

Questions and Answers from the EPA Radionuclides Rule Webcast



June 29, 2004

1. What are the treatment options?

EPA identified Best Available Technologies (BATs) and Small System Compliance Technologies (SSCTs) in the Final Radionuclides Rule (40 CFR 141.66). In addition, treatment options were discussed during the second Radionuclides Rule Web cast on August 4, 2004. Copies of the presentations can be found at: <http://www.epa.gov/safewater/dwa/rules.html>

2. Since the 200.8 method for uranium mass is allowed, has EPA looked at the correlation between the mass value and the corresponding calculated value using the 1.49 conversion? If both values are available, which should be used?

The 1.49 value is the inverse of 0.67. The latter is used to convert mass to activity assuming the amount of radioactivity from U-238 equals that from U-234. If you measure activity first from gross alpha, use the 1.49 to convert to mass (or divide by 0.67). Gross alpha below 20 (with error) indicates mass will be below 30 ug/L. *Note: Method 200.8 for uranium has not officially been approved yet, although EPA anticipates it will be finalized by the end of August.*

3. How are we going to address monitoring schedules in SDWIS now that this Rule is outside the standard monitoring framework?

EPA extended the initial compliance monitoring period for Radionuclides until 2007, so that the first compliance cycle is consistent with the Standardized Monitoring Framework.

4. Why doesn't the Radionuclide Rule apply to Non-transient, Non-community water systems (NTNCWSs)?

EPA applied the cost/benefit analysis and the modeling indicated that the impact would not be great enough to warrant a regulation.

5. If a system exceeds the maximum contaminant level (MCL), the Rule requires the system to continue quarterly monitoring until the result is below the MCL, unless the system enters into another schedule as part of a formal compliance agreement. If they are under an agreement with the state, can the monitoring be reduced to once per year to save money if they continue to provide public notice?

If the average of the results from a sampling point is above the MCL in the INITIAL monitoring period, the system must continue to collect and analyze quarterly samples at that sampling point until the system has results from four consecutive quarters that are AT OR BELOW the MCL (40 CFR 141.26(a)(2)(iv)). After the initial monitoring period, a system that has a monitoring result that exceeds the MCL must collect and analyze quarterly samples at that sampling point until the system has results from four consecutive quarters that are BELOW the MCL (40 CFR 141.26(a)(3)(v)).

The costs associated with the increased monitoring frequencies for systems exceeding an MCL, are justified by the level of public health protection that quarterly sampling provides. While the Rule grants States the flexibility to change these monitoring frequencies if the system enters into another schedule as part of a formal compliance agreement with the State (40 CFR 141.26(a)(2)(iv) and (a)(3)(v)), it was not EPA's intent to allow systems exceeding the MCL to reduce the monitoring frequency solely to save money.

- 6. I have prepared a memo for detection limits (DLs). Are these DL values correctly presented? The Consumer Confidence Report Implementation Guidance (EPA 816-R-99-008, August 1999), Appendix G details the list of EPA's Minimum Detection Limits that apply to presentation of the data in your annual CCR. For Gross Beta, the minimum detection limit is 4 pCi/L, and for other radionuclides, it is 1/10 the applicable limits. In the new Radionuclides Rule, a discussion of analytical methods and compliance determinations is presented in the Code of Federal Regulations at 40 CFR Subsection 141.25. The section includes tables showing the highest acceptable detection limits for gross alpha, radium and uranium [Subsection 141.25(c)(1), Table B] and gross beta/photon emitters [Subsection 141.25 (c)(2), Table C] for use in compliance determinations and monitoring frequency determinations. The detection limits referred to in 40 CFR Subsection 141.25(c) are also used to define what level of radionuclides is considered a detected amount for the purpose of presentation in your CCR. The new detection limits apply to the results of radionuclides analyses on water samples collected after the effective date of December 8, 2003.**

The Consumer Confidence Report Implementation Guidance (EPA 816-R-99-008), Appendix G lists EPA's Radionuclide Minimum Detection Limits from the original 1976 Radionuclides Rule. The CCR guidance was published in August of 1999 and thus reflected the old rule and not the new Radionuclides Rule published on December 7, 2000. 40 CFR 141.25(c)(1), Table B accurately depicts the detection limits for the 2000 Radionuclides Rule. Systems that detect radionuclides greater than these detection limits after the effective date of December 8, 2003, would need to present this data in their CCR. *Note: In a June 29, 2004 National Primary Drinking Water Regulations: Minor Corrections and Clarification to Drinking Water Regulations Final Rule, EPA amended Table B at Sec. 141.25(c)(1) to add a detection limit of 1 [mu]g/L (1 ppb) for uranium. (69 FR 38850)*

- 7. If radium 228 is non-detect after initial monitoring, is future monitoring required?**

Guidance in California says it is not required, only initial monitoring.

