

U.S. Environmental Protection Agency
Science Advisory Board
Radiation Advisory Committee (RAC)
Summary Minutes of Public Face-to-Face Meetingⁱ
July 18 & 19, 2011

- Committee:** Radiation Advisory Committee (RAC) of the U.S. Environmental Protection Agency's (EPA's) Science Advisory Board (SAB) augmented for the Agency's Uranium In-Situ ISL/ISR Advisory (See Roster)¹
- Date and Time:** July 18, 2011, 9:00 A.M. to 5:30 P.M. and July 19, 2011, 8:30 a.m. to 3:00 p.m. (See Federal Register Notice)²
- Location:** Saint Regis Hotel, 923 16th Street and K Street, NW, Washington, DC 20006.
- Purpose:** The purpose of this meeting was to conduct a reviewⁱⁱ on the Agency's draft technical report dated June 2011 and entitled: "*Considerations Related to Post-Closure Monitoring of Uranium In-Situ Leach/In-Situ Recovery (ISL/ISR) Sites*"
- SAB/RAC Attendees:** RAC Members for all 2 days: Dr. Bernd Kahn, Dr. Thomas Borch (he had arrived at 3:00 pm, due to travel difficulties), Dr. Douglas B. Chambers, Dr. Shih-Yew Chen, Dr. Faith Davis, Dr. June T. Fabryka-Martin, Dr. R. William Field, Dr. Thomas E. Johnson, Dr. Jonathan M. Links, Dr. William F. Morgan, Mr. Bruce A. Napier, Dr. Brian A. Powell, Dr. Dale L. Preston, and Dr. Daniel O. Stram were present. [Dr. Susan M. Bailey and Dr. Thomas B. Borak were not present]. (See Roster).¹
- Agency Staff Attendees:** SAB Staff: Dr. K. Jack Kooyoomjian (Designated Federal Officer of

ⁱNOTE: Please note that these minutes provide highlights and summaries of individual comments, observations, discussions with Agency staff and other participants, as well as highlights and summaries of public commentary. For definitive advice from the subject matter experts, please refer to the final, approved advisory transmitted to the EPA Administrator, as well as to public comments. The commentary contained in the minutes are individual or summary statements and opinions and are not necessarily consensus comments at this stage of the process in the review of any given topic. In all cases, the final SAB report to the EPA Administrator represents the consensus on the topic.

ⁱⁱSee the July 12, 2011 conference call minutes where the Augmented RAC discussed the planning for the July 18 & 19, 2011 meeting, discussed the charge questions, determined if the review and background materials provided by the Agency were adequate to respond to the charge questions, requested specific items to be presented or clarified during their presentation of July 18, 2011, heard from the public regarding this review topic, and formally began this review activity.

RAC - in both days), Dr. Vanessa Vu, SAB Staff Office Director (participated in portions of each day), ORIA, Staff for all 2 days, except as noted: Mr. Valentine (Val) T. Anoma, Ms. Lindsey V. Bender, Ms. Andrea K. Cherepy (day 1, only), Dr. Mary E. Clark, Mr. Kenneth S. Czyscinski, Ms. Kathleen (Kathy) Economy, Ms. Diedra Hodges, Dr. David Pawel (day 1 only), Mr. Tom Peake, Dr. Daniel J. Schultheisz, Ms. Kathryn Snead; Ms. Evelyn R. White, Mr. Jonathan D. Edwards.

Public Attendees: Attended for all 2 days, unless otherwise noted: Ms. Amanda Aspatore , National Mining Association (Day 2), Mr. Harry Chemelynski, EPA Contractor, Mr. Gary Comfort, U.S. Nuclear Regulatory Commission (NRC, day 1, only), Mr. Geoffey (Geoff) Fettus, Natural Resources Defense Counsel (NRDC) (day 1, only), Mr. John Schmuck, CAMECO, Dr. Elise A. Striz U.S. NRC.

