Questions and Answers from the Radionuclides Rule Web Cast

August 4, 2004

1. Where can we find the responses to the questions asked at the last rads webcast?

The answers are posted on EPA's web site at
http://www.epa.gov/safewater/dwa/rules.html

2. Has EPA validated this (SPARRC) model with a pilot plant?

No piloting work was undertaken to validate the Spreadsheet Program to Ascertain Radioactive Residual Concentration (SPARRC) model. The relationship between relevant treatment and raw water variables included in the model is based on peer-reviewed literature and some limited field and lab generated gray literature. Moreover, running pilot studies would be very expensive especially considering that this model has five different treatment technologies for uranium and radium. We believe the most economical way to validate this model would be through collecting data from treatment plants that operate technologies similar to those modeled in SPARRC.

3. What is the 15 pounds based on? Per load, per year?

If a system has source material that contains more than 0.05 percent uranium or thorium, by weight, and has a total of no more than 15 pounds in its possession at any time, it is considered to have a "small quantity" of source material (see 10 CFR 40.22) and is subject to the general license requirements of 10 CFR 40.22 or equivalent regulations of the Agreement States. Under this general license, systems may not possess more than 150 pounds of source material in any one calendar year. Source material held under this general license normally requires disposal at facilities authorized to accept low-level radioactive waste (LLRW).

Systems that exceed these small quantity thresholds must apply for specific licenses from the Nuclear Regulatory Commission (NRC) or Agreement State and dispose of residuals at facilities authorized to accept LLRW (unless regulators approve another type of disposal). Water treatment facilities that exceed the small quantity thresholds can also apply to the NRC for an exemption from regulatory requirements in 10 CFR Part 40

4. Do we have any examples of successful uranium treatment residuals disposal?
Given that the uranium MCL just went into effect in December of 2003 and systems have until December of 2007 to collect their initial samples, many systems have not yet begun

treating for uranium in their source water. EPA does not have any specific examples of uranium residual disposal, although it is very possible that systems have already been addressing this issue successfully.

5. What level of barium is left after treatment?

The levels of soluble barium in the treated water from processes using barium sulfate or barium-sulfate-impregnated media are not a concern in the water supply. The barium MCL is 2 mg/L whereas about 0.2 mg/L barium was observed in process effluent where barium sulfate impregnated alumina was used to remove radium (Garg and Clifford, 1992)

6. Has any research been done on using metal oxides other than MnO2 (e.g., iron and aluminum oxides)? What about using solid MnO2 vs. MnO2 coated media?

High-surface-area-aluminum oxides (activated alumina) have been used successfully (Garg and Clifford, 1992). Iron oxides will also possibly work, but have not been extensively studied.. Solid MnO2 will work to some extent, but the surface area is so low that the capacity will be very limited compared with MnO2 coated fibers or preformed MnO2 coagulants.

7. How effective is ion exchange for uranium removal at pH in the range of 5.5 - 6.5? Is pH adjustment required to pH 7.5?

Ion exchange is effective for uranium removal in the pH range of 5.5-6.5. Ion exchange at pH 5.8 for uranium removal was tested in a Chimney Hill, TX pilot study and was found to be equally effective as pH 8, for 27,000 BV run lengths. It is not necessary to adjust the pH to 7.5.

8. Is ferric oxide an approved method for uranium or arsenic removal?

Granular Ferric Oxide (GFO) and Granular Ferric Hydroxide (GFH) are the most frequently recommended treatment methods for arsenic in small community water supplies. As mentioned in an earlier answer, iron oxides/hydroxides will probably work for uranium removal but have not been studied, to our knowledge.

Ferric oxide is not listed as a Best Available Technology (BAT) or a Small System Compliance Technology (SSCT) in either the Arsenic Rule or the Radionuclides Rule. However, any technology that is accepted by the State primacy agency and achieves compliance with the maximum contaminant level (MCL) is allowed.

