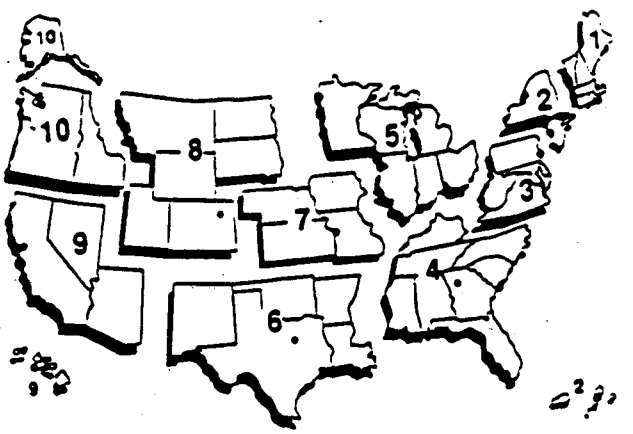
Colorado, Montana, North Dakota, Sourth Dakota, Utah, Wyoming

EPA Region 9
Drinking Water & Groundwater Protection Branch
75 Hawthorne Street
San Francisco, CA 94105
(415) 744-1818

Arizona, California, Hawaii, Nevada, American Samoa, Guam, Trust Territories of the Pacific

EPA Region 10
Drinking Water Branch
1200 Sixth Avenue
Seattle, WA 98101
(206) 442-1225

Alaska, Idaho, Oregon, Washington



EPA Safe Drinking Water Hotline
☎ 1-800-426-4791