

Radionuclides Rule Overview

Overview

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Abbreviations & Acronyms

µg/L	Micrograms per Liter
CWS	Community Water System
DL	Detection Limit
EPTDS	Entry Point to the Distribution System
GA	Gross alpha particle activity
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal

Abbreviations & Acronyms, cont.

mrem/year	Millirems per Year
NPDWR	National Primary Drinking Water Regulation
NTNCWS	Nontransient Noncommunity Water System
pCi/L	Picocuries per Liter
Ra-226	Radium-226
Ra-228	Radium-228
RAA	Running Annual Average
SDWA	Safe Drinking Water Act

Radionuclide Sources

➤ Naturally occurring radionuclides

- Regional (e.g., Great Lakes, mountains)
- Geological (granitic formations, sandstone aquifers, shales, phosphate deposits)

➤ Man-made radionuclides

- Nuclear weapons & power plants
- Hospitals/medical facilities
- Industry (labs, pharmaceuticals)



Types of Radiation

➤ Ionizing

- Alpha radiation (uranium, Ra-226)
- Beta radiation (Ra-228, manmade sources)
- Gamma radiation (Ra-226)

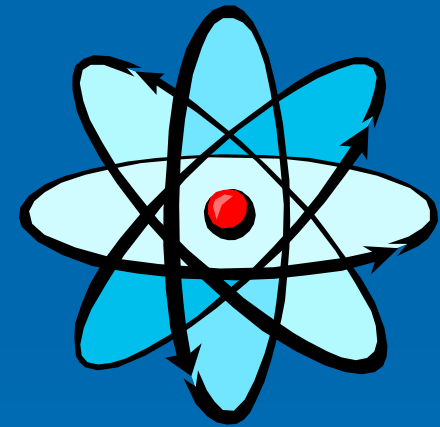
➤ Non-ionizing

- Microwaves
- Radio waves



Health Effects

- **Ionizing radiation damages living tissue**
- **Risk of cancer**
- **Risk of congenital defects**
- **Kidney toxicity (uranium)**



Regulatory Background

➤ 1976 interim regulations

- MCLs for gross alpha, Ra-226/228, beta/photon emitters

➤ 1991 proposed regulation

- Revise existing MCLs
- Regulate uranium and radon
- Regulate NTNCWSs



Final Rule Requirements

- **Effective December 8, 2003**
- **Applies to all CWSs**
- **Sets uranium MCL (CA – 35ug/L)**
- **Retains MCLs for:**
 - **Combined Ra-226 & Ra-228**
 - **Gross alpha**
 - **Beta particle and photon radioactivity**



Final Rule Requirements, cont.

- **Sets revised monitoring requirements**
 - **EPTDS monitoring**
 - **Standardized monitoring framework**
 - **No substitutions for Ra-228**



Regulatory Comparison

Provision	1976 Rule	2000 Final Rule
MCLG	None	MCLG = 0
Uranium MCL	Not Regulated	30 µg/L
Monitoring baseline	4 quarterly measurements > 1/2 MCL? 4 samples/4 yrs ≤ 1/2 MCL? 1 sample/4 yrs	Standardized Monitoring Framework
Beta Particle & Photon Emitters	Surface water systems > 100,000 screen at 50 pCi/L. Vulnerable systems screen at 15pCi/L	Vulnerable systems screen at 50 pCi/L

Radionuclide MCLs

Radionuclide MCLs	
Combined Ra-226/Ra-228	5 pCi/L
Gross alpha particle activity	15 pCi/L
Uranium (new MCL)	30 µg/L
Beta/photon emitters	4 mrem/year

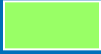

Monitoring Requirements



June 2000

Dec. 8, 2003

Dec. 31, 2007

-  States can allow grandfathering of samples collected
-  Systems collect 4 consecutive quarterly samples at each EPTDS
-  Results determine monitoring frequency

Grandfathered Data

- **Can satisfy initial monitoring**
- **Requires state approval**
- **Collected between 6/00 – 12/8/03**
- **Not permitted for beta/photon emitters**



Grandfathered Data, cont.

- **System sampled at EPTDS, or**
- **System has 1 EPTDS and collected samples from distribution system, or**
- **State finds distribution system data are representative of all EPTDS**

Initial Monitoring

- **Complete by December 31, 2007**
- **4 quarterly samples at EPTDS**
 - **State can waive last 2 quarters**
- **Compositing is permitted**
- **Compliance based on running annual average (RAA)**



