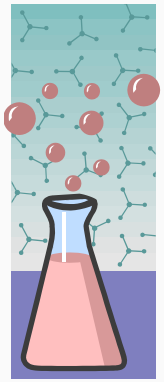
EPA Radionuclides Rule and the RadNet Program

Kelly Moran
(215) 814-2331
moran.kelly@epa.gov



What is a radionuclide (radioisotope)?

- element
  - any one of 100+ unique substances from which **all matter is comprised**; defined by the number of protons
  - examples: hydrogen, oxygen, nitrogen, carbon
- isotope
  - variant of an element with a different number of neutrons, but with the same number of protons
  - the number following the element indicates the mass number (protons + neutrons)
  - examples: radium-226, radium-228 (both have 88 protons but radium-226 has 138 neutrons and radium-228 has 140 neutrons)

What is a radionuclide (radioisotope)?

- isotopes are either stable or unstable
- unstable isotopes are radioactive
- unstable isotopes undergo radioactive decay to achieve stability
- one of three types of particles or radiation (alpha particles, beta particles and gamma rays) is emitted during each stage of decay
- radioisotopes can emit more than one kind of radiation, but are classified by the most dominant

Radioactive Decay Series

- examples of decay series:

Uranium-238

U-238 → **Ra-226** → **Rn-222** → **Po-210** → **Pb-206**

(α) (α) (α) (β) (stable)

Thorium-232

Th-232 → **Ra-228** → **Ra-224** → **Pb-208**

(α) (β) (α) (stable)

Radionuclides in the Environment

- natural sources
  - uranium and other deposits
- man-made sources
  - hospitals
  - research facilities
  - pharmaceutical companies
  - nuclear power plants
  - fallout from nuclear weapons testing
- uses
  - nuclear medicine
  - industry & mining
  - food preservation
  - household goods
  - geology, archaeology and paleontology

Radionuclides in the News

- Marcellus Shale
  - 400 million year old marine sedimentary rock
  - largely untapped natural gas reserves
  - environmental concerns around the drilling and extraction processes
  - releases of naturally occurring radioactive material to the environment
- Fukushima & I-131
  - 3/11/11 earthquake and tsunami
  - nuclear meltdowns
  - releases of radioactive isotopes (I-131)
  - largest nuclear accident since Chernobyl

Radionuclides Rule
Code of Federal Regulations

40 CFR

141.25 – analytical methods

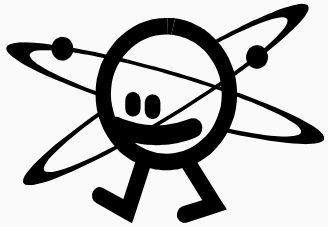
141.26 – monitoring frequency

141.55 -- MCLGs

141.66 – MCLs

142.16 – special primacy requirements

142.65 – variances and exemptions



EPA
United States
Environmental Protection
Agency

Radionuclides Rule: A Quick Reference Guide

Overview of the Rule

Title*	Radionuclides Rule 66 FR 76708 December 7, 2000 Vol. 65, No. 236
Purpose	Reducing the exposure to radionuclides in drinking water will reduce the risk of cancer. This rule will also improve public health protection by reducing exposure to all radionuclides.
General Description	The rule retains the existing MCLs for combined radium-226 and radium-228, gross alpha particle radioactivity, and beta particle and photon activity. The rule regulates uranium for the first time.
Utilities Covered	Community water systems, all size categories.

*This document provides a summary of federal drinking water requirements; to ensure full compliance, please consult the federal regulations at 40 CFR 141 and any approved state requirements.

Public Health Benefits

Implementation of the Radionuclides Rule will result in . . .	Reduced uranium exposure for 620,000 persons, protection from toxic kidney effects of uranium, and a reduced risk of cancer.
Estimated impacts of the Radionuclides Rule include . . .	Annual compliance costs of $87 million. Only 795 systems will have to install treatment.