If a system is unable to meet the MCL with its chosen technology, the system is not eligible for a variance unless it has installed a BAT and still cannot achieve compliance.

9. Re: Last slide - How might each of these residuals be disposed of?

EPA could not determine which slide the question was referring to. EPA surmised that the disposal options for the referenced residuals would depend on the characteristics of the wastes, the volume of the wastes, and what state regulations allowed.

10. Has anyone looked at the treatment of water that contains both arsenic and uranium? Any suggestions on how to optimize for the removal of uranium? What about the wastes?

Arsenic and uranium are anions that are readily removed by ion exchange with chloride-form strong-base resins and regenerated with sodium chloride. The run length to arsenic breakthrough, typically 400-4000 bed volumes (BV), will be much shorter than the uranium run length (typically > 30000 BV). Therefore, a process that removes both arsenic and uranium would be regenerated at arsenic breakthrough, which would ensure the removal of both arsenic and uranium.

11. How do public water systems (PWSs) overcome the high cost of disposal to a Class I underground injection control (UIC) well?

Class I wells are technologically sophisticated wells used to inject large volumes of hazardous, industrial and municipal wastes into deep isolated rock formations that are separated from the lower most underground source of drinking water. EPA imposes stringent technical requirements on these wells, through both UIC and the Resource Conservation and Recovery Act (RCRA) regulations, to safeguard against the public health risks posed by hazardous wastes. The multiple levels of protection provided by Class I well construction, along with testing, monitoring, and operating, requirements can be expensive to implement. However, Class I wells are generally less costly when compared to other disposal options available to hazardous waste generators.

Generally, EPA recommends that systems avoid treatment technologies that would produce liquids that would be considered radioactive (10 CFR 20, Appendix B, Table 2, Column 2) according to UIC regulations or hazardous (40 CFR 261.3) and encourages PWSs to seek less expensive disposal options, as appropriate. For example, recycling of liquid wastes could reduce the overall quantity of liquids, while direct discharge or discharge to a publicly owned treatment works (POTW) may also be an option for a system. The system would need to check with the POTW to determine whether or not this method of disposal would be a viable option, and if discharging to a stream, the system would need to determine whether their National Pollutant Discharge Elimination System (NPDES) permit would allow such a discharge.

12. What does OTM stand for?

OTM stands for "other-than-municipal" in the State of Wisconsin. OTMs are community water systems that are not owned by a municipality. Examples include mobile home parks, apartment buildings, and condominium associations.

13. According to the underground injection control (UIC) regulations, at what concentration would uranium or radium be considered "hazardous waste" or "radioactive waste"?

Under UIC regulations, radioactive refers to any waste containing radioactive concentrations that exceed those listed by the Nuclear Regulatory Commission in 10 CFR 20 Appendix B, Table 2, Column 2. These concentrations are 60 pCi/L for radium-226, 60 pCi/L for radium-228, and 300 pCi/L for uranium.

The presence of radionuclides themselves, do not necessarily classify the waste as hazardous or non-hazardous. Hazardous waste generation will most likely be the result of the removal of co-occurring waste stream contaminants such as arsenic. Water systems should analyze their waste to determine if the waste generated is considered hazardous waste under RCRA as defined under 40 CFR 261.3. If the residuals exhibit a hazardous characteristic, the residuals must be managed pursuant to the requirements of RCRA Subtitle C (hazardous waste).

14. What is the uranium concentration of the source waters?

EPA is not clear to what study the question is referring to.

15. Why is barium sulfate co-precipitation such a rarely implemented treatment option?

Ion-exchange softening works just fine and is not expensive if brine disposal is allowed to the sewer. Other than ion exchange softening, it seems that all other systems are rarely implemented in the USA. Two ground water treatment plants in Saudi Arabia switched from MnO2 to barium sulfate, presumably because of the black precipitate that formed when MnO2 was used as a preformed coagulant/adsorbent. They much preferred the white BaSO4. It is hypothesized that costs are similar for BaSO4 and MnO2.