Meeting Summary: The discussion generally followed the issues and general timing as presented in the meeting Agenda⁴ except where otherwise noted in the minutes.

Convene the Meeting:

Dr. K. Jack Kooyoomjian, Designated Federal Officer (DFO), opened the meeting at 9:00 a.m. with introductory remarks. He introduced himself as the DFO for the Radiation Advisory Committee (RAC), augmented for review of the Agency's Uranium In-Situ ISL/ISR draft technical report. He noted that the Augmented RAC will receive presentations from the Agency, receive public comments, engage and organize to begin the process of creating a draft advisory report within the meeting in direct response to the Charge Questions³ relating to the Environmental Protection Agency (EPA)/Office of Radiation and Indoor Air (ORIA) draft technical report. (See Meeting Agenda).⁴

He advised the participants that the SAB/RAC operates under the requirements of the Federal Advisory Committee Act (FACA) and conducts business under the auspices of the chartered SAB. Consistent with FACA and with EPA policy, the deliberations of the augmented RAC are conducted in public meetings, for which advance notice is given, and where he is present as DFO to ensure that the requirements of FACA are met, including the requirements for open meetings, for maintaining records of deliberations of the augmented RAC, and making available the public summaries of meetings, as well as providing opportunities for public comment.

Dr. Kooyoomjian also noted that the members of the augmented RAC were in compliance with Federal ethics and conflict-of-interest laws that apply to them. He further noted that Ethics Training was completed by the RAC and all augmented participants and is on file at the SAB staff office. He advised that the biosketches of each RAC member are posted on the SAB website. He also advised that the SAB staff office had received written public comments, which are on the table of handouts, and that we have received requests from the public for

comments, which will be provided after lunch today, and tomorrow morning.

Welcoming Remarks:

Dr. Vanessa Vu, SAB staff office Director, provided some brief welcoming remarks, indicated that Drs. Kooyoomjian and Kahn will discuss the logistics in more detail, and that Mr. Jonathan Edwards, and Dr. Mary E. Clark of the ORIA Staff will introduce the topic and the ORIA staff office participants. She thanked the SAB/RAC participants for agreeing to engage on this important advisory topic and then handed the meeting over to Dr. Kahn.

Introductory Remarks, Review of the Agenda, and Introduction of Committee and Guests:

At 9:12 a.m. Dr. Kahn, Chair of the RAC, welcomed everyone and gave a brief introduction to the logistics of the review. He then asked each of the members of the augmented RAC to introduce themselves. He asked that they highlight their experience as it relates to the topic at hand, and any special research interests they might have in the topic, including that of their colleagues and institutions where they work, or activities in professional societies and other affiliations related to the topic. He began the introductions by asking Dr. William Morgan to introduce himself and then continue with the introductions around the table. Each participant provided information as to how they relate to the topic under discussion.

EPA Technical Presentations:

At 9:22 a.m., Dr. Kahn asked Mr. Jonathan Edwards, as Director of the Radiation Protection Division (RPD) in ORIA, to provide an overview of the topic at hand. Mr. Edwards provided this overview of the EPA rulemaking and placed it in the context of the current specific request to the SAB for the advisory pertaining to pre- and post-closure monitoring of uranium in-situ leach/in-situ recovery (ISL/ISR) sites.⁵ He explained how EPA develops standards for milling and mill tailings, and that the U.S. NRC implements and enforces the EPA standards for active mills through the licensing process. He explained that existing standards, while they cover active and closed mills, and address groundwater, soil and building clean-up requirements, lack explicit provisions and performance criteria specifically for uranium ISL/ISR operations. He noted that the ISL/ISR process is now a principal means of uranium recovery at a number of sites in the United States (U.S.). The U.S. NRC considers the ISL/ISR process to be essentially underground milling.