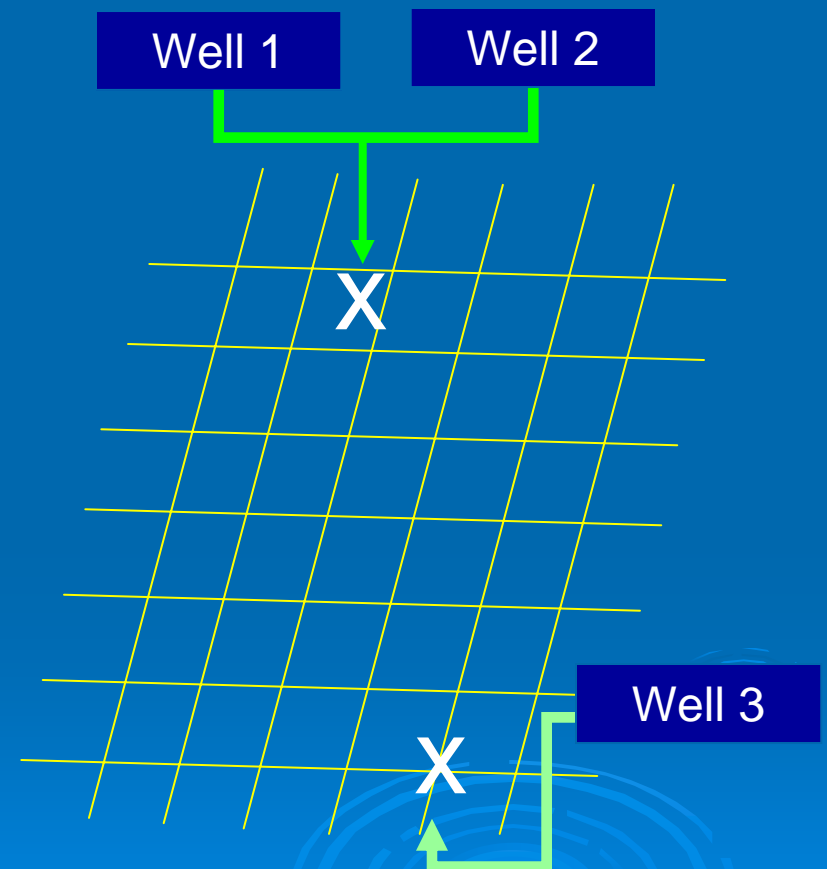
Initial Monitoring, cont.

- **Samples are not in consecutive quarters:**
 - **Base RAA on number of samples collected, AND**
 - **Collect final sample as soon as possible, OR**
 - **Collect sample in missed quarter, next year**



Monitoring Locations

- **Sample for each radionuclide at EPTDS**
 - State can designate representative sampling point
- **Sample during normal operating conditions**
 - Water should represent all sources in use



Routine/Reduced Monitoring

- **Determine sampling frequency**
 - Use RAA or grandfathered data from each EPTDS
- **Begin routine monitoring**
 - Use subsequent data to set schedule
- **Schedules are determined for *each contaminant* and for *each EPTDS***

Monitoring Frequency

- For combined radium, gross alpha, uranium:

$< DL$	1 sample every 9 years
$\geq DL$ and \leq one-half MCL	1 sample every 6 years
$>$ one-half MCL \leq MCL	1 sample every 3 years
$> MCL$	1 sample per quarter until results from 4 consecutive quarters \leq MCL

Calculating an RAA to Determine Monitoring Requirements

Ground Water System Monitors for Gross Alpha (MCL 15 pCi/L)

Date	Result
Jan 06	9
Apr 06	13
Jul 06	12
Oct 06	10

Running Annual Average	11
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$$\frac{9 + 13 + 12 + 10}{4} = 11$$

System must collect gross alpha samples from this EPTDS once every 3 years

Gross Alpha (GA) Substitutions

➤ Substituting gross alpha for Ra-226

If GA is:	Use formula:	Determines:
< Detect	1.5 pCi/L + Ra 228	Reduced monitoring frequency (Qtrly, 3, or 6 yrs)
≥ Detect but ≤ 5	GA result + Ra 228	Compliance with 226/228 MCL Reduced monitoring frequency (Qtrly or 3 yrs)

Gross Alpha (GA) Substitutions, cont.

- Substituting gross alpha for uranium

GA result	State should:
≤ 15 pCi/L	Assume all of gross alpha = uranium
> 15 pCi/L	Require uranium sampling & calculate net alpha

Net Alpha

Gross Alpha



- **Gross alpha minus uranium**
- **Lab analyzes and reports activity**
- **States use lab results OR convert uranium:**
 - **Convert uranium mass to activity**
 - Multiply by 0.67 pCi/μg
 - **Convert uranium activity to mass**
 - Multiply by 1.49 μg/pCi