The Radionuclides Rule retained the combined radium-226 and radium-228 MCL of 5 pCi/L. 40 CFR 141.66 states that the combined radium-226 and radium-228 value is determined by the addition of the results of the analysis of radium-226 and the analysis of radium-228. The future monitoring frequency for the system described in your question would depend on the result for radium-226 taken during the initial monitoring period. The radium-226 result would then be added to the non-detect result for radium-228. For example, if the radium-226 result was also non-detect, the state could allow the system to monitor for both radium-226 and radium 228 once in the next nine years.

- 8. If a system monitors quarterly in 2005 and they are in violation, do they have until 2007 to comply? Would they have to give public notice at the end of 2005 and quarterly thereafter if they continue to sample?**

No, the system does not have until 2007 to comply. If a system collects four consecutive quarterly samples for Ra-226, Ra-228, gross alpha, and uranium anytime during the initial monitoring period (12/7/03 to 12/31/07) and the average of the contaminant results exceeds the MCL for the respective contaminant, the system is immediately in violation for that contaminant (40 CFR 141.26(a)(2)(iv)). A Tier 2 Notice would be required within 30 days of the Radionuclide MCL violation (40 CFR Part 141, Appendix A to Subpart Q). For any unresolved violations following an initial Tier 2 notice, a repeat notice every three months is required for as long as the violation persists.

Water systems with existing radionuclides monitoring data demonstrating that the system is out of compliance with new provisions would have been out of compliance on the effective date of December 8, 2003. Water systems with existing data that demonstrates non-compliance with the 1976 Rule would continue to be out of compliance.

- 9. If a community water system (CWS), say, collects only three (of four) quarterly samples, is the running annual average (RAA) calculated with just the three available data points?**

If a system does not collect all required samples when compliance is based on a running annual average of quarterly samples, compliance is based on the running annual average of the samples collected (40 CFR 141.26(c)(3)(iv)). The system has committed a monitoring and reporting violation for the missed quarterly sample.

- 10. What is the correct holding time for gross alpha, radium226/228 and uranium? (1 year or 6 months?)**

The correct holding time for gross alpha, Ra-226 and Ra-228, and uranium is 6 months (see Manual for the Certification of Laboratories Analyzing Drinking Water EPA 815-B-97-001, March 1997 Criteria and Procedures Quality Assurance); however, for annual compositing of

radionuclide samples, the holding time is 12 months. This confusion was the result of a mismatch between the certification manual and the regulation. A footnote was added to the March 1997 edition of the certification manual, which acknowledged the conflict and stipulated a 12 month holding time for a composite. Therefore, systems can composite radionuclide samples during the initial monitoring period for up to one year.

11. Can you take more than one confirmation sample if there is significant difference from the original sample?

A state may require confirmations samples at its discretion (for either positive or negative results) and may require more frequent monitoring than specified in the Rule. Any state required sample (including confirmation samples) must be averaged with the initial samples to determine compliance and systems must include all samples taken and analyzed in determining compliance, even if that number is greater than the required minimum. 40 CFR 141.26(c).

12. Is compositing of four quarterly samples possible? EPA method specifies a 6-month holding time for gross alpha samples - compositing of four quarterly samples would exceed the 6-month holding time. What is EPA's position on this? Also, can radium compliance be determined using radium-226 and radium-228 results from different samples taken at different times?

For your first question, see answer to question #10. In terms of your second question, the Rule does not explicitly state that samples from the same EPTDS cannot be taken at different times; however, standard sampling practice would dictate that analytes measured at a sampling point should be taken from the same sample, or if not from the same sample, at least very close in time for representation purposes. EPA would highly recommend for compliance purposes that both Ra-226 and Ra-228 be analyzed from the same sample and not from samples taken at different times, which can introduce variability into the results.

13. If the lab has a detection limit of 1 pCi/L for gross alpha, can we substitute 0.1 pCi/L for R-226?

If using the same logic as when the gross alpha detection limit is 3 pCi/L, a system could substitute 0.5 pCi/L (i.e. $\frac{1}{2}$ DL) for either Ra-226 or uranium if the gross alpha detection limit was 1.0 pCi/L. Since radium-226 has a detection limit of 1 pCi/L and 0.5 pCi/L is less than that value, the system could go to reduced monitoring of once every 9 years, as opposed to once every 6 years.

14. Where did the reliably and consistently requirement come from? What is the reference?

40 CFR 141.23(c)(8) does use the “reliably and consistently” language; however radionuclides are not listed as contaminants regulated by this section of the CFR. In 40 CFR

141.26(a)(2)(iv), it requires systems to continue taking quarterly samples until they have **four** consecutive quarterly samples below the MCL. It does not mention the reliably and consistently language. For radionuclides, EPA advises states to follow the requirements of 40 CFR 141.26 and require both surface water and ground water systems to collect and analyze quarterly samples at that sampling point until the system has results from four consecutive quarters that are at or below the MCL before issuing a "return to compliance" determination. States can reserve the right to not issue this determination if there appears to be an upward trend in the quarterly data or there are other concerns.

15. At what level of total dissolved solids (TDS) will there be sufficient interference with the gross alpha" result? How high is "HIGH?"