Mr. Edwards advised that EPA is considering revising the current rule (40 CFR Part 192 under the provisions of UMTRCA (the Uranium Mill Tailings and Radiation Control Act, Public Law 95-604) to include groundwater performance standards specific to the ISL/ISR process. He explained that EPA, under the Atomic Energy Act and UMTRCA is responsible for developing standards which the U.S. NRC implements and enforces, including licensing activity. This includes active and abandoned sites, radiological and non-radiological standards, uranium recovery through such processes as the ISL/ISR technology, and release (clearance) of sites for future use, once cleared as available for other uses.

Mr. Edwards explained that EPA is seeking advice from the SAB on technical issues pertaining to the uranium ISL/ISR process at facilities that have the appropriate geology to allow using the ISL/ISR process in the US. He noted that the Agency had developed 40 CFR Part 192 in the early 1980's and had revised the regulation in the mid 1990's, but has not touched this regulation since about 1995. Since the early 1980's, the price of uranium fell due to a lack of orders for new nuclear power plants in the US, and the uranium mills were shut down. The recent price of uranium has increased substantially with the renewed interest in nuclear power, and there is a renewed interest by the uranium mining industry to re-visit these mining sites.

The Agency is particularly interested in incorporating provisions within 40 CFR Part 192 that recognize the ISL/ISR process, which has been around for decades, as well as to incorporate advice from the SAB/RAC which addresses such topical areas as establishing baseline conditions, and acquiring better understanding regarding how to compare pre- and post-operational conditions, as well as receiving advice pertaining to post-operational stability issues. The Agency wishes to acquire technical and science-based advice on the application of statistical methods and monitoring, and the identification of additional technical analyses and information that might be helpful in developing site-specific performance-based standards for ISL/ISR operations.

Mr. Edwards touched on the action development process where the Agency is seeking to balance different qualities to achieve legally defensible, clear, concise, logical technical advice at the staff level and in the work group and rulemaking process. He advised that potential policy decisions need to be made in the technical context, and the Agency is optimistic that this SAB/RAC advisory process will provide an opportunity to receive focused technical advice, as well as helpful public commentary. He anticipated that rulemaking will follow this advisory, perhaps in late spring, or early summer of 2012. He completed his brief presentation at 9:38 am. This was followed by some questions and answers from the SAB/RAC with the ORIA staff.

Dr. Kahn advised that the ISL process has been around for some time (5 decades), and noted with appreciation the Agency's interest to place this in a proper science-based context to groundwater, soil and structures. A discussion followed with Dr. Links framing the question to provide focused responses to the questions pertaining to 40 CFR Part 192 and to address such issues as the concentration limits. Others asked Mr. Edwards to clarify aspects of the performance standards. Mr. Thomas Peake of the ORIA staff touched specifically on the focus by the Agency to address the environmental protection and public health aspects of the standards within the current regulation. A multiple part question was asked by the SAB/RAC if the EPA considers the current standards to be inadequate, and in what respect might they be inadequate, whether people are in danger right now, and specifically are we seeing harm to the workers around these sites?

The Agency staff responded that the current EPA rule does not explicitly address performance standards, and while there are sections within 40 CFR Part 192 that allow the ISL

activity, there isn't enough specificity, and we also have to deal with the Agreement Statesⁱⁱⁱ, as well as the US NRC. For a number of years, the uranium industry has been dormant. The US NRC has guidance, but there currently is a lot of leeway as to how 40 CFR Part 192 gets interpreted by the NRC. It was noted by the RAC that while some Agreement States have been rather creative and inventive; what is actually needed nationally is consistency from EPA regarding expectations for these activities relating to performance measures specifically pertaining to the public health and environmental protection aspects of this activity.

At 9:56 a.m., Dr. Mary Clark introduced the ORIA staff to make the presentation (Mr. Tom Peake, Ms. Andrea Cherepy, and Dr. Daniel Schulteisz.) (See Agency briefing material entitled "Considerations Related to Post-Closure Monitoring of Uranium In-Situ Leach/Recovery Sites An Advisory," dated July 18, 2011).⁶ Mr. Thomas Peake gave an overview of the presentation, touching on the draft technical report elements of the charge questions, provided background as well as the regulatory context and framework as it applies specifically to the ISL/ISR operations, and touched on details on the elements of the four charge questions.

