

Group Exercise

Calculating Compliance



Definitions & Acronyms

ND	Non-detect
NM	Not measured
Q	Quarter
RAA	Running Annual Average
Net alpha	Gross alpha activity minus uranium activity. Under the 2000 Radionuclides Rule, net alpha can be used in place of gross alpha to meet gross alpha sampling requirements and determine compliance with the gross alpha MCL

Scenario 1

- Calculate gross alpha and combined radium RAAs
- Determine routine monitoring schedules
- Community Water System A
 - Two wells, two entry points
 - Did not qualify for grandfathering
 - Begins initial monitoring Quarter 3 2006

Scenario 1: Monitoring Results

Well 1			Well 2		
Q3 2006	Gross Alpha	12 pCi/L	Q3 2006	Gross Alpha	6 pCi/L
	Radium-226	2 pCi/L		Radium-226	ND
	Radium-228	2 pCi/L		Radium-228	1 pCi/L
Q4 2006	Gross Alpha	10 pCi/L	Q4 2006	Gross Alpha	4 pCi/L
	Radium-226	3 pCi/L		Radium-226	NM
	Radium-228	2 pCi/L		Radium-228	3 pCi/L
Q1 2007	Gross Alpha	9 pCi/L	Q1 2007	Gross Alpha	7 pCi/L
	Radium-226	2 pCi/L		Radium-226	1 pCi/L
	Radium-228	1 pCi/L		Radium-228	2 pCi/L
Q2 2007	Gross Alpha	16 pCi/L	Q2 2007	Gross Alpha	ND
	Radium-226	3 pCi/L		Radium-226	NM
	Radium-228	3 pCi/L		Radium-228	2 pCi/L

Scenario 1: Well 1 RAAs

Well 1		
Q3 2006	Gross Alpha	12 pCi/L
	Radium-226	2 pCi/L
	Radium-228	2 pCi/L
Q4 2006	Gross Alpha	10 pCi/L
	Radium-226	3 pCi/L
	Radium-228	2 pCi/L
Q1 2007	Gross Alpha	9 pCi/L
	Radium-226	2 pCi/L
	Radium-228	1 pCi/L
Q2 2007	Gross Alpha	16 pCi/L
	Radium-226	3 pCi/L
	Radium-228	3 pCi/L

$$\begin{aligned}\text{Gross Alpha} \\ &= (12 + 10 + 9 + 16)/4 \\ &= 12 \text{ pCi/L}\end{aligned}$$

$$\begin{aligned}\text{Combined Ra-226 \& Ra-228:} \\ &= ((2 + 2) + (3 + 2) + (2 + 1) + (3 + 3))/4 \\ &= (4 + 5 + 3 + 6)/4 \\ &= 5 \text{ pCi/L}\end{aligned}$$

Calculating RAAs for Well 1

- To calculate the RAA for gross alpha for Well 1, the system adds the four quarterly gross alpha results and divides the sum by the total number of samples collected. The result is 12 pCi/L.
- To calculate the RAA for combined radium-226 and -228 for Well 1, the system first adds together the individual results for radium-226 and -228 in each quarter to determine the combined radium value. The combined radium values are 4 pCi/L (Quarter 3 2006), 5 pCi/L (Quarter 4 2006), 3 pCi/L (Quarter 1 2007), and 6 pCi/L (Quarter 2 2007). The system then adds these combined radium values together and divides the sum by the total number of combined radium samples. The result is 5 pCi/L.

Scenario 1: Well 2 RAAs

Well 2		
Q3 2006	Gross Alpha	6 pCi/L
	Radium-226	ND
	Radium-228	1 pCi/L
Q4 2006	Gross Alpha	4 pCi/L
	Radium-226	NM
	Radium-228	3 pCi/L
Q1 2007	Gross Alpha	7 pCi/L
	Radium-226	1 pCi/L
	Radium-228	2 pCi/L
Q2 2007	Gross Alpha	ND
	Radium-226	NM
	Radium-228	2 pCi/L

$$\begin{aligned}\text{Gross Alpha} \\ &= (6 + 4 + 7 + 0)/4 \\ &= 4 \text{ pCi/L}\end{aligned}$$


$$\begin{aligned}\text{Combined Ra-226 \& Ra-228:} \\ &= ((0 + 1) + (4 + 3) + (1 + 2) + (1.5 + 2))/4 \\ &= (1 + 7 + 3 + 3.5)/4 \\ &= 4 \text{ pCi/L}\end{aligned}$$