It's difficult to determine an exact TDS amount that would cause sufficient interference with a gross alpha result. Any TDS in an evaporated sample that is greater than the calibration standard with the lowest efficiency is too high. Some trial and error testing for unfamiliar samples is normally required. For known samples, tables are usually prepared designating how much sample volume to use given TDS concentration. Method 900.0 (from the 1980 EPA Prescribed Procedures for the Measurement of Radioactivity in Drinking Water) recommends that for gross alpha, the solid density thickness should not exceed 5 mg/cm² in the counting planchet. Similarly, in Standard Methods 7110 B gives a recommendation in that solids should be less than 100 mg for a 20 cm² planchet.

16. How much time do you think it will take to get the gamma spec method approval?

Standard Methods is in the process of approving a gamma spec method. Gamma spectroscopy has long been approved for gamma emitters. One could combine method 900.1 for sample preparation and gamma spec for measurement. This is the basis of both the Georgia Tech and pending Standard Methods procedure. State agencies would need to approve gamma spectroscopy through their performance evaluation procedures to allow systems to use gamma spec. EPA, however, cannot provide verbal or written approval of this method to the States until this method is formally adopted in EPA's Rules. EPA is currently exploring this regulatory option.

17. What about the provision in the guidance document allowing a Public Water System (PWS) to go back and separately analyze for uranium by mass method if the converted pCi/L level is over 30 ug/L?

You would first measure uranium by mass since that is what the MCL is. The 0.67 conversion is from mass into a conservative picocurie activity. If you do the activity and convert to a mass (dividing by 0.67) over 30, you could measure mass directly. You may have more U-234 relative to U-238 so your mass would not be as high as the conversion might indicate.

18. Does "consecutive" truly mean four calendar quarters in a 12 month period? For

example, if the 3rd quarter is missed and a system waits till the 3rd quarter of the following year to collect a seasonally representative sample, the term consecutive no longer holds for, especially for the enforcement folks.

40 CFR 141.26(a)(2)(i) requires system to collect and analyze four consecutive quarterly samples before December 31, 2007. EPA's intent during this initial monitoring period was for systems to provide contaminant information during each of the four seasons. Strict adherence to this goal, however, could create a situation where systems that take a number of non-consecutive quarterly samples (all of which show no detects) still never satisfy the initial monitoring requirements.

EPA suggests that states require the system to either collect the fourth quarterly sample as soon as possible, or collect the sample the following year in the quarter that was missed. Compliance must be based on the running annual average of the collected samples.

After the initial monitoring period, if a system has a result above the MCL, the system must increase the frequency of monitoring at that entry point to quarterly sampling. Quarterly sampling must continue until four consecutive quarterly samples are below the MCL (40 CFR 141.26(a)(3)(v)).

19. If R-228 is below detection and R-226 equals 3 pCi/L, do both constituents need to be resampled every 6 years or can the R-228 be resampled in 9 years

Since the combined radium-226/228 result in your example is greater than ½ the MCL but less than or equal to the MCL, both radium-226 and radium-228 would need to be resampled in three years.

20. Can you be more specific as to how to take in to account the counting error for determining compliance with the radiochemical MCLs?

If a system substitutes a gross alpha measurement for either Ra-226 (if gross alpha does not exceed 5 pCi/L) or uranium (if gross alpha does not exceed 15 pCi/L), the standard deviation for the gross alpha measurement must be added to the gross alpha result to determine the final measurement for substitution. The CFR states it as such, "The gross alpha measurement shall have a confidence interval of 95% ($1.65\bar{F}$, where \bar{F} is the standard deviation of the net counting rate of the sample) (CFR 141.26 (a)(5)). This does not apply when systems are not using substitution. In that case, the actual measured value is used. The logic behind adding in the standard deviation when substituting is that there is already some uncertainty when an analytical result that is actually measured is substituted for a contaminant that is not measured. Adding in the error on the high side allows for some protection against this uncertainty. As an example:

Gross Alpha: 3 pCi/L \pm 0.3

Ra-226: substitute GA results (3.3 pCi/L is # 5 pCi/L)
Ra-228: 2 pCi/L \pm 0.2
Uranium: substitute GA results (3.3 pCi/L is # 15 pCi/L)

21. When will the radon rule be finalized?

EPA is evaluating regulatory priorities. The Radon Rule is on the December 2005 agenda, however, this priority will need to be balanced with other regulatory priorities, such as Stage 2 and Ground Water Rule regulations.

22. For those systems that are required to measure uranium directly, do systems have to submit both activity and mass for uranium? Does this mean they need to pay for two analyses (for activity and mass)?

Unless required by your state, uranium can be reported in mass or activity. The state will convert the uranium mass measurement to activity using a conversion factor of 0.67 pCi/ug and will convert uranium activity values to mass by multiplying the uranium activity by 1.49 ug/pCi. Conversion factors that have been calculated by assessing the uranium mass to activity ratios for individual systems may not be used (40 CFR 141.25 Footnote 12).