The goal of the regulatory activity is to ensure that future users of groundwater from the ISL/ISR sites are protected, such that within the ore zone, water quality is not degraded, and outside of the ore zone, there is no migration. Mr. Peake indicated that advice from the SAB/RAC will assist the Agency to develop technical options to address those analyses that best demonstrate that these goals can be achieved, and how much analysis and data may be necessary to assure that this is achieved (that is, UMTRCA requires EPA's standards to be consistent). Mr. Peake explained how 40 CFR Part 192 incorporates RCRA groundwater protection requirements for units managing hazardous waste, that there is flexibility in use of statistical methods, and how the Agency could apply RCRA performance standards to the ISL/ISR sites and operations.

At 10:13 a.m., Dr. Daniel Schulteisz started at page 10 of the Agency briefing⁶ to discuss the typical lifecycle of an ISL/ISR facility. He touched upon the phases expected in the lifecycle of an ISL/ISR facility, from exploration and site characterization and establishing baseline conditions through to post-restoration stability monitoring of groundwater to decommissioning of the mined area and surface facilities.

Charge Question/Element #1: Touching on designing & implementing a monitoring network and identifying any technical considerations that may have been omitted or mischaracterized:

Dr. Schulteisz noted that the term, "edge of wellfield area," is usually defined in the permits. A discussion followed on locations of monitoring wells, understanding the location of the ore zone and conditions of the overlying and underlying aquifers, the dimensions of the aquitard (confining layers), injection and production well patterns, the variations expected in the ore body area and flow properties, and wellfield locations that are typical or that may be close to the site boundaries and may be of concern to the public. Discussion took place on expectations for stable

iii There currently are five Agreement States: Colorado, Illinois, Texas, Utah, and Washington that address in situ ISL/ISR activities.

versus steady state conditions.

BREAK - The participants took a break at 10:30 a.m. and re-convened at 10:45 a.m..

A discussion took place on how one might take “hot spots” into account. Circumstances were discussed where a mine has been operating for a number of years, then had closed, and now the owners wish to go back and mine once again. Questions were raised on how stable a site might be if it was left to stabilize “on its own.”

A discussion took place on the role of colloids, the possible need to look at seasonality for one year or more, the presence of anomalies and, the use of min/max values to assist to define the baseline related issues.

At 10:45 a.m., Dr. Kooyoomjian commented briefly on the typical role of an advisory in the SAB, so that the newer participants understood what their role is in the context of an advisory activity. Typically in an advisory, the Agency has not decided the exact directions they may take, and so the advice that is being provided should indicate that if the Agency were to decide to take one direction or path, then the following needs to be considered, or if they decided to go in a different direction or path, then these other things might come into play. He mentioned that an advisory touches on those directions that might be taken by the Agency on a topic under study, and where the Agency has not yet made those decisions.

Dr. June Fabryka-Martin touched on the similarities and comparative issues to the hydrofracking scenarios. Dr. S.Y. Chen touched on the topic of aquitards. Dr. Schulteisz characterized the typical confining unit, the EPA literature on characterizing confining layers, the issues with parametric and non-parametric statistics, the fact that EPA uses non-parametric statistics in the current draft technical document, as well as other related topics.

Dr. Bernd Kahn cited experiences with existing mines and the need for obtaining case studies involving sufficient as well as insufficient data. Dr. S.Y. Chen discussed the importance of groundwater speed, direction and flow. Dr. Schulteisz cited the need to adjust the frequency of data sampling, depending on such factors as groundwater (GW) flow rates.

