

# Radionuclides Rule Overview

# Overview

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# Abbreviations & Acronyms

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

# Abbreviations & Acronyms, cont.

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

# 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)

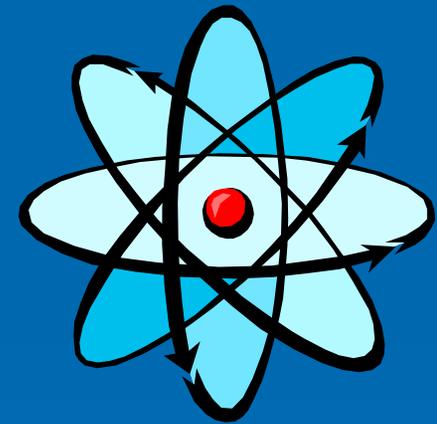
## ➤ Non-ionizing

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

# Monitoring Requirements



June 2000

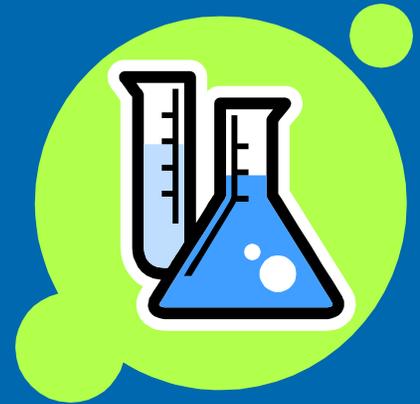
Dec. 8, 2003

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)**



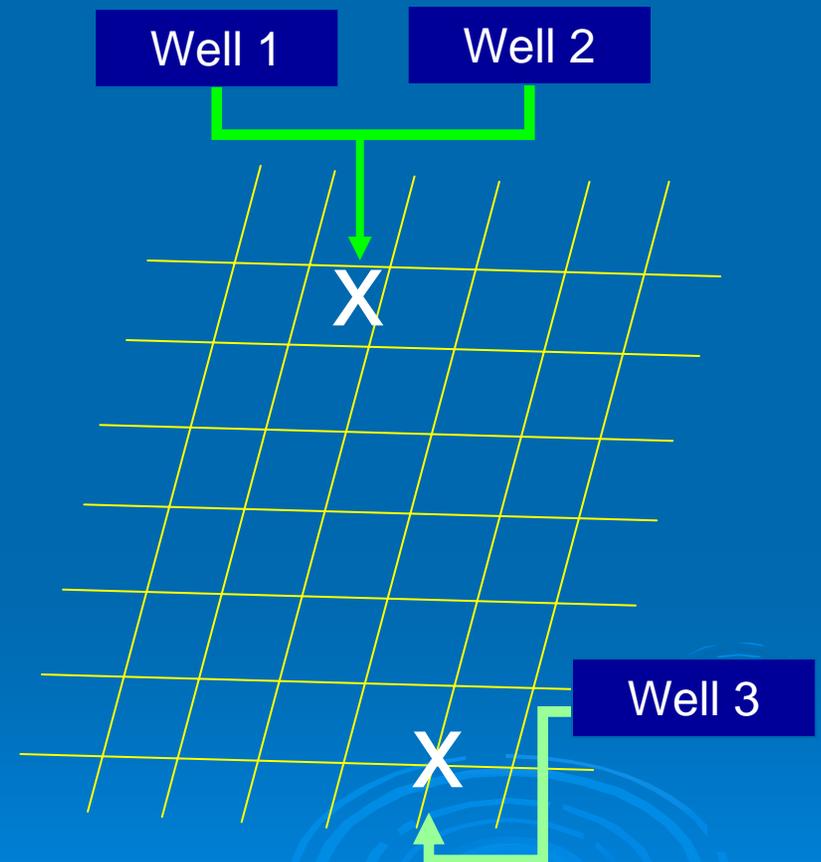
# Initial Monitoring, cont.