23. How should active/emergency sources be sampled if they are never put into service during the initial monitoring period? Should they just be sampled if/whenever they are turned on no matter when?

Systems must sample every entry point to the distribution system that is representative of all sources being used under normal operating conditions. If the emergency well is not used under normal operating conditions, it does not need to be turned on just to satisfy monitoring requirements.

24. Following installation of treatment, how frequently should I require a system to take confirmation samples? Annually? Triennially? Other?

A system's monitoring frequency is determined by its previous analytical results. The state may require confirmations samples at its discretion (for either positive or negative results) and may require more frequent monitoring than specified in the Rule 40 CFR 141.26(c).

EPA encourages states to treat systems installing new treatment the same as systems using a new source of supply. New CWSs and systems that begin using a new source of supply must conduct initial monitoring for gross alpha, radium-226/228, and uranium (i.e., collect and analyze four consecutive quarterly samples). In accordance with the initial monitoring requirements, this monitoring must begin within the first quarter after initiating use of the new source (40 CFR 141.26(a)(1)(ii)).

25. Does reduced monitoring begin immediately after initial round or do all systems start at the same time on Jan. 1, 2008?

All systems begin reduced monitoring starting on Jan. 1, 2008. At that point, sampling can be reduced to once every 3, 6, or 9 years depending on the contaminant level.

26. What is the CFR reference for the 4 times the MCL being an automatic violation?

40 CFR 141.26(c)(3)(i) states that, “for systems monitoring more than once per year, if any sample result will cause the running average to exceed the MCL, at any sample point, the system is out of compliance with the MCL immediately.” If a system has a result that is more than four times the MCL, even if the next three quarters results are non-detect, the system mathematically will have an average of greater than the MCL.

27. Can you provide some information about health risk from exposure to water with high uranium when taking a shower with this water?

Presumably the private water supply in question is not used for drinking water but provides water for other household uses. Skin penetration by uranium from bathing is not well established and no dose or risk estimates are available, but the hazard is expected to be low. An approximation for skin absorption can be made using the EPA equation for dermal absorption and associated default values for inorganics (from the EPA handbook on dermal absorption⁽¹⁾). During a 15 minute shower (or bath), an estimated 0.00486 pCi of uranium could be absorbed through the skin. This should be upper limit of expected absorption. While there are no risk coefficients for dermal absorption in Federal Guidance Report No. 13⁽²⁾, estimates can be made by dividing the activity absorbed by the f_1 for that element. This gives an ingestion equivalent for dermal absorption. The risk of fatal cancer would be about 3.48×10^{-10} per year for the uranium isotopes absorbed through the skin. Dose and risk estimates for the stomach and colon would be over estimated since the radionuclide wasn't ingested, but for these cases, the effect is not substantial.

Using external exposure dose coefficients from FGR 12⁽³⁾ and risk coefficients from FGR-13⁽²⁾, one can estimate the risk for immersion in water. For a daily 15 minute bath (or shower), the risk from external exposure to radiations from the uranium isotopes about 1.74×10^{-13} cancer deaths per year of exposure.

Any intake and risk from inhaled uranium in steam or ingestion of uranium in water during a shower is expected to be negligible.

References:

(1) *Dermal Exposure Assessment: Principles and Applications*, EPA/600/8-9-91, US EPA, Washington, DC, 1991.

(2) *Federal Guidance Report No. 13, Cancer Risk Coefficients for Environmental Exposure to Radionuclides*, EPA 402-R-99-001, US EPA, Washington, DC, 1999.

(3) *Federal Guidance Report No. 12, External Exposure to Radionuclides in Air, Water, and Soil*, EPA 402-R-93-081, US EPA, Washington, DC, 1993.

Note on Dermal Penetration Calculation:

Using the approach described in the EPA Dermal Assessment manual⁽¹⁾,

$$DA_{event} = K_p^w C_w t_{event}$$

$$DA_{event} = \text{Activity absorbed per unit area per event (pCi / cm}^2 \text{ - event)}$$

$$K_p^w = \text{Permeability coefficient from water (cm / hr)}$$

$$C_w = \text{Concentration in water (pCi / cm}^3 \text{)}$$

$$t_{event} = \text{Duration of event (hr / event)}$$

Since there are no published permeability coefficients for radium, radon or uranium a default estimate from the EPA Dermal Assessment manual will be used.

$$K_p^w = 10^{-3} \text{ cm / hr}$$

The equation for dermal absorption from water used is:

$$DA = (10^{-3} \text{ cm / hr})(0.25 \text{ hr / event})(\text{conc. in pCi / cm}^3)$$

The calculation for the 15 minute daily shower (or bath) was for an average adult with an assumed surface area of $1.8 \times 10^4 \text{ cm}^2$.

This yields an estimate of 0.00486 pCi of uranium that could be absorbed through the skin each day. If this activity is divided by the f_1 for the element, 0.02 for uranium, the resulting activity is the oral intake equivalent (0.243 pCi) producing the same tissue activity as the dermal absorption. Estimates of stomach or colon dose and risk are high because there would be substantially no activity in the contents of either organ as there would be with an ingestion exposure. The over estimate would be less than a factor of 2 for uranium.