Regulated Contaminants

Regulated Radionuclide	MCL	MCLG
Beta/photon emitters**	4 mrem/yr	0
Gross alpha particle	15 pCi/L	0
Combined radium-226/228	5 pCi/L	0
Uranium	30µg/L	0

**A total of 168 individual beta particle and photon emitters may be used to calculate compliance with the MCL.

Critical Deadlines & Requirements

For Drinking Water Systems	
June 2000 - December 8, 2003	When allowed by the State, data collected between these dates may be eligible for use as grandfathered data (excluding beta particle and photon emitters).
December 8, 2003	Systems begin initial monitoring under State-specified monitoring plan unless the State permits use of grandfathered data.
December 31, 2007	All systems must complete initial monitoring.
For States	
December 2000 - December 2003	States work with systems to establish monitoring schedules.
December 8, 2000	States should begin to update vulnerability assessments for beta/photon and particle emitters and notify systems of monitoring requirements.
Spring 2001	EPA meets and works with States to explain new rules and requirements and to initiate adoption and implementation activities.
December 8, 2002	States submit a primacy revision application to EPA. (EPA approves within 90 days.)

Quick Reference

	MCL [§141.66]	MCLG [§141.55]	DL [§141.25, Table B]	BAT [§141.66(g), Table B]
Gross α	15 pCi/L (excludes Rn & U; includes Ra-226)	0	3 pCi/L	RO
Ra-226	5 pCi/L	0	1 pCi/L	IE, RO, LS
Ra-228		0	1 pCi/L	
Uranium	30 μg/L	0	1 μg/L	IE, RO, LS, C/F
Gross β/ photon	4 mrem/yr	0	varies	IE, RO

RO = reverse osmosis; IE = ion exchange; LS = lime softening; C/F = coagulation/filtration

Radionuclides Rule Overview

- the Rule applies to all CWS
- sampling is to be performed at each entry point to the distribution system (EP)
- specifies MCLs for gross alpha, combined Ra-226/-228, uranium and beta/photon emitters
- provides public health protection by reducing exposure to natural and man-made radionuclides

Alpha Emitters
(gross α, Ra-226/-228 and U)

- initial monitoring
  - systems without historical data had to take 4 quarterly samples before 12/31/07
  - if initial monitoring samples are > MCL, quarterly monitoring is required until 4 consecutive quarters are < MCL

Alpha Emitters
(gross α, Ra-226/-228 and U)

- <u>reduced monitoring</u>
  - RAA BDL → sample every 9 years
  - DL ≤ RAA ≤ ½ MCL → sample every 6 years
  - ½ MCL < RAA ≤ MCL → sample every 3 years
- <u>increased monitoring</u>
  - RAA > MCL → quarterly sampling until 4 consecutive quarters are < MCL

Beta/Photon Emitters

(gross β, γ emitters, I-131, Sr-90 and tritium)

- man-made radionuclides
- no monitoring required for most CWS
- monitoring only required if designated by the State as “vulnerable” or “contaminated”
- “vulnerable” screening level = 50 pCi/L
- “contaminated” screening level = 15 pCi/L
- screening level = “level of concern”

Beta/Photon Emitters

(gross β, γ emitters, I-131, Sr-90 and tritium)

- <u>monitoring – “vulnerable” systems</u>
  - quarterly samples for gross β
  - annual samples for tritium and Sr-90
  - if the RAA of (gross β - K-40) ≤ 50 pCi/L → reduced monitoring (1 sample/3 years)
  - any exceedance triggers monthly monitoring until the 3-month running monthly average is < screening level (50 pCi/L)
  - exceedance of screening level requires analysis of individual radionuclides (speciate) and dose calculation for compliance with 4 mrem/yr MCL

Derived Concentrations (pCi/l) of Beta and Photon Emitters in Drinking Water

Yielding a Dose of 4 mrem/yr to the Total Body or to any Critical Organ as defined in NBS Handbook 69