16. What are the concerns regarding backwash waste from ion exchange to on-site septic (for very small community water systems (CWS)) and how were they dealt with?

The impacts from drinking water treatment residuals to onsite systems are not fully understood. Dissolved inorganics, organics, and corrosives associated with residual waste streams are of great concern from a public health standpoint. The Office of Wastewater

Management has received complaints from the onsite industry claiming that the brine from water treatment systems may cause onsite systems to fail by effecting the septic tank layering and clogging drainfields. OWM is working with the onsite industry to investigate these complaints.

The UIC program regulates as Class V wells onsite systems that receive waste from multiple family residences or from any non-residential establishment that includes any waste other than sanitary waste or that has the capacity to serve 20 or more persons per day (also known as Large Capacity Septic Systems). The UIC program does not regulate single-family residential waste disposal systems such as domestic cesspools or septic systems. Class V wells, once authorized, may inject non-hazardous and non-radioactive waste according to UIC regulation as long as the wastes do not endanger underground sources of drinking water. The UIC Program may require additional public health protection measures for Class V wells on a case-by-case basis if, for example, the geology, hydrology or waste stream characteristics warrant such actions. States may have additional or more stringent requirements for single family and large capacity onsite systems as well.

17. Can we find Wisconsin's waste disposal guidance on their website?

The Radionuclide Wastewater Disposal Criteria is located at: http://dnr.wi.gov/org/water/dwg/plrev/Guidelines.htm. Once on the website, the document can be found in the left column under the topic "Types".

18. What does EPA use as criteria for disposal to a private septic system or into a drywell?

See response to Question 16.

19. Do we have any evidence that exposures are significant at water treatment plants?

We have not obtained measured data at this time on dosages that may be received by plant workers.

However, radiation measurements of residuals and filters have been quite high in some geographic areas of the country with elevated radionuclide occurrence in source waters. In some instances, radium has been found on radium-selective resins or adsorbents at concentrations of up to 3,500 pCi/g, while ion exchange resins may have radium activity levels an order of magnitude greater than that. Depending on a worker's job, the time in hours annually spent in close proximity to or handling such materials, and the health and safety precautions taken (or not taken!), the dose could be significant and merit implementation of Occupational Safety and Health Administration (OSHA) regulations for workers.

20. Is the radon level of 4 pCi/L meant to be in air, and not water?

Correct, the level of 4 pCi/L refers to the concentration of radon in air and not water.

21. Can exposures be significant from point of use (POU) devices?

EPA does not have radiation measurements from small point of use devices, though because of the smaller amounts of water filtered by them, we do not expect the radiation levels to be significant provided they are changed at regularly recommended and scheduled intervals.

For reverse osmosis, significant exposure is unlikely to be an issue, since the membrane splits the stream into product and reject waters and very little will be retained on the membrane. If adsorptive media are used, then there may be an issue with radioactive decay of adsorbed contaminants. However, EPA is recommending that the cartridges with media be replaced every six to nine months (one year at the most). If further studies indicated that decay could produce a significant exposure, then EPA would consider revising the guidance to indicate that systems should replace the cartridges at six months and not try to extend the useful life to nine months or a year.

22. What is the current status of the new ICP-mass spec method for the testing of uranium in drinking water?

EPA published a final rule on August 25, 2004 (69 Fed. Reg. 52176) approving the use of three additional analytical methods for compliance determinations of uranium in drinking water. The rule can be found at:
http://frwebgate5.access.gpo.gov/cgi-bin/waisgate.cgi?WAISdocID=24851881296+0+0+0&WAISaction=retrieve

23. What are the regulations for disposal of spent filter media? At what concentrations?

The following federal statutes and regulations apply to the disposal of spent filter media:

The Resource Conservation and Recovery Act (RCRA; 40 CFR 238 to 252), which governs the identification, classification, and management of solid[1] and hazardous wastes.[2]

The Municipal Solid Waste Landfill (MSWLF) Requirements (40 CFR 258, under Subtitle D of RCRA), which establish minimum national criteria for MSWLFs covering landfill location, operation, and design; ground water monitoring; corrective action; closure and post-closure, and financial assurance.