28. How is it possible to meet hold times for samples and composite over 4 quarters?

See answer to question #10.

29. The presentation on calculations did not talk about adding the standard deviation to the gross alpha value that is substituted for Ra-226 or uranium. Does this need to be added

or should it just be used to determine the data quality?

Yes, the standard deviation should be added if substituting gross alpha for Ra-226 or uranium. See answer to Question #20.

30. How does EPA propose states determine Uranium compliance when using samples based on differing ratio assumptions for converting activity data to mass?

You are not converting activity to mass, but mass to activity for the purpose of subtracting uranium from gross alpha to determine compliance with the gross alpha MCL. Measure uranium by mass directly, which does not need a conversion. If you have activity data, divide by 0.67 and it will yield a conservatively high mass number. Then, if that result exceeds 30, measure mass directly. The mass to activity value may vary from well to well.

31. How likely is it for one sample result to be four times that of a previous result? I thought radionuclides are very consistent over long periods of time.

You are right generally, but in theory if a result was four times the MCL the remaining samples could not mathematically be averaged to below the MCL. In some cases, radionuclides have changed concentration by drawdown of aquifer or changing geochemistry altering pH causing more Ra to go into solution (e.g. NJ).

32. What is the effective uranium DL (1ppb or 3ppb 1/10th the MCL) to use in order to determine monitoring frequency?

In a June 29, 2004 *National Primary Drinking Water Regulations: Minor Corrections and Clarification to Drinking Water Regulations Final Rule*, EPA amended Table B at Sec. 141.25(c)(1) to add a detection limit of 1 [mu]g/L (1 ppb) for uranium.(69 FR 38850)

33. Can samples from multiple sources be composited by the laboratory (to save on analysis costs)?

40 CFR 141.26(a)(4) allows systems to composite up to four consecutive quarterly samples from a single entry point if analysis is done within a year of the first sample. Spatial compositing (i.e., compositing from more than one location such as different entry points or different sources) is not allowed under the Radionuclides Rule.

34. How would you determine the monitoring frequency for uranium, if substituting gross alpha for uranium, in light of the expected difference in the gross alpha and uranium

MDLs?

A gross alpha particle activity measurement may be substituted for the required uranium measurement if the gross alpha particle activity is less than or equal to 15 pCi/L. States should assume all of the gross alpha activity is due to uranium. If the gross alpha particle activity is greater than 15 pCi/L, then samples must be collected for uranium (40 CFR 141.26(a)(5)).

If the gross alpha particle activity result is less than the detection limit, one-half the detection limit (i.e., 1.5 pCi/L) is used for the uranium result (40 CFR 141.26(a)(5)). The gross alpha activity needs to be converted to mass by multiplying the activity by 1.49 ug/pCi. (1.5 x 1.49 = 2.24 ug/L). Since 2.24 ug/L is greater than or equal to the uranium detection limit (1 ug/L) but less than or equal to ½ the MCL for uranium, the system must monitor once every 6 years.

35. Please explain the "sum of fractions" for beta and photon emitters. Speaker had to skip the slide due to time limit. Please provide a sample calculation using sum of fractions to determine compliance.

The sum of the fraction method is used because each photon emitter targets a different organ of the body, which results in a different magnitude of risk. The sum of the beta and photon emitters shall not exceed 4 millirems/year (40 CFR 141.66(d)(2)).

While the measure used in risk calculations is "millirems," contaminants are analyzed in "pCi/L." Therefore, to determine compliance, each beta and photon emitter must be converted from pCi/L to millirems using the conversion tables listed in "Maximum Permissible Body Burdens and Maximum Permissible Concentrations of Radionuclides in Air or Water for Occupational Exposure" [National Bureau of Standards (NBS) Handbook 69 as amended August, 1963, U.S. Department of Commerce]. The table is included in Appendix I of EPA's Implementation Guidance for the Radionuclides Rule (EPA 816-F-00-002), which can be found at:

http://www.epa.gov/safewater/rads/final_rads_implementation_guidance_appendices.pdf

The column titled "1976 limits based on critical organ at 4 mrem/yr" indicates what 4 mrem of exposure would be for that contaminant expressed as pCi/L. For each emitter that is detected by the laboratory, the system must divide the pCi/L found in the sample by the value in the conversion tables. This provides a fraction of how much the particular beta or photon emitter is providing towards the maximum of 4 mrem/year for all of the beta photon emitters.

$$\frac{\text{pCi/L found in sample (from laboratory results)}}{\text{conversion factor}} = \text{fraction of the maximum 4 mrem/year exposure limit}$$

pCi/L equivalent of 4 mrem of exposure (from conversion table)

Each fraction must then be converted to a dose equivalent of 4 mrem/year by multiplying the fraction by 4. The results for each emitter must be summed to determine compliance

