

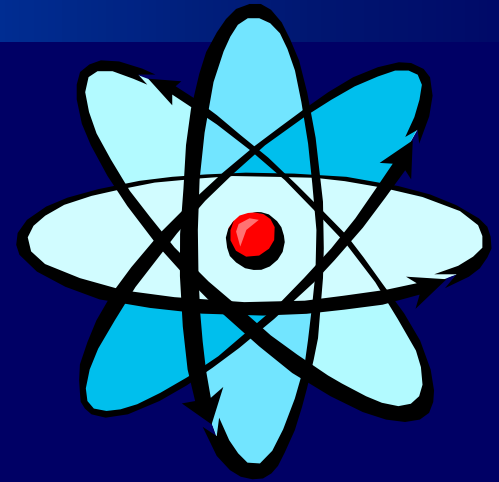
# The Radionuclides Rule

Monitoring, Compliance, and  
Substitution



# Overview

- Monitoring
  - Frequency
    - Initial
    - Routine/Reduced
    - Increased
  - Location
- Compliance Calculations
- Substitution



The focus is on Gross Alpha, R-226, R-228, and Uranium

But. . .

will talk about Beta and Photon Emitters!

# Standards

Contaminant	MCL	Detection Limit
Gross Alpha	15 pCi/L	3pCi/L
Combined R-226/228	5 pCi/L	1pCi/L
		1pCi/L
Uranium	30 ug/L	TBD
Gross beta	4 mrem/yr 168 individual emitters may be used to calculate compliance	4



# Monitoring Frequency

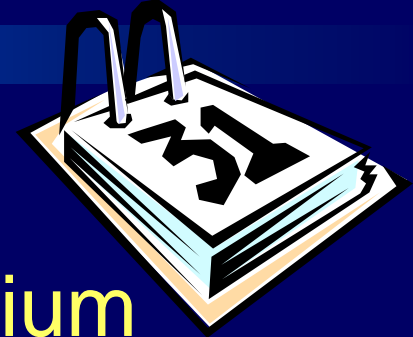
Initial

Routine/Reduced

Increased

Beta and Photon Emitters

# Initial Monitoring



## Gross Alpha, R-226, R-228, & Uranium

- Complete by December 31, 2007
- Establish compliance with 4 consecutive quarterly samples at each entry point
- Compliance based on running annual average (RAA) of samples
- First 2 initial samples < detection limit
  - State can waive last 2 quarters of sampling

# Routine/Reduced Monitoring

## Gross Alpha, R-226, R-228, & Uranium

- Determine frequency for each contaminant at each entry point
  - After initial monitoring period
    - Use the RAA or Grandfathered data from each entry point to determine future monitoring frequency
  - Routine monitoring
    - Based on previous analytical results
    - An increase in contaminant concentration may increase monitoring frequency for that contaminant

# For Gross Alpha, R-226, R-228, & Uranium, if the Result at an Entry Point is. . .

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

# Increased Monitoring

## Gross Alpha, R-226, R-228, & Uranium

- MCL Exceedance?
  - Must begin quarterly sampling
  - Continue until 4 consecutive quarterly samples are < MCL
- If a system fails to monitor in consecutive quarters:
  - Running annual average (RAA) is based on the number of samples collected
  - EPA recommends:
    - Collect final sample as soon as possible, or
    - Collect sample in missed quarter, the following year



# Special Considerations

- States can require confirmation samples
- New systems & systems using a new source
  - Conduct initial monitoring for new source
  - Initial results serve as “occurrence profile”
  - Begin in first quarter after initiating use

# State Flexibilities

- Determine a representative sampling point
- Waive last 2 quarters of initial monitoring
- Require system to take “missed” quarterly samples either as soon as possible, or the same quarter the next year
- Compositing
- Grandfathering