Department of Transportation (DOT) regulations (49 CFR 171 to 180), which govern the shipping, labeling, and transport of hazardous (including radioactive) materials.[3]

Under the Low-Level Radioactive Waste Policy Act (42 USC 2021b(9)) radium is not considered source or byproduct material but uranium and thorium are considered "source material" (42 USC 2014(z)) and are subject to NRC licensing and regulation. However, source material is of an "unimportant quantity" (10 CFR 40.13) and is *exempt* from NRC

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[1]Any garbage, refuse, sludge from a wastewater treatment plant, water supply treatment plant, or air pollution control facility, and other discarded material, including solid, liquid, semisolid, or contained gaseous material, resulting from industrial, commercial, mining, and agricultural operations and from community activities. (U.S. EPA, *Mixed Waste Glossary*) For the purposes of hazardous waste regulation, a solid waste is a material that is discarded by being either abandoned, inherently waste-like, a certain waste military munition, or recycled. (U.S. EPA, 2003)

[2]Hazardous waste is defined under 40 CFR 261.3. Waste is considered hazardous if it is a solid waste (as defined under 40 CFR 261.2) that is not excluded from regulation as hazardous waste under 40 261.4(b) and when it meets the criteria listed under 40 CFR 261.3(a)(2) and (b).

[3]In 49 CFR 173.436, DOT provides levels for individual radionuclides (both in terms of concentration and a total consignment activity) that are exempt from labeling requirements (i.e., the material is not "radioactive for the purposes of transport") (See "Hazardous Materials Regulations; Compatibility With the Regulations of the International Atomic Energy Agency; Final Rule." 69 FR 3632 (January 26, 2004) at http://www.tgainc.com/pdf/69fr-3631.pdf). In the preamble to the Rule, DOT explains that the exemptions apply to, "other natural materials or ores...when those materials or ores are to be used because of some other physical or chemical characteristics...[or] when these have been subjected to physical or chemical processing, when the processing was not for the purpose of extracting radionuclides...provided that their radionuclide concentration does not exceed 10 times the activity concentration in the table in [section] 173.436." For example, uranium is listed in the table in [section] 173.436 at 27 pCi/g and radium-226 and -228 are listed at 270 pCi/g. Therefore, a system would need to transport over 270 pCi/g of uranium or 2,700 pCi/g of radium before meeting the "10 times" exemption threshold.

regulation if the uranium or thorium makes up less than 0.05 percent by weight (or approximately 335 pCi/g for natural uranium) of the material.

If a system has source material that contains more than 0.05 percent uranium or thorium, by weight, and has a total of no more than 15 pounds in its possession at any time, it is considered to have a "small quantity" of source material (see 10 CFR 40.22) and is subject to the general license requirements of 10 CFR 40.22 or equivalent regulations of the Agreement States. Under this general license, systems may not possess more than 150 pounds of source material in any one calendar year.

Systems that exceed these small quantity thresholds must apply for specific licenses from the NRC or Agreement State and dispose of residuals at facilities authorized to accept LLRW (unless regulators approve another type of disposal). Water treatment facilities that exceed the small quantity thresholds can also apply to the NRC for an exemption from regulatory requirements in 10 CFR Part 40.

Mixed waste is regulated under RCRA and the Atomic Energy Act (AEA) of 1954. Mixed waste "contains both hazardous waste and source...or byproduct material subject to the Atomic Energy Act of 1954." (42 USC 6903.41) Therefore, systems generating waste containing uranium or thorium (source material) as well as hazardous waste could potentially have a mixed waste. If wastes contain licensable amounts of source material (any concentration exceeding the "unimportant quantity" in 10 CFR 40.13(a)) and hazardous waste, these wastes must be disposed at a facility authorized to accept mixed waste.