For example, a water system near a nuclear power facility collects a sample which the laboratory speciates by EPA method 902.0 (gamma spectrometry analysis). The laboratory also analyses for strontium-90 using EPA method 905.0. The analysis indicates the following:

Cesium-134 (Cs-134): 5,023 pCi/L
 Cesium-137 (Cs-137): 30 pCi/L
 Strontium-90 (Sr-90): 4 pCi/L
 Iodine-131 (I-131): 2 pCi/L

To determine compliance the following calculations are completed:

Emitter	(X) Lab Analysis (pCi/L)	(Y) Conversion from table (pCi/4mrem)	(X/Y=A) Calculated Fraction ¹	(A*4) Calculated Total mrem ²
Cs-134	5,023	20,000	0.25115	
I-131	2	3	0.7	
Cs-137	30	200	0.150	
Sr-90	4	8	0.5	
Sum-of-the-fractions			1.60115	7

¹To ensure accuracy, the results were rounded to the number of figures in the conversion table. See Appendix I of EPA's Implementation Guidance for the Radionuclides Rule (EPA 816-F-00-002), which can be found at: http://www.epa.gov/safewater/rads/final_rads_implementation_guidance_appendices.pdf.

²Since data reported to the State or EPA should be in a form containing the same number of significant digits as the MCL, the results were rounded to one significant digit. The last significant digit was increased by one unit if the digit dropped was a 5, 6, 7, 8, or 9; and was not altered if the preceding number was a 0, 1, 2, 3, or 4.

The system is in violation of the MCL because the “sum-of-the-fractions” is 7 mrem, which means that the sum of the annual dose equivalent to the total body, or to any internal organ, exceeds 4 mrems/year.

36. Why did EPA decouple Ra-226 and Ra-228? The MCL is still a 'combined' MCL but the monitoring is decoupled, meaning that Ra-228 monitoring does not depend on Ra-226 in the new rule.

Ra-228 never depends on Ra-226. They originate from different parent decay chains – Ra-228 from thorium and Ra-226 from uranium. However, they have the same number of protons, so both isotopes are radium. In order to maintain or provide greater protection of health, decoupling would have presented a difficult problem. Protection is represented by picocuries of radiation, not changing perceptions of risk associated with individual isotopes. EPA considered lowering the Ra-228 component to 3 pCi/L, but the cost of the reduction did not justify the benefit. The Radio nuclides Rule maintained the level of public health protection by retaining the MCL.

The problem with the 1976 Rule was the tiered approach which made the Ra-228 measurement dependent on the Ra-226 measurement when in reality, there is no connection. A system might have high Ra-228 and little Ra-226. In the 1976 Radio nuclides Rule, Ra-226 that was below 3 pCi/L was indicative of Ra-228 less than 2 pCi/L which means together they are below 5 pCi/L. It is now known that this was an incorrect assumption. De-linking them ensured that both radium-228 and radium-226 (or gross alpha proxy for radium-226 if the system is using the substitution allowed under the Rule) were properly accounted for in the radium total. De-linking them provided a more accurate look at Ra-228.

37. Uranium methods on the slide - EPA method 200.8, SM 3125, ASTM D5673-03. Are these all the same but different names used by different agencies?

All three methods use an inductively coupled plasma mass spectrometry (ICP-MS) technology. The methods are published by different entities: EPA, American Society of Testing and Materials International (ASTM), and the Standard Methods Committee (EPA 200.8, ASTM D5673-03, and SM 3125). In each of these methods, sample material in solution is introduced by pneumatic nebulization into a radiofrequency plasma where energy transfer processes cause desolvation, atomization and ionization. The ions are extracted from the plasma through a differentially pumped vacuum interface and separated on the basis of their mass-to-charge ratio by a quadrupole mass spectrometer having a minimum resolution capability of one atomic mass unit peak width at five percent peak height. The ions transmitted through the quadrupole are detected by an electron multiplier or Faraday detector and the ion information processed by a data handling system. The sensitivity of each ICP-MS method for compliance determinations of uranium in drinking water is acceptable and is sensitive enough to detect at less than one part per billion (1 ug/L). The uranium MCL is 30 ug/L. EPA reviewed each of these methods for performance and applicability to compliance determinations of uranium in drinking water.

38. Why didn't EPA include NTNCWS? What was the justification when all other rules (Ph2/5, arsenic) include NTNCWS?

EPA applied the cost/benefit analysis and the modeling indicated that the impact would not be great enough to warrant a regulation.

39. Why was the risk stated in the 1991 Proposal lower? That is, it allowed EPA to consider 20 pCi/L from 5 pCi/L (1976) for the Radiums. Please explain the logic behind proposing such a higher level in 1991 and then returning to the original 1976 level in the final rule. Did EPA have new risk information in 1991?