# Routine Monitoring

## Beta and Photon Emitters

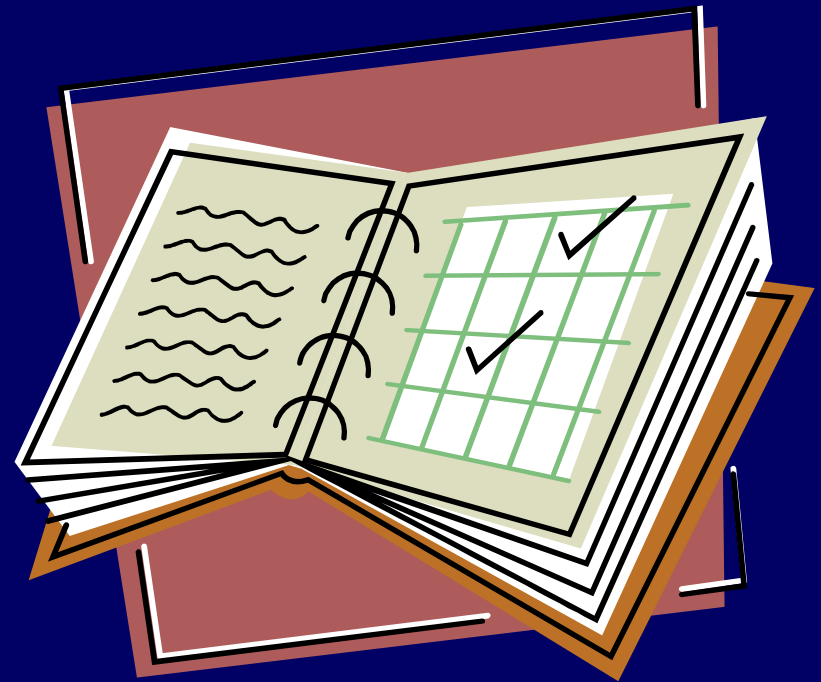
	Quarterly	Annually
Vulnerable Systems	Gross Beta	Tritium
Contaminated Systems	Gross Beta Iodine - 131	Strontium-90

# Reduced Monitoring Beta and Photon Emitters

<b>If Gross Beta Minus Potassium-40 Has a RAA of...</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>

# Increased Monitoring Beta and Photon Emitters

- Exceedance of Gross Beta Minus Potassium-40
  - Speciate for most likely emitters
- MCL violation
  - Monthly Monitoring





# Monitoring Locations

# Monitoring Locations



- Sample for each contaminant at each entry point
  - State can determine if another sampling point is more representative
- Sample during normal operating conditions
  - For seasonal systems, water should represent all sources in use



# Determining Compliance

Running Annual Average  
Sum of the Fractions  
Reliably and Consistently  
Return to Compliance



# Calculating Compliance

## Gross Alpha, R-226, R-228, & Uranium

- Compliance must be determined for each contaminant at each entry point
- If one entry point is in violation of an MCL the system is in violation of the MCL



# Systems Monitoring Less Than Once Per Year

- $>$  MCL at any entry point triggers quarterly monitoring at that entry point
  - Compliance based on RAA of 4 consecutive quarterly samples
  - Quarterly sampling continues until results from 4 consecutive quarters are  $<$  MCL
- An increase in contaminant concentration may increase monitoring frequency for that contaminant

# Systems Monitoring More Than Once Per Year

- RAA at each entry point determines compliance
  - If RAA is  $>$  MCL, system is out of compliance
  - If RAA is  $<$  MCL, system is in compliance
- If a system fails to monitor in consecutive quarters
  - RAA is based on the number of samples collected

# Violations

- One sample result is 4 times the MCL
- One sample result causes RAA to exceed MCL
- RAA exceeds MCL

# Special Considerations

- Systems monitor separately for Ra-226 and Ra-228
  - Compliance is based on the combined Ra-226 and Ra-228 results
- Any required confirmation samples must be averaged with original analytical result
- If sample is < detection limit
  - Use 'zero' in RAA calculation
  - Exception: gross alpha substitutions

# Reliably & Consistently

- Primacy Agency has sufficient knowledge to predict that MCL will not be exceeded
- Ground water systems must take a minimum of 2 quarterly samples
- Surface water systems must take a minimum of 4 quarterly samples
- Need not be consecutive quarters!
- State can reduce monitoring to once every three years

# Return to Compliance

- State has made a reliably and consistently determination
- Ground water systems have taken minimum of 2 consecutive quarterly samples
- Surface water system have taken a minimum of 4 consecutive quarterly samples
- All sampling results < MCL
- System is monitoring and reporting in accordance with the criteria for compliance