It is the responsibility of the individual states to determine the most appropriate analytical method for testing water treatment plant waste containing technically enhanced naturally occurring radioactive material, or TENORM (and possibly source material) and any requirements or guidelines for disposal. If allowed by the state, systems can use the NRC/EPA "Guidance on the Definition and Identification of Commercial Mixed Low-Level Radioactive and Hazardous Waste" (available at http://www.epa.gov/radiation/mixed-waste/mw_pg25.htm).

24. I have measured the radiation levels at 1,200 to 1,400 mrem near an iron filter. Is this a problem?

Most radiation meters will measure radiation levels as an exposure rate in microroentgens (microR) per hour, rather than millirems, though some of the more expensive meters will actually convert the radiation rate to an equivalent dose (millirems). Whichever is the case for the measurement taken, the levels are elevated and would require caution for exposure, handling, and disposal.

Background radiation levels in most places in the U.S. are less than 10 microR/hr. Depending on a worker's job, the time in hours annually spent in close proximity to or

handling such materials, and the health and safety precautions taken (or not taken!), the dose could be significant and merit implementation of OSHA regulations for workers.

25. According to Water Supply Guidance #21 (1981), all radionuclide results should be rounded off to the nearest whole number. Is this the correct procedure when determining compliance with each of the radionuclides?

Guidance for the individual analysis of radionuclides is not specific, so the following common practice is highly recommended. For individual sampling events (i.e. quarterly sampling), non-significant figures should be included in the calculations. When averaging results, use these individual measurements with the non-significant figures to determine the 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.

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

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)

26. Should systems avoid generating residuals classified as low level radioactive waste (LLRW)? If so, how do we calculate the time to pull a resin before it becomes LLRW?

Systems should do everything possible to economize their operation. There is a tradeoff between run length and the buildup of radioactivity on the resin. Depending on the cost of disposal versus operational advantages, systems ought to optimize the running of the treatment plant. There are two ways of determining when it's a good time to pull the system offline. The first method is through pilot testing if systems can afford to conduct these tests. The second approach is through simulating the plant conditions into a model such as SPARRC.

27. Is there a guidance document (summary) for worker's safety, handling, and use of radionuclide water treatment devices?

The EPA draft guidance for regulators (*DRAFT A Regulators' Guide to the Management of Radioactive Residuals from Drinking Water Treatment Technologies*) is intended to introduce the topic. OSHA regulations (29 CFR 1910.1096) provide basic safety requirements that should be followed, depending upon state implementation. Depending on responses to our current guidance, we will evaluate whether additional guidance on worker safety for handling of water treatment devices and wastes is needed.

28. Where can I find more information on upcoming webcasts?

Information about the upcoming Web casts is included on EPA's web site at http://www.epa.gov/safewater/dwa/rules.html.

29. Does EPA have information on how to optimize treatment technologies for the removal of uranium? (Considerable time, effort, and funds have been spent doing this for arsenic treatment.) Where can this information be found (e.g., EPA's Web site, publications, etc)?

The following publications by Dennis Clifford and co-workers will be helpful in optimizing treatment for uranium removal:

Clifford, D. A., and Z. Zhang, "Combined Uranium and Radium Removal by Ion Exchange", J. Amer. Water Works Assoc., Vol. 86, No. 4, pp. 214-227 April 1994.

Z. Zhang, and D. A. Clifford, "Exhaustion and Regeneration of Resins for Uranium Removal", J. Amer. Water Works Assoc., Vol. 86, No. 4, pp. 228-241, April, 1994.

Clifford, D. A., "Ion Exchange and Inorganic Adsorption," Chapter Nine in Water Quality and Treatment Fifth Edition, pp. 9.1-9.91, Ray Lettermam, ed., McGraw Hill, Inc., New York, 1999.

Clifford, D. A., and Z. Zhang, "Removing Uranium and Radium from Ground Water by Ion Exchange Resins," in Ion Exchange Technology: Recent Advances in Pollution Control, Arup K. Sengupta, ed., pp. 1-59, Technomic Publishing Co., Lancaster, PA, 1995.