The EPA Science Advisory Board/Radiation Advisory Committee (SAB/RAC) suggested that the Agency use the risk per unit exposure for external radiation proposed by the United Nations Scientific Committee on the Effects of Atomic Radiation and the International Commission on Radiation Protection Report No. 30 in making risk calculations for the proposed Drinking Water regulations proposed and published in 1991. The SAB/RAC review was completed in late 1990 and their recommendations were included in the proposed regulations. However, by the time the proposal was published in 1991, these risk estimates had been shown to be about a factor of three too low. At the same time, there were improvements in the biokinetic models being used and better information on the distribution of cancers by organ. All these factors affect the estimated risk per unit intake of radionuclides.

Also, the risk models adopted for risk protection are relative risk models. That is, the risk is an incremental increase in the spontaneous cancer rate, so as the rate of cancer in the population increases, so does the number attributable to radiation. The risk calculation for the 1991 proposal were based on 1980 vital statistics, while calculations for the 2000 proposal were based on 1990 vital statistics. Since cancer mortality rates were higher in 1990, the estimated risks would be higher too. All of these factors combined to yield about a four fold increase in the risk estimates for radionuclides in water.

With the new risk estimates, the MCLs suggested in 1991 yielded risks greater than the 10^{-4} risk which is the maximum in the EPA risk range. The risks could be recalculated, so that they would fall into the 10^{-4} - 10^{-6} risk range, but then a new rule making would have been required. Therefore, the MCLs (i.e. current drinking water standards) from 1976 were retained because the vast majority were below 10^{-4} and within the EPA risk range. In addition, the Safe Drinking Water Act has an anti-backsliding provision which says a standard cannot be changed in such a way that there could be less public health protection.

40. The holding times for the methods listed on Table 1-8(?) is 6 months but the holding time for compositing samples is 12 months? Please explain the difference.

Please see the answer to question #10

41. Is it true that when using a gross alpha measurement as a surrogate for the uranium mass measurement, the uranium mass detection limit of 1 ug/L is automatically

exceeded, (as it is for radium) hence precluding a once in every 9 year sampling frequency for uranium? In addition, it looks like 2.24 ug/L would be the result to use in a running annual average (RAA). I get 2.24 ug/L by a) substituting one-half the gross alpha detection limit of 3 pCi/L, hence 1.5 pCi/L; b) converting this to mass units by multiplying by 1.49 ug/pCi (i.e., the inverse of 0.67 pCi/ug); which, c) results in 2.24 ug/L.

A gross alpha particle activity measurement may be substituted for the required uranium measurement if the gross alpha particle activity is less than or equal to 15 pCi/L. States should assume all of the gross alpha activity is due to uranium. If the gross alpha particle activity is greater than 15 pCi/L, then samples must be collected for uranium (40 CFR 141.26(a)(5)).

If the gross alpha particle activity result is less than the detection limit, one-half the detection limit (i.e., 1.5 pCi/L) is used for the uranium result (40 CFR 141.26(a)(5)). The gross alpha activity needs to be converted to mass by multiplying the activity by 1.49 ug/pCi. ($1.5 \times 1.49 = 2.24$ ug/L). Since 2.24 ug/L is greater than or equal to the uranium detection limit (1 ug/L) the system could not move to a once every nine years sampling frequency.

- 42. With regard to Beta Particle and Photon Radioactivity, an allowance for naturally occurring potassium-40 (K-40) is made, in that the K-40 is subtracted from the gross beta particle activity prior to comparing to the regulatory levels (50. pCi/L, or 15. pCi/L, which ever is the appropriate screening level). Is there any allowance for the naturally occurring beta particle emitting daughters of U-238 (Th-234 & Pa-234m)?**

There are no allowances for Th-234 and Pa-234.

- 43. With regard to the health protectiveness of establishing the MCL as a mass concentration (i.e., 30. ug/L), as a chemical toxicity level, will EPA be providing any health advisory or guidance on how to evaluate cases that have not only significant uranium mass from U-238, but also U-234 alpha particle activity (radio-toxicity) above and beyond the 0.67 pCi/ug, 'U-Nat' 1-to-1 U-238-to-U-234 ratio? As an example, I would offer the real world example of a BIA boarding school which has uranium values (by alpha spectroscopy) of: U-238 @ 8.3 pCi/L and U-234 @ 46.5 pCi/L, with a U-mass measurement of 26.0 ug/L (in agreement with $8.3 \text{ pCi/L} \times 3 \text{ ug/[pCi/L of U-238]} = 24.9$ ug/L). The U-mass MCL is met, as 25 or 26 is less than 30 ug/L. However, the U-234 activity at 5.6 times the assumed 1-to-1 ratio, clearly makes the water considerably more radio-toxic than is appreciated from the 26 ug/L figure. I can appreciate, not trying to cover these somewhat special situation with a regulatory rule; but believe guidance is needed.**

You are correct, we initially tried to establish a dual standard of activity and mass both at 30 pCi/l and 30 ug/L. It had to do with risk of cancer for the activity, and benefits, not one to one ratio. However conversion factors and other factors led to selecting activity, then mass (since

mass was more limiting usually) as the MCL. However, the rule is effectively a U-238 rule and U-234 is left out. The exception you pointed out was hoped to be rare. We put the advice in the preamble that activity should be below 30 pCi/L as well but did not make it a requirement