Dr. Douglas Chambers discussed that when looking at the GW of a site, there may be 12 or 14 parameters that are being observed as stable, then what level and number of components should we specify when looking for stability? Dr. Schulteisz acknowledged that to be a good question. Dr. Bernd Kahn expressed the utility of having EPA’s regulatory perspective so we can end up recommending which items might be useful primary and which might be useful secondary indicators.

Dr. Brian Powell commented on core water exchanges, how to determine the proper frequency of sampling, how one might go about using statistical tests, such as for determining trends within the monitoring data, and/or determining compliance with restoration goals. It was acknowledged that tests used for these purposes may have different characteristics and data

needs, depending on how the test is applied (pg. 20 of briefing)⁶. Other issues associated with statistical tests were discussed,(p. 21 of briefing)⁶, such as parametric versus non-parametric tests, outliers in the data set (they should be discarded), and levels of confidence desired in the samples.

Dr. Daniel Schulteisz observed that the Agency used non-parametric tests because of limited data (see page 23 of briefing)⁶, but at this point in the advisory process the Agency has no specific preference and is receptive to advice from the SAB/RAC on this topic. The Agency was pondering whether it may be simpler to average over the entire wellfield as a baseline/restoration measure (page 26 of briefing)⁶. The Agency recognizes that this approach has drawbacks, such as having no accounting for “hot spots” and no accounting for trending within the field. The staff asked the SAB/RAC about the strengths, weaknesses and challenges of each approach, and what might be the impediments or demands of each, or if the approach could be “hybridized” (see page 27 of briefing)⁶, and what technical analyses would the SAB/RAC recommend. A case study of a site in Wyoming was discussed (see page 29 of briefing)⁶.

Charge Question/Element #2: Commenting on approaches considered for establishing baseline groundwater chemical conditions in the pre-mining phase and proposed approaches for determining the duration of such monitoring to establish baseline conditions:

Mr. Thomas (Tom) Peake presented this portion of the briefing (see pages 30 to 36 of briefing)⁶. He asked what are the issues to determine sufficiency? He illustrated that in RCRA, the number of wells needs to be “sufficient.” Dr. Jonathan Links asked about the range of practice and what is done in the field, and pointed to the reality that there are straight-forward technical and scientific rules that can be applied directly from sampling theory. He thought that what we needed is some sense of scale for the recommendations to be helpful.

Mr. Peake touched on methods, components and parameters to establish baseline conditions (see pages 31-33 of briefing)⁶. Dr. June Fabryka-Martin noted that at Los Alamos National Laboratory (LANL), it is their experience that wells take years to stabilize. A discussion followed on the effects of and importance of seasonality to adjust the data set. A case study of the Dewey-Burdock Site in South Dakota was discussed (pg 35 of briefing)⁶ and examples were offered dealing with seasonal variation in wells.

Charge Question/Element #3: Comment on the approaches considered for monitoring in the post-operational (post mining)/ restoration phase and the approaches considered for determining when groundwater chemistry has reached a “stable” level.

Mr. Thomas Peake presented an option that the Agency is considering (see pages 37 to 41 of briefing)⁶ for addressing the post-operational phase and whether the chemistry has reached a stable level. The Agency is thinking that they might be able to establish a performance standard with a requirement that the constituent levels could attain a specified confidence level in wells within the wellfield. The post-operational monitoring requirement would then have to demonstrate when the GW chemistry has reached “stable” levels.

Dr. Dale Preston asked who decides on the number and kind of analytes? Mr Peake answered that it is the EPA who decides, but we also look at what is sufficient from the NRC perspective, since they are the party to grant the license to operate to the licensee. A discussion followed on this topic. Dr. Faith Davis asked if the raw site data is analyzed on site? It was recognized that most raw site data can be collected from public records.