30. The 1999 reference prepared for EPA, *Technologies and Costs for the Removal of Radionuclides from Potable Water Supplies,* Section 6, discusses anion exchange and uranium removal. All but one of the studies are from the 1980s. Are there any additional studies that would help engineering firms design and optimize pilot studies and treatment facilities for the removal of uranium?

The papers listed in the answer above are available to help engineering firms design and optimize pilot studies for uranium removal.

31. The CWSs facing uranium problems in Nebraska are primarily rural with substandard economies and populations less than 2,000 (several are well under 1,000). These CWSs do not have the money to do multiple research/pilot studies to determine the best type of uranium treatment and how to optimize it. Will EPA make any grants available for pilot studies on uranium removal as they have done for arsenic removal?

At this time, EPA does not have plans in making grants available for uranium removal pilot studies.

32. Will a uranium concentration protective of aquatic life be developed for discharges from treatment facilities to streams?

Currently, EPA does not have aquatic criteria for radionuclides; however, this criterion may be explored in the future. States do have the authority to develop and enforce their own criteria if desired. State Water Quality Standards (WQSs) can be found at http://www.epa.gov/waterscience/wqs/.

33. The November 2000 *Draft Suggested Guidelines for Handling and Disposal of Drinking Water Treatment Wastes Containing Technologically Enhanced Naturally Occurring Radioactive Materials* cites a document entitled *Brine, Concentrate, and Filtration Media Disposal: Critical Analysis and Cost Estimates* prepared by EPA in 2000. Is the cited document available?

The 2000 Draft Report: *Brine, Concentrate, and Filtration Media Disposal: Critical Analysis and Cost Estimates* was finalized in March 2002 and renamed, *Disposal of Residuals from Water Treatment Plant Operations: Critical Analysis and Cost Estimates.* For a copy of these documents, please contact Andrea Matzke (202-564-3842) or Rajiv Khera (202-564-4881) in EPA's Office of Groundwater and Drinking Water.

34. When will the final point of use (POU)/point of entry (POE) guidance manual be issued?

Both final drafts of the guidance manual and "Cost Evaluation of Small System Compliance Option POU/POE Treatment Units" are in the process of going out for peer review. It is anticipated that these two products should be finalized by early next year. POE technologies are not eligible as small system compliance technologies (SSCTs) for radionuclides

35. Does EPA know of any POU devices that are certified for the removal of uranium? The last time I checked I was unable to find any POU devices that had been certified by NSF or NIST for the removal of uranium.

It does not appear that uranium is included in the current version of the NSF standards. EPA is preparing an Issue Paper that will be discussed at the next Joint Committee Meeting for Drinking Water Treatment Units to start development of a test protocol for uranium in NSF/ANSI Standards 53 and 58. Until that test protocol is developed and incorporated into the NSF/ANSI Standards, there will be no certified units for uranium. The Safe Drinking Water Act states that "If the American National Standards Institute has issued product standards applicable to a specific type of POE or POU treatment unit, individual units of that type shall not be accepted for compliance with a MCL or treatment technique requirement unless they are independently certified in accordance with such standards." Once the product standard is developed, systems will need to use units that have been independently certified using those standards.

36. Currently homeowners are allowed to throw the used filters or media from their POU devices in the trash that is taken to the nearest RCRA Part D landfill (sanitary landfill). When a CWS has many filters or media cartridges to dispose of, will the CWS be able to do as the private homeowner does and send the waste to the nearest RCRA Part D landfill? Will testing of waste media, and perhaps a more expensive disposal option, be required for CWSs that select anion exchange POU devices

According to 40 CFR Section 261.4(b)(1), POU/POE devices even when installed by a CWS are exempt from RCRA requirements. 40 CFR 261.4(b)(1) defines "household waste" as any material derived from households. Since the filter was installed in a home, it is household waste when removed. There is no significant difference between filters installed by a CWS and ones installed by a homeowner on his own initiative.