Calculating RAAs for Well 2

- To calculate the RAA for gross alpha for Well 2, the system adds the four quarterly gross alpha results and divides the sum by the total number of samples collected. The result is 4 pCi/L. Note that because the analytical result in Quarter 2 2007 was a non-detect, the system uses zero for that quarter when calculating compliance.
- To calculate the RAA for combined radium-226 and -228 for Well 2, the system first adds together the individual results for radium-226 and -228 in each quarter to determine the combined radium value.
- Note that in Quarter 4 2006, the system uses the gross alpha result for Well 2 (4 pCi/L) to substitute for radium-226. As a result, the combined radium result for that quarter (7 pCi/L) is above the combined radium MCL of 5 pCi/L.
- In Quarter 2 2007, the system substitutes the gross alpha result for radium-226. Because the gross alpha result is a non-detect, the system uses one-half the gross alpha detection limit, or 1.5 pCi/L, as the radium-226 result.
- The combined radium values are 1 pCi/L (Quarter 3 2006), 7 pCi/L (Quarter 4 2006), 3 pCi/L (Quarter 1 2007), and 3.5 pCi/L (Quarter 2 2007). The system then adds these combined radium values together and divides the sum by the total number of combined radium samples. The result is 4 pCi/L.

Scenario 1: Well 1 Monitoring Schedules

- Gross alpha: 12 pCi/L
 - $> \frac{1}{2}$ MCL and \leq MCL
 - Collect 1 sample every 3 years

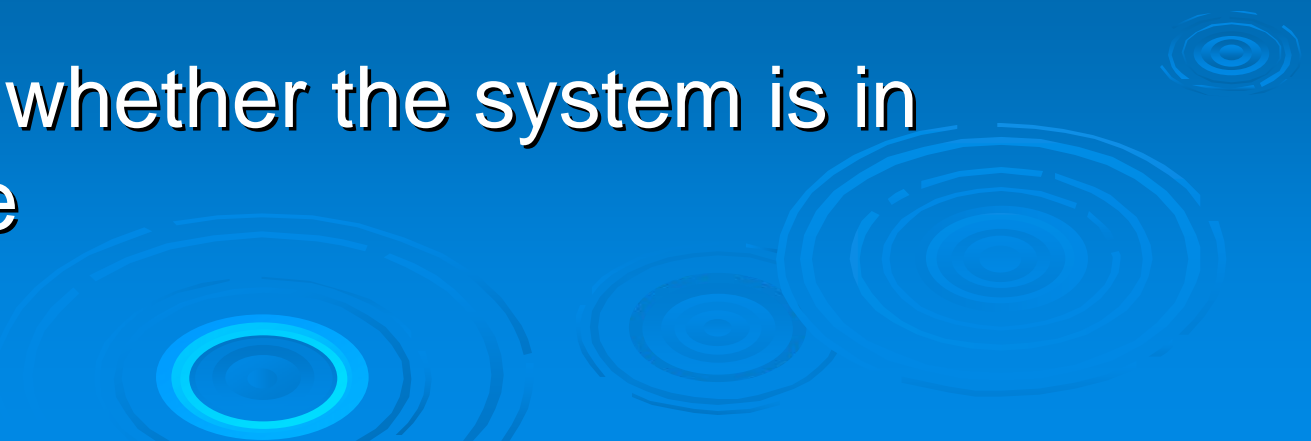
 - Combined radium: 5 pCi/L
 - $> \frac{1}{2}$ MCL and \leq MCL
 - Collect 1 sample every 3 years
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Scenario 1: Well 2 Monitoring Schedules

- Gross alpha: 4 pCi/L
 - \geq DL and \leq $\frac{1}{2}$ MCL
 - Collect 1 sample every 6 years