Dr. Douglas Chambers discussed uranium sulfate solubility being determined by the presence of radon as an indicator. Dr. June Fabryka-Martin discussed the extent of disturbance from wells. A discussion followed on a number of issues relating to this topic and included how to maximize production on the wells, but also to measure data from the wells to account for seasonality, as well as other trends, and which statistical tests should be used. The discussion covered the before and after comparisons made between multiple wells, tests needed to confirm compliance of all wells with restoration goals, and the situation of post-restoration data being different from restoration goals. The discussion also covered how to compare baseline to stability for the monitoring wells for the pooled data of all wells combined and other scenarios.

Discussion touched on the MCLs and ACLs as numbers, but with no uncertainty or uncertainty bounds necessarily being attached to them. Discussion also took place on differences in measurement accuracy and measurement precision. Advice was conveyed on alpha and beta errors, and further discussion took place on what is meant by “adjustment for seasonality” and other topics, such as “who owns the brines in New Mexico?” It was understood that the Agency was trying to determine that if the levels are “below the level of concern,” then the site could be released for general uses.

Dr. Morgan asked ...”Who makes the measurements?” Dr. Daniel Schulteisz answered that the operators make the measurements. Dr. Links thought that it is a conundrum distinguishing between seasonality and annuality, and we need to know the time frame to place this in the proper context.

Dr. Vanessa Vu observed that it is important to understand the current practices and what might be needed to obtain adequate background to answer the charge question. Dr. Douglas Chambers commented on the role of monitoring and noted that another useful tool is modeling and a reference to a holistic data set, and that these tools should be viewed as another important ‘arrow in the quiver’ of tools available to the decision-maker.

Dr. Daniel Schulteisz observed that the operator would have to continually monitor to conduct hypothesis testing in order to know if the site actually achieves the desired or anticipated results, such as a natural attenuation mechanism, or some other state. A discussion followed on significant components of the hypothesis, the experiences with Type I and Type II errors, and related topics.

Charge Question/Element #4: *Comment on the statistical techniques about which you are aware that have been used in other applications (particularly for the areas in elements 2 and 3,*

above).(See pages 42 to 45 of briefing)⁶.

Dr. Daniel Schulteisz presented this portion of the briefing, and advised the SAB/RAC and participants that the Agency has examined different statistical techniques for use in different environmental programs and settings, including the RCRA and CERCLA programs for applicability to the ISL/ISR issues. They have conducted some analyses, such as within the RCRA Program, to provide a basis for discussion (See Agency's Draft Technical Report "Considerations Related to Post-Closure Monitoring of Uranium in-Situ Leach/In-Situ Recovery (ISL/ISR) Sites.")⁷, and concluded that they had achieved a 95% confidence level within the RCRA Program for applicability to the ISL/ISR issues.

Dr. Dale Preston observed that the hypothesis testing is in place, but there is much use of confidence levels. Dr. Daniel Stram observed that what is needed is complete confidence (by the public) that the patterns measured and stated by others are, in fact, there.

LUNCH BREAK: 12:14 p.m. to 1:15 p.m..

Public Comments: Dr. Kooyoomjian opened the floor for public comments at 1:15 p.m..

Mr. John Schmuck of CAMECO Chemical Resources in Wyoming, provided verbal commentary. He made some observations on the desired process of having data that actually matches the questions being asked. He observed that as a scientist, he found it very useful to focus on the data that directly answers the question. Simply put, if there is a problem, one needs to match data inputs to the questions. Poorly planned data acquisition means that you are most likely to have to do the exercise over, as you can expect to miss the mark in the first rounds of data acquisition. There is also an issue of regulatory agencies making very specific data requests, but the question being asked by the regulator is very vague. The regulatory framework, therefore, is critical and should be focused upon and very relevant to the activity. He offered an example of an aquifer exemption, where a specifically tailored question relevant to the DQO process would be helpful. A brief discussion followed on this concept.