37. What frequency of testing, both initial and routine, is recommended for POU devices?

The draft POU guidance manual does have a recommended monitoring frequency for POU devices - with each unit being sampled once every three years consistent with the monitoring frequency for contaminants in source water. Under this approach, one-third of the units will be monitored each year.

The issue currently being debated is the use of representative monitoring. The challenge with representative monitoring is whether additional sampling is triggered by an exceedance.. The unit with an exceedance plus how many others will need to be monitored more frequently to determine whether the running annual average at those units is below the MCL. It is much easier under the approach where all units are being monitored, since only those units where there is an exceedance will need to be monitored quarterly to demonstrate that they are below the MCL

38. What is the maximum number of connections for POU devices to be economically feasible?

While the National Drinking Water Advisory Council Arsenic Work Group indicated that POU could be used even in systems with over 500 people, the maintenance and administrative costs may overwhelm the cost savings from only treating a portion of the water. Previous EPA cost comparisons have shown a range of between 80 and 120 households as the cutoff between central treatment and a centrally-managed POU approach. This would translate to an upper bound of around 325 people.

For additional information on costs, refer to an EPA presentation given at the NSF POU/POE Conference in Orlando in 2003.
http://www.nsf.org/cphe/pou/Kempic_Khera.pdf

39. Are there any references or software available to help engineering firms and CWSs estimate exposures?

Assistance and advice are available from the appropriate State Radiation Control Program, the Conference of Radiation Control Program Directors at http://www.crcpd.org, and the EPA Regional Radiation Programs. Individual contacts and sources of information will be provided in EPA's *DRAFT A Regulators' Guide to the Management of Radioactive Residuals from Drinking Water Treatment Technologies*. Additional information on radiation is available from EPA at http://www.epa.gov/radiation .

40. Does EPA have any plans to develop safety guidance manuals or work with another agency to develop such manuals? These would help workers minimize exposure levels in the drinking water treatment facility, during the denaturing of sledges, packaging and storage of waste sledges or resins, etc. Please note that in Nebraska, this rule is affecting primarily towns with populations of less than 2,000 who do not have the money or expertise to develop safety manuals.

See answer to question #27.

41. What type of storage facility is recommended for treatment sludges, spent resins, or other spent media?

EPA's *DRAFT A Regulators' Guide to the Management of Radioactive Residuals from Drinking Water Treatment Technologies* provides a range of options for storage and disposal of liquid and solid wastes, but a system's options will depend on state regulations, the location of the system, the characteristics of the waste, and cost-effectiveness. There is no one type of storage facility which we can recommend as being better than another as this decision is highly dependent on these individual waste, water system, legal, and geographic location factors.

42. We understand that there are some treatment systems in the west for uranium removal from drinking water sources using anion exchange resins. Is there any

substantial treatment experience in the east? Are there specific resins which are more effective than others, such as the DOW Chemical Co. resin?

Generally, all strong-base anion resins are extremely selective for uranium over all competing anions. However, macroporous (MP) resins have higher uranium capacity than gel resins for uranium removal. All major manufacturers (Dow, Rohm and Haas, Purolite, Bayer, Mitusibishi and etc.) produce strong-base MP resins that can be used for uranium removal. The selective Dow resin, which may be referred to in this question, is impregnated with barium sulfate micro-crystals, and is made for radium not uranium removal.

43. Are there any surrogates which can be analyzed easily on-site for monitoring ion exchange capacity exhaustion for uranium removal?

Surrogates are not necessary for uranium removal by ion exchange because the runs are so long, (e.g., more than 100,000 bed volumes (BV)). What is generally done is to arbitrarily stop the run and backwash/regenerate at 20,000 to 40,000 BV, which is long before uranium breakthrough. It is felt that extremely long run lengths, although possible, is not the best engineering practice because of resin plugging and fouling issues.