- **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:
$\leq 15$ 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

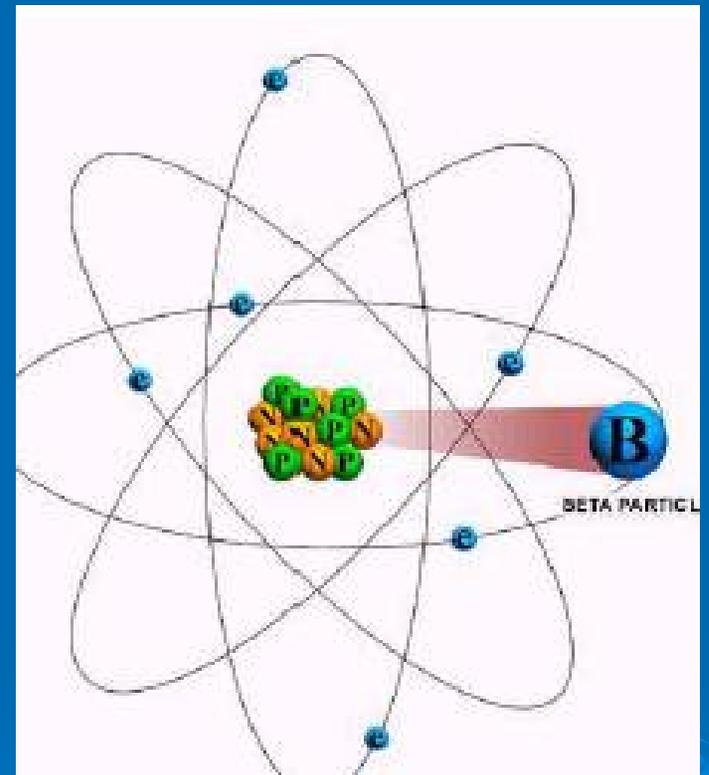
1. One sample result is  $> 4$  times the MCL
2. One sample result causes RAA to exceed MCL
3. RAA is  $> \text{MCL}$

## 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 <sup>1</sup>	Tritium & Strontium-90 <sup>3</sup>
Contaminated Systems	Gross Beta <sup>1</sup> & Iodine-131 <sup>2</sup>	Tritium & Strontium-90 <sup>3</sup>

<sup>1</sup>Gross Beta – **monthly analysis** or monthly sample composites qtrly

<sup>2</sup>Iodine 131 – composite of five consecutive daily samples qtrly

<sup>3</sup>Tritium and Strontium 90- composite of 4 qtrly samples or 4 qtrly analysis

# Beta/Photon Reduced Monitoring

<b>If RAA of Gross Beta Minus Potassium-40 is...</b>	<b>Reduce Monitoring to Once Every. .</b>
<b><math>\leq 50</math> pCi/L in Vulnerable Systems</b>	<b>Three Years</b>
<b><math>\leq 15</math> pCi/L in Contaminated Systems</b>	<b>Three Years</b>

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

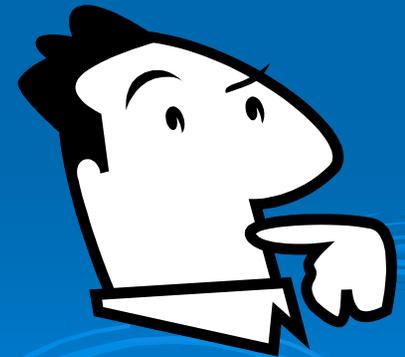
Emitter	X Lab Analysis (pCi/L)	Y Conversion from table (pCi/4mrem)	X/Y Calculate Fraction	4(X/Y) Calculate Total (mrem)
Cs-134	5,023	20,000	0.2512	1.0046
Cs-137	30	200	0.15	0.6
Sr-90	4	8	0.5	2
I-131	2	3	0.7	2.8
Sum of the Fractions =			1.6012	6

# 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?