- Combined radium: 4 pCi/L
 - $>$ $\frac{1}{2}$ MCL and \leq MCL
 - Collect 1 sample every 3 years

Scenario 2

- Use gross alpha and uranium values to calculate net alpha values
 - Calculate RAAs for gross alpha (using net alpha) and uranium
 - Determine whether the system is in compliance
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Scenario 2: Monitoring Results

System B Initial Monitoring Results

Q1 2007	Gross Alpha	20 pCi/L
	Uranium	10 µg/L
	Net Alpha	
Q2 2007	Gross Alpha	31 pCi/L
	Uranium	10 µg/L
	Net Alpha	
Q3 2007	Gross Alpha	27 pCi/L
	Uranium	9 µg/L
	Net Alpha	
Q4 2007	Gross Alpha	18 pCi/L
	Uranium	7 µg/L
	Net Alpha	

Scenario 2: Net Alpha Calculations

System B Initial Monitoring Results			
Q1 2007	Gross Alpha	20 pCi/L	
	Uranium	10 µg/L	
	Net Alpha	1	$10 \mu\text{g/L} \times 0.67 \text{ pCi/L} = 7 \text{ pCi/L}$
		2	$20 \text{ pCi/L} - 7 \text{ pCi/L} = 13 \text{ pCi/L}$
Q2 2007	Gross Alpha	31 pCi/L	
	Uranium	10 µg/L	
	Net Alpha	1	$10 \mu\text{g/L} \times 0.67 \text{ pCi/L} = 7 \text{ pCi/L}$
		2	$31 \text{ pCi/L} - 7 \text{ pCi/L} = 24 \text{ pCi/L}$

Calculating the net alpha value is a two-step process. First, you must convert the uranium mass measurement to activity using a conversion factor of 0.67 pCi/µg. Then, the converted uranium result must be subtracted from the gross alpha measurement.

Scenario 2: Net Alpha Calculations, cont.

System B Initial Monitoring Results			
Q3 2007	Gross Alpha	27 pCi/L	
	Uranium	9 µg/L	
	Net Alpha	1	$9 \mu\text{g/L} \times 0.67 \text{ pCi/L} = 6 \text{ pCi/L}$
		2	$27 \text{ pCi/L} - 6 \text{ pCi/L} = 21 \text{ pCi/L}$
Q4 2007	Gross Alpha	18 pCi/L	
	Uranium	7 µg/L	
	Net Alpha	1	$7 \mu\text{g/L} \times 0.67 \text{ pCi/L} = 5 \text{ pCi/L}$
		2	$18 \text{ pCi/L} - 5 \text{ pCi/L} = 13 \text{ pCi/L}$

Scenario 2: Calculating RAAs

System B		
Q1 2007	Net Alpha	13 pCi/L
	Uranium	10 µg/L
Q2 2007	Net Alpha	24 pCi/L
	Uranium	10 µg/L
Q3 2007	Net Alpha	21 pCi/L
	Uranium	9 µg/L
Q4 2007	Net Alpha	13 pCi/L
	Uranium	7 µg/L

$$\begin{aligned}\text{Gross (Net) Alpha} &= (13 + 24 + 21 + 13)/4 \\ &= 18 \text{ pCi/L}\end{aligned}$$

$$\begin{aligned}\text{Uranium} &= (10 + 10 + 9 + 7)/4 \\ &= 9 \text{ µg/L}\end{aligned}$$

Calculating RAAs for System B

- To calculate the RAA for gross alpha, the system adds the net alpha values and divides the sum by the total number of samples collected. The result is 18 pCi/L.
- To calculate the RAA for uranium, the system adds the four quarterly uranium results and divides the sum by the total number of samples collected. The result is 9 $\mu\text{g/L}$.

Determining Compliance

- Gross (Net) Alpha: 18 pCi/L
 - RAA is $>$ MCL
 - System must continue quarterly monitoring

- Uranium: 9 μ g/L
 - \geq DL and \leq $\frac{1}{2}$ MCL
 - Collect 1 sample every 6 years

Questions?