Nuclide	pCi/l	Nuclide	pCi/l	Nuclide	pCi/l	Nuclide	pCi/l	Nuclide	pCi/l	Nuclide	pCi/l
H-3	20,000	Ni-65	300	Nb-95	300	Sb-124	80	Nd-147	200	Os-191	300
Be-7	6,000	Cu-64	900	Nb-97	3,000	Sb-125	300	Nd-149	300	Os-191m	9,000
C-14	2,000	Zn-65	300	Mo-99	600	Te-125m	800	Pm-147	800	Os-193	200
F-18	2,000	Zn-69	8,000	Tc-96	300	Te-127	900	Pm-149	100	Ir-189	300
Na-22	400	Zn-69m	900	Tc-96m	30,000	Te-127m	200	Sm-151	1,000	Ir-192	100
Na-24	500	Ga-72	100	Tc-97	6,000	Te-129	2,000	Sm-153	200	Ir-194	90
S-31	8,000	Ga-73	8,000	Tc-97m	1,000	Te-129m	90	Eu-152	200	Pt-191	300
P-32	30	As-73	1,000	Tc-99	900	Te-131m	200	Eu-154	80	Pt-193	3,000
S-35 inorg	500	As-74	100	Tc-99m	20,000	Te-132	90	Eu-155	600	Pt-193m	3,000
Cl-36	700	As-76	80	Ru-97	1,000	I-126	3	Gd-153	600	Pt-197	300
Cl-38	1,000	As-77	200	Ru-103	200	I-129	1	Gd-159	200	Pt-197m	3,000
K-42	900	Se-75	300	Ru-105	200	I-131	3	Tb-160	100	Au-198	600
Ca-45	10	Br-82	100	Ru-106	30	I-132	90	Dy-165	1,000	Au-199	600
Ca-47	80	Rb-86	600	Rh-103 m	30,000	I-133	10	Dy-166	100	Hg-197	800
Sc-46	100	Rb-87	300	Rh-105	300	I-134	100	Ho-166	90	Hg-197m	600
Sc-47	300	Sr-85 m	20 000	Pd-103	900	I-135	30	Er-169	300	Hg-203	60
Sc-48	80	Sr-85	900	Pd-109	300	Cs-131	20,000	Er-171	300	Tl-200	1,000
V-48	30	Sr-89	20	Ag-105	300	Cs-134	80	Tm-170	100	Tl-201	900
Cr-51	6,000	Sr-90	8	Ag-110m	60	Cs-134m	20,000	Tm-171	1,000	Tl-202	300
Mn-52	90	Sr-91	200	Ag-111	100	Cs-136	900	Yb-175	300	Tl-204	300
Mn-54	300	Sr-92	200	Cd-109	600	Cs-137	200	Lu-177	300	Pb-203	1,000
Mn-56	300	Y-90	60	Cd-115	80	Ba-131	600	Ta-182	100	Bi-206	100
Fe-55	2,000	Y-91	80	Cd-115m	80	Ba-140	90	W-181	1,000	Bi-207	200
Fe-59	200	Y-91m	9,000	In-113m	3,000	La-140	60	W-185	300	Pa-230	600
Co-57	1,000	Y-92	200	In-114m	60	Ce-141	300	W-187	200	Pa-233	300
Co-58	300	Y-93	90	In-115	300	Ce-143	100	Re-186	300	Np-239	300
Co-58m	9000	Zr-93	2,000	In-115m	1,000	Ce-144	90	Re-187	9,000	Pu-241	300
Co-60	100	Zr-95	200	Sn-113	300	Pr-142	90	Re-188	200	Bk-249	2,000
Ni-59	300	Zr-97	60	Sn-126	60	Pr-143	100	Os-185	200		
Ni-63	90	Nb-93m	1,000	Sb-122	90						

13

Beta/Photon Emitters

(gross β, γ emitters, I-131, Sr-90 and tritium)