- 44. If a system has a gross alpha particle activity result which is less than detection (less than 3 pCi/L), and the system uses this gross alpha particle activity measurement in lieu of the radium-226 and the uranium measurement, ½ the detection limit for gross alpha, 1.5 pCi/L, is used for radium-226 and uranium to determine compliance and future monitoring frequency. Since 1.5 pCi/L is greater than the regulatory detection limit for radium-226 (1 pCi/L), and uranium (1ug/L x 0.67 pCi/ug = 0.67pCi/L), should this system report radium-226 and uranium in their Consumer Confidence Report (CCR) as detected at 1.5 pCi/L?**

CFR regulations do not specify whether or not to list either Ra-226 or uranium as a detected contaminant in a CCR when a gross alpha result is substituted for them. The following language was developed that systems could add as a footnote to the contaminant table in the CCR:

“The detected level of gross alpha is allowed to be substituted for uranium and radium-226 measurements. This result indicates that either of these contaminants may be present at a level ranging from 0 - 3.0 pCi/L, which is still below the MCL.”

- 45. Do we have a DL for uranium activity? Although our MCL is in mass, if systems grandfathered uranium data, it may have originally been measured in activity, since they subtracted uranium from gross alpha, which was in activity. Or, do you not worry about the DL for uranium activity and simply take the activity and convert to mass for compliance purposes?**

Since the uranium MCL is in ug/L, the detection limit for uranium is 1 ug/L. If a system measures activity, you would simply convert it to mass using the 1.49 ug/pCi conversion factor. As long as the gross alpha detection limit was met by the lab, there shouldn't be a problem with determining whether a system is in or out of compliance for uranium mass.

- 46. According to the regulation, gross alpha has an MCL of 15 pCi/L and combined radium-226/228 has an MCL of 5pCi/L. Neither of the above have a decimal (.) point after the whole number, so it is assumed that the MCL is the whole number and that to exceed the MCL, gross alpha would have to be 15.5 pCi/L which rounds up to 16 pCi/L and combined radium-226/228 would have to be 5.5 pCi/L which rounds up to 6 pCi/L.**

The question with gross alpha would not appear to be a problem, but for radium-226 and radium-228 an issue arises. We get a separate reading for both radium-226 and radium-228. The detection limit for each of the above is 1 pCi/L, so if the number is less than 1.5 pCi/L it would be rounded down to 1 pCi/L which is at the detection limit.

The following is a quick example of why the concern exists:

You have a reading of 3.4 pCi/L for radium-226 and a reading of 2.4 pCi/L for radium-228 which if added together would be 5.8 pCi/L, which would round to 6 pCi/L or an MCL exceedance; or, you have a reading of 3.4 pCi/L for radium-226 and a reading of 2.4 pCi/L for radium-228 and you round each one before you come up with the combined radium-226/228. The numbers would be 3 pCi/L for radium-226 and a 2 pCi/L for radium-228 when added together would be a 5 pCi/L or at the MCL but not exceeding.

What needs to be identified is when is the rounding performed? Is it correct to say that a system exceeds the MCL at 6 which could be anywhere from 5.5 up? Another part of this is do you do the rounding each quarter or annually to get the average? The thought is each quarter.

These questions are all based on the reading of *Water Supply Guidance #21* which is listed as the reference on Appendix E-18. This guidance states ".....while 5.4 pCi/l of combined radium-226 and radium-228 would round down to 5 pCi/l." It does NOT state radium-226 and radium-228 should be looked at individually.

Guidance for the individual analysis of radium is not specific, so the following common practice is highly recommended. For individual sampling events (i.e. quarterly sampling), when adding the Ra-226 and Ra-228 results together, non-significant figures should be added as well for summation purposes. When averaging results, use these individual measurements with the non-significant figures and determine average. This result is then rounded up or down to the nearest whole number. This average should be reported to SDWIS/FED in a form containing the same number of significant digits as the MCL. The last significant digit should be increased by one unit if the next digit is 5, 6, 7, 8, or 9. The last significant digit should not be increased if the next digit is 0, 1, 2, 3, or 4.

An Example of Initial Quarterly Monitoring Calculations For Ra-226/228

Q1: Ra-226 = 3.2	Ra-228 = 2.2	Ra-226 + Ra-228 = 5.4 pCi/L
Q2: Ra-226 = 1.6	Ra-228 = 3.1	Ra-226 + Ra-228 = 4.7 pCi/L
Q3: Ra-226 = 1.5	Ra-228 = 1.3	Ra-226 + Ra-228 = 2.8 pCi/L
Q4: Ra-226 = 4.6	Ra-228 = 5.4	Ra-226 + Ra-228 = 10.0 pCi/L

Average: $(5.4 + 4.7 + 2.8 + 10.0)/4 = 5.725$ pCi/L

Round to nearest whole number for compliance: **6 pCi/L** (exceeds 5 pCi/L MCL)