# Compliance Determination

## Beta and Photon Emitters

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





# Substitution

Using Gross Alpha for R-226

Using Gross Alpha for  
Uranium

# Gross Alpha For R-226

- If gross alpha is  $< 3$  pCi/L (detection limit)
  - Use 1.5 pCi/L for R-226 value
  - Combine with R-228 result to determine monitoring frequency for R-226/228
- Gross alpha is  $> 3$  pCi/L but  $< 5$  pCi/L
  - Use whole gross alpha result for R-226 value
  - Combine with R-228 result to determine monitoring frequency for R-226/228

# Gross Alpha For R-226

- Systems substituting gross alpha for R-226 cannot move to 9 year routine monitoring schedule for R-226/228
  - Can't confirm that radium-226 is below its detection limit (1 pCi/L)
- Account for analytical error in gross alpha result
  - Confidence interval of 95%
    - $1.65s$ , where  $s$  = standard deviation of net counting rate of sample

# If a system substitutes Gross Alpha for R-226. . .

And the result is:	The Primacy Agency must:
<p data-bbox="287 629 548 689">&lt; 3 pCi/L</p> <p data-bbox="186 722 649 782">(Detection Limit)</p>	<p data-bbox="763 554 1772 686">Use 1.5 pCi/L + R-228 to determine compliance with R-226/228 MCL</p> <hr/> <p data-bbox="763 722 1772 858">Determine monitoring frequency as quarterly or once every 3 or 6 years</p>
<p data-bbox="287 972 548 1032"><math>\geq 3</math> pCi/L</p> <p data-bbox="373 1065 462 1125">but</p>	<p data-bbox="763 896 1705 1115">Use whole gross alpha result + R-228 to determine compliance with R-226/228 MCL</p> <hr/>
<p data-bbox="287 1158 548 1218">&lt; 5 pCi/L</p>	<p data-bbox="763 1160 1753 1293">Determine monitoring frequency as quarterly or once every 3 years</p> <hr/>

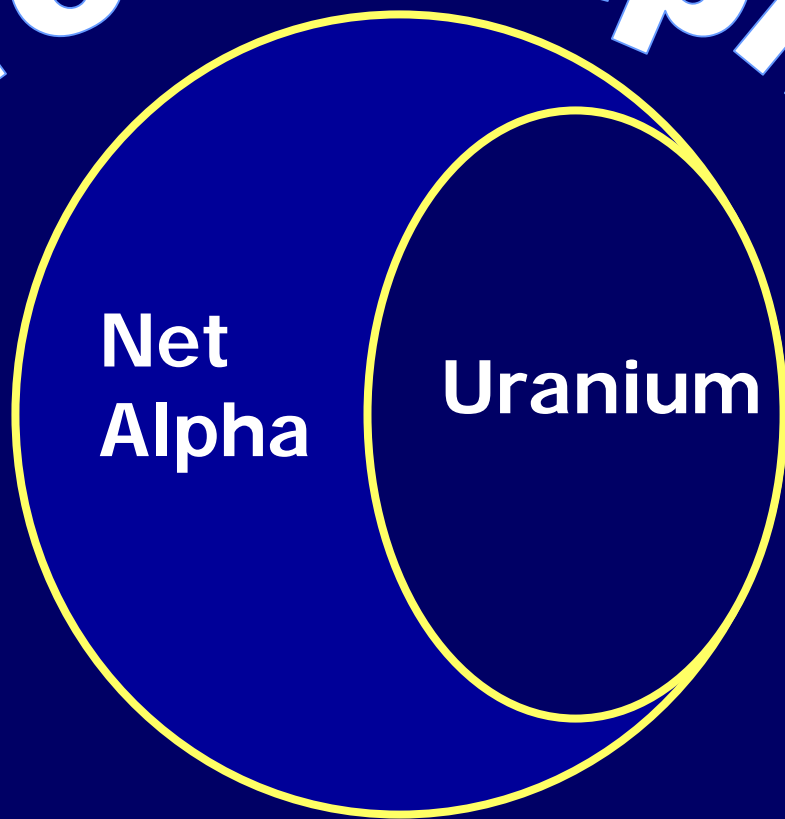
# Gross Alpha & Uranium

- Systems with gross alpha  $\leq 15$  pCi/L
  - Can substitute for uranium
  - Account for analytical error in gross alpha result
- Systems with gross alpha  $>15$  pCi/L
  - Must monitor for uranium and report both mass and activity to the state
  - State must convert uranium mass to activity
  - Can subtract uranium activity from gross alpha
  - This “net alpha” result can be used to determine compliance with gross alpha MCL