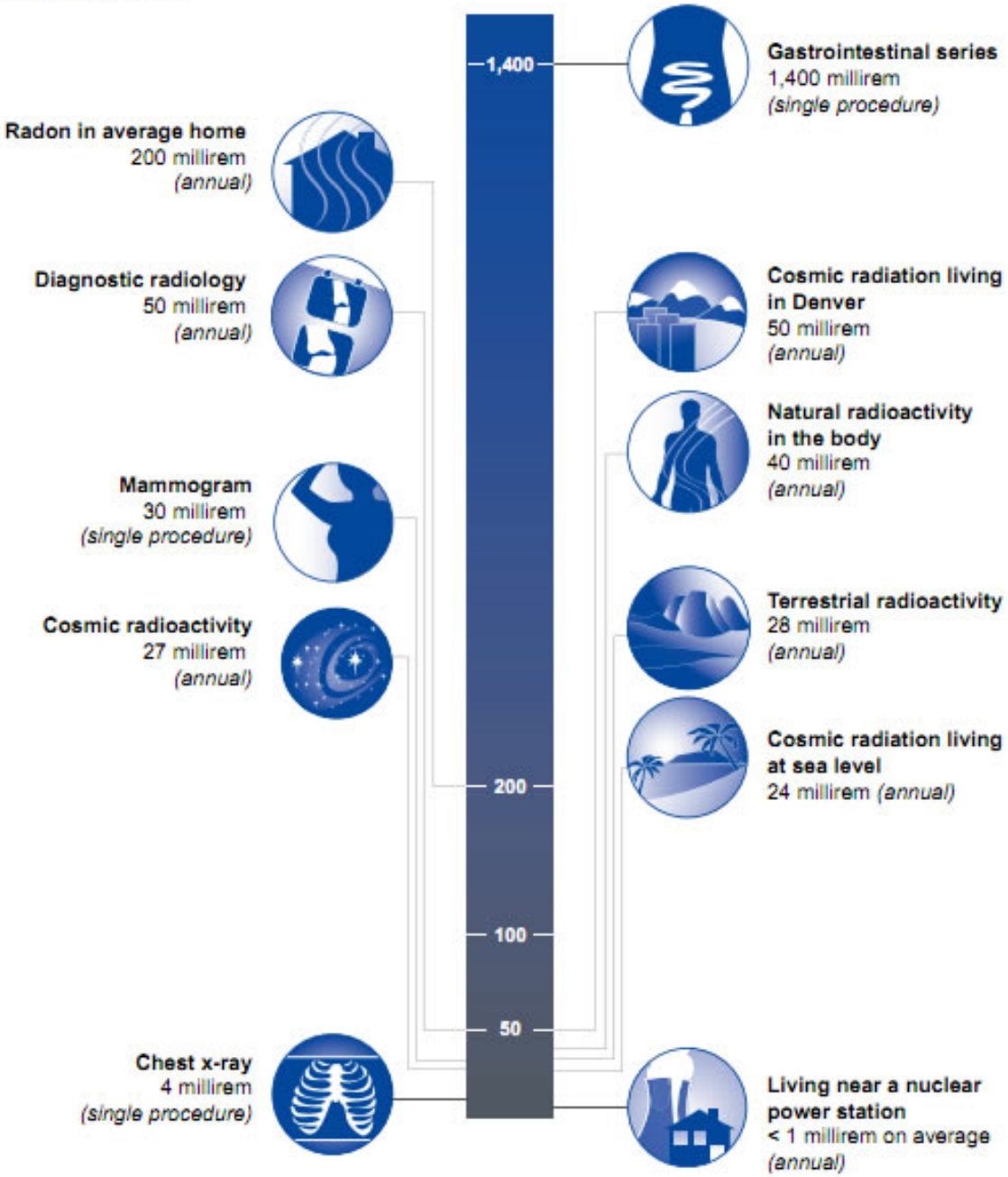
- <u>monitoring – "contaminated" systems</u>
  - quarterly samples for gross β and I-131
    - monthly samples or composites of 3 monthly samples
    - average 5 consecutive daily samples 1x/quarter (I-131)
  - annual samples for tritium and Sr-90
    - composite or average of 4 quarterly samples
  - if the RAA of (gross β - K-40) ≤ 15 pCi/L → reduced monitoring (1 sample/3 years)
  - any exceedance triggers monthly monitoring until 3-month running monthly average < 15 pCi/L
  - exceedance of screening level → same as "vulnerable" systems