Dr. Chambers observed that it would be helpful to know what parameters are relevant to the GW exemption. Dr. Vanessa Vu thought that the Agency (EPA) and the NRC representatives could better explain the process around the exemption being reviewed. Dr. Mary Clark of ORIA acknowledged that they (EPA/ORIA) will have a brief discussion and overview, including the roles of the NRC and the EPA. Mr. Tom Peake observed that the UMTRCA standards regulate uranium & thorium in the environmental and public health standards within 40 CFR Part 192. It is up to the NRC and the Agreement States to work the compliance aspects, and the Aquifer Exemption is separate from UMTRCA. He further noted that the criteria for GW exemptions, now or in the future cannot expect to save or restore the GW as a source for drinking water.

Dr. Brian Powell thought that it is relevant to discuss an MCL in the exempted area. Dr. S.Y. Chen observed that if GW is not a drinking water source under the exempted area, then it

does not apply to the exempted GW. Dr. Douglas Chambers clarified that the exception is under the Safe Drinking Water Act (SDWA) and UMTRCA picks up from there. ORIA staff offered further clarification that the Underground Injection Control (UIC) program was exempted under the SDWA. Underground waters (wells) are being exempted because of extraction of ores from the source, and the exception only applies to and exempts a portion (emphasis added) of the aquifer. There are separate issues as to whether the exemption applies in certain circumstances.

All of the discussion aside, the point that Dr. June Fabryka-Martin made is that the applicant has to demonstrate that the restoration goals, once established, are either achievable or not. The EPA/ORIA staff asserted that the operator has to demonstrate that the remediation goals can or cannot be achieved. The exempted aquifer can be removed from consideration as a drinking water source. The NRC staff clarified that they do not regulate the UIC program, and that sometimes agreement states regulate this. There is a clear requirement to protect drinking water that is outside of the well fields. The US NRC acknowledged that UMTRCA applies to all by-product materials whether to baseline or MCLs, whichever is higher. The licensee is responsible for restoration, and the industry is looking at such technologies as bioremediation to address this issue.

Dr. Kahn asked about post operations after restoration. A discussion followed on In-Situ Remediation (ISR) and the implications for long-term stewardship. According to the NRC staff in attendance, the NRC will not approve a GW restoration plan until the applicant has demonstrated GW protection.

NOTE AND OVERVIEW OF WRITTEN COMMENTS:

Both Mr. Donovan Porterfield of Los Alamos, NM and Dr. Richard Abitz, Geochemist and Technology Program Manager at the Savannah River National Laboratory in Aiken, SC provided written comments.^{8,9} Neither gentleman provided verbal comments or participated in the face-to-face meeting. Their written comments were posted onto the SAB Website for this meeting, were forwarded to the RAC participants, and were placed on the handouts table. The following overview provides a brief overview of those written comments.

On July 3, 2011, Mr. Donovan Porterfield of Los Alamos, NM provided public comments in response to the June 23, 2011 Federal Register Notification. His comments addressed in-situ extraction and the need to maintain and insure the continued integrity and viability of GW resources in the vicinity of such extraction operations. After having reviewed the Agency's Draft Technical Report⁷, he suggested that the example radionuclide monitoring analyte lists are too minimal to properly characterize possible changes in the GW system, and offered suggestions to expand the analytes that might be monitored.⁸

On July 19, while the meeting was taking place, Dr. Richard J. Abitz, Geochemist and Technology Program Manager at the Savannah River National Laboratory in Aiken, SC forwarded written comments on the Agency's Draft Technical Report.⁹ His memo received July 19, 2011 and entitled "Baseline water quality at ISL uranium mines," contained a cover note and

three attachments addressing the UIC process. The three attachments are as follows: **Attachment 1** addressed the UEC Goliad Project (Application for Production Area 1, August 27, 2008 Comment by R. Abitz; **Attachment 2** addressed Anthropogenic Induced Redox Disequilibrium in Uranium Ore Zones, by Richard Abitz, Savannah River National laboratory, and Richard Darling, Southwest Groundwater Consulting, LLC, GSA 2010, Denver, CO; and **Attachment 3** addressed Anthropogenic Induced Risk Disequilibrium in Uranium Ore Zones.