# Gross Alpha

Net  
Alpha

Uranium



# If a system substitutes Gross Alpha for Uranium. . .

And the result is:

$\leq 15$  pCi/L

$>15$  pCi/L

The Primacy Agency must:

Assume all of gross alpha =  
uranium

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Use mass to activity ratio of  
1:1

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Require the system to  
collect uranium samples

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# Examples



# Initial Monitoring

System takes 4 quarterly samples for Gross Alpha in 2005 (MCL 15 pCi/L)

Date	Result	
Jan. 05	Initial Result	16
	Confirmation	15
Apr 05		12
Jul 05		13
Oct 05		16

Average = 16 pCi/L

RAA

14

$$\frac{16 + 12 + 13 + 16}{4} = 14 \text{ pCi/L}$$

# Routine Monitoring Schedule

- Initial monitoring results = 14 pCi/L
  - > one-half MCL < the MCL
- Routine gross alpha sample required by 2008
  - One sample every 3 years

# Reduced Monitoring Schedule

- Routine sample in 2008 = 7 pCi/L
  - > detection limit and < one-half MCL
- Next routine sample 2014
  - One sample every 6 years

# Gross alpha result that causes RAA to exceed MCL

Date	Result	
Jan. 04	Initial Result	34
	Confirmation	32
Apr 04	31 pCi/L	
Jul 04	Future sample assume ND	
Oct 04	Future sample assume ND	

Average = 33 pCi/L

**MCL Violation**

**16**

$$\frac{33 + 31 + 0 + 0}{4} = 16 \text{ pCi/L}$$

# Gross Alpha for R-226

Sample	Value
Gross Alpha	< Detect
Ra-228	2 pCi/L

Total Ra-226/228	3.5 pCi/L
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1. Substitute 1.5 pCi/L for < detect gross alpha
2. Add to Ra-228 result
3. Determine Ra-226/228 monitoring frequency
  - a. MCL = 5 pCi/L
  - b.  $5 \text{ pCi/L} \leq 3.5 > 2.5 \text{ pCi/L}$
  - c. 1 sample every 3 years

# Gross Alpha and Uranium

Sample	Result
Gross alpha	$24 \pm 3$ pCi/L
U (mass)	$22 \mu\text{g/L}$
U (activity)	$15$ pCi/L

<b>Net Alpha</b>	<b><math>9</math> pCi/L</b>
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1. Convert mass to activity  
 $22 \text{ ug/L} \times 0.67 \text{ pCi/ug} = 15 \text{ pCi/L}$
2. Subtract activity from gross alpha result  
 $24 \text{ pCi/L} - 15 \text{ pCi/L} = 9 \text{ pCi/L}$
3. Take uranium sample in the next 3 year compliance period  
 $> \frac{1}{2}$  the MCL but  $\leq$  MCL
4. Take gross alpha sample in the next 3 year compliance period  
“net alpha” value of  $9 \text{ pCi/L}$  is  $> \frac{1}{2}$  the MCL but  $\leq$  MCL

# Sum of the Fractions

- Step 1: Convert lab analysis (pCi/L) into pCi/4mrem using conversion table
- Step 2: Calculate Fraction
- Step 3: Calculate Total mrem

# Sum of the Fractions

<b>Emitter</b>	<b>Lab Analysis (pCi/L)</b>	<b>Conversion from table (pCi/4mrem)</b>	<b>Calculate Fraction</b>
<b>Cs-137</b>	30	200	0.150
<b>Sr-90</b>	4	8	0.5
<b>I-131</b>	2	3	0.7
<b>SUM OF THE FRACTIONS</b>			<b>1.35 x 4mrem = 5.4</b>