Background Radiation & Relative Doses

- <u>background radiation</u>
  - exposure has increased from 360 mrem/yr → 620 mrem/yr
  - due to an increase in medical imaging procedures
- <u>relative doses</u>
  - mammogram = 30 mrem/yr
  - gastrointestinal series = 1,400 mrem/yr
  - cosmic radiation (Denver) = 50 mrem/yr
  - live near a nuclear power station = < 1 mrem/yr
  - **gross β MCL = 4 mrem/yr = single chest x-ray**

RELATIVE DOSES FROM RADIATION SOURCES

Millirem Doses



EPA's RadNet Program

- background
  - environmental monitoring since 1978
  - national network of monitoring stations
  - regularly collect air, precipitation, milk and drinking water
  - tracks ambient radiation levels in the environment
- RadNet drinking water program
  - quarterly sampling in Jan, April, July and Oct
  - more than 50 sites nationwide
  - sites are primarily located in major population centers
  - from finished water supplies (tap samples)
  - volunteer driven

EPA's RadNet Program

- <u>RadNet is NOT</u>
  - regulatory/compliance monitoring
  - a check on drinking water systems
  - a means for monitoring nuclear facilities
  - an early warning system for nuclear accidents
- <u>additional sampling</u>
  - EPA initiated extra rounds of sampling
  - states in Region 3 monitored
  - some systems sampled ahead of reduced monitoring schedule

EPA's RadNet Program

- results
  - below levels of public health concern
  - consistent with what was expected from the Japanese Nuclear Incident
- data
  - all Japan related sample analysis: www.epa.gov/japan2011
  - RadNet website: www.epa.gov/radnet

Iodine-131

- facts
  - radioactive form of iodine
  - byproduct of nuclear fission
  - half-life of 8 days
  - used to treat thyroid disease/cancer
  - sources include nuclear power plants, hospitals, medical treatment centers and pharmaceutical manufacturers
  - regulated contaminant – one of 168 individual emitters (gross β)

Iodine-131

- MCL
  - 3 pCi/L, yielding a dose of 4 mrem/yr
  - calculated based on standard assumptions: 2 L intake per day, at an average body weight of 70 kg and over a 70 year life span (chronic exposure)
  - extremely protective of human health
  - World Health Organization standard = 270 pCi/L
  - Canadian standard = 162 pCi/L

Iodine-131

- Philadelphia & I-131
  - elevated I-131 levels persist in Philadelphia after Fukushima related radiation subsides in the rest of the country
  - RadNet data reveals detects of I-131 slightly over MCL in Philadelphia in last few years
  - conclusion: source of I-131 in the Philadelphia area unrelated to Fukushima

Iodine-131

- source track-down
  - Philadelphia's drinking water is safe!
  - PWD, PADEP and EPA have entered into a Joint Action Plan to aggressively track down potential sources of I-131 in Philadelphia's source waters
  - PWD sampling its three drinking water plants (raw & finished) for gross β and I-131
  - PWD also sampling for ambient source water concentrations of gross β and I-131 at seven locations in the Wissahickon Creek, downstream of POTWs

Iodine-131

- source track-down
  - PADEP sampling effluent for I-131 at the five POTWs in the Wissahickon Creek
  - EPA looking at sewer collection areas for each POTW in the Wissahickon
  - so far, no “smoking gun” identified
  - patients treated with I-131 for thyroid disease could be a cause
  - low flow stream sampling may help to identify potential sources

Questions???