Increased Monitoring

➤ Result is $>$ MCL

- Sample quarterly
 - Need 4 consecutive samples $<$ MCL



Violations

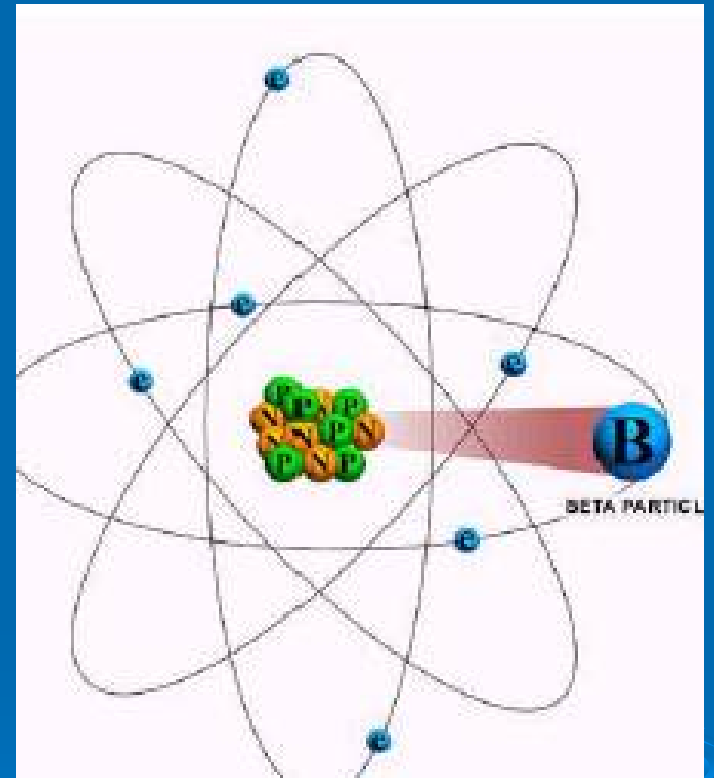
1. One sample result is > 4 times the MCL
2. One sample result causes RAA to exceed MCL
3. RAA is $> \text{MCL}$

Violation Examples – System on Quarterly GA Monitoring

1	Q3 Result = 76 pCi/L
2	Q1 = 13 pCi/L, Q2 = 13 pCi/L, Q3 = 14 pCi/L, Q4 = 25 pCi/L
3	Q1 = 12 pCi/L, Q2 = 19 pCi/L, Q3 = 16 pCi/L, Q4 = 16 pCi/L

Beta/Photon Applicability

- **State discretion**
- **“Vulnerable” systems**
 - Historical results
 - Geology & location
 - Nearby facilities
- **Systems using “contaminated” waters**
 - Effluents from nuclear facilities



Beta/Photon Emitter Monitoring

	Quarterly	Annually
Vulnerable Systems	Gross Beta ¹	Tritium & Strontium-90 ³
Contaminated Systems	Gross Beta ¹ & Iodine-131 ²	Tritium & Strontium-90 ³

¹Gross Beta – **monthly analysis** or monthly sample composites qtrly

²Iodine 131 – composite of five consecutive daily samples qtrly

³Tritium and Strontium 90- composite of 4 qtrly samples or 4 qtrly analysis

Beta/Photon Reduced Monitoring

If RAA of Gross Beta Minus Potassium-40 is...	Reduce Monitoring to Once Every. .
≤ 50 pCi/L in Vulnerable Systems	Three Years
≤ 15 pCi/L in Contaminated Systems	Three Years

Potassium Beta Activity = elemental potassium (mg/L) x 0.82

Beta/Photon Increased Monitoring

➤ Exceedance of gross beta minus potassium-40

- Speciate for most likely emitters

➤ MCL violation

- Monthly monitoring until 3 month rolling avg < MCL



Beta/Photon Compliance Determination

- **Sum of the fractions**
- **MCL = 4 mrem/year**
- **“Maximum Permissible Body Burdens and Maximum Permissible Concentrations of Radionuclides in Air or Water for Occupational Exposure”**

Sum of Fractions: Example

	X	Y	X/Y	4(X/Y)
Emitter	Lab Analysis (pCi/L)	Conversion from table (pCi/4mrem)	Calculate Fraction	Calculate Total (mrem)
Cs-134	5,023	20,000	0.2512	1.0046
Cs-137	30	200	0.15	0.6
Sr-90	4	8	0.5	2
I-131	2	3	0.7	2.8
Sum of the Fractions =			1.6012	6

New Systems & Sources

- **New systems & systems with new source**
 - **Conduct initial monitoring for new source**
 - **Begin in first quarter after initiating use**
 - **Initial results can serve as “occurrence profile”**
 - **States may require beta/photon monitoring**

Additional Considerations

- States can require confirmation samples
- Average confirmation samples with original analytical result
- If sample is $<$ detection limit
 - Use 'zero' in RAA calculation
 - Exception: gross alpha substitutions



State Flexibility Summary

- **Set representative sampling point**
- **Waive last 2 quarters of initial monitoring**
- **Set “missed” quarterly sampling requirements**
- **Compositing**
- **Grandfathering**



Questions?