General Discussion:

At 1:54 p.m., a general discussion took place concerning presentation, public comments and issues raised. Dr. Jonathan Links raised issues pertaining to kinetic modeling and he discussed issues as how one might utilize kinetic (not the statistical) characterization for the ISL approach toward the GW characterization. Dr. June Fabryka-Martin followed up with a discussion of the usefulness of a model reaction path framework perhaps to give more confidence to know if you are heading in the right direction.

Dr. Daniel Schultheisz observed that if you are using a statistical approach, and you know that you are in the expected concentration range of uranium, then you don't need geochemistry to tell you that you are in the right ballpark such as when you detect a cluster of a dozen reactions of iron. Dr. Stram noted that the rate laws and models do not require known concentrations of metals underground, and the alternative approach is, in fact, empirical.

Discussions followed on long-term monitoring of an ISL field. Dr. Elise Striz of the NRC acknowledged that the NRC may not have that concentration data, but the sites are restored to national GW standards. Dr. Thomas Johnson observed that the reality is that nobody has gone back to see if the site is still stable. There is no monitoring, but the good news is that it appears that there is no evidence of contamination. Dr. Links postured an analogy that it is like reviewing the Blue Book if you have no cancer data. Dr. Dale Preston offered the thought that developing the model(s) is important, so that the relevant data can be gathered and assessed. Dr. Links extended the Blue Book analogy by observing that we don't know whether four months of data has meaning, because we don't know the activity and the rates of the GW flows at the site.

Dr. Daniel Schulteisz noted the difficulties to apply relevant analogs when a lot of RCRA and CERCLA sites are so different and site-specific. Dr. Elise Striz of the NRC explained how the NRC goes about conducting their safety review to look at such things as an unconfined aquifer or those circumstances where the water table is below the confining area.

Dr. Bernd Kahn remarked on the case of Yucca Flats which has a relatively small and defined volume, and where the parties are looking for alternative sites for a repository. The EPA/ORIA staff observed that specifically with regard to nuclear repositories, they are in the unsaturated zone, and not applicable to ISL/ISR sites. It was further noted that those conditions containing high level wastes and spent nuclear fuel do not translate to the conditions found at ISL/ISR sites.

A discussion followed on geochemical modeling of Tier I sites that are in active bioremediation. It was observed that trace metals may be more of a problem. Discussion took place on distribution coefficients, and how some of the states, such as Texas, Wyoming, and Colorado may be monitoring stability at these sites. The NRC staff observed that states monitor their own restoration data.

The question was asked by one participant if any facilities that are currently closed down have resulted in a contamination. A discussion took place on monitoring requirements, the availability of data (including raw monitoring data), different geologies and water chemistry situations that exist at sites. The NRC staff commented that they have recently approved their first license in 13 years in Wyoming, and that several sites are being discussed for future approvals. It was noted that NUREG 1569^{iv}, which provides a standard review plan for in-situ leach uranium extraction license applications under provisions of Title 10 of the Code of Federal Regulations Part 40 (10 CFR Part 40) dealing with domestic licensing of source materials, would be a useful reference.

Plenary Discussion of Charge Question #1 Pertaining to Designing and Implementing a Monitoring Network:

At 2:37 p.m. Dr. Bernd Kahn asked this Subgroup (Dr. Thomas Johnson is Lead, and Dr. Jonathan Links is Scribe) to lead the discussion on this topic. The other member is Dr. S.Y. Chen.

Dr. Thomas Johnson remarked that all the technical considerations have not been specified, and that deciding what is important at this juncture is difficult. To date they have not seen sites dealing with public water supplies which have been contaminated. The RAC discussed the NRC definition for “excursion” and the need to monitor chlorine ions. If wells are further out, for instance, you do not want to find chlorine ions, because that could be a harbinger of an anticipated contamination problem. Dr. Thomas Johnson was hopeful that the modeling tool would be very useful, but thought that more research is needed in this area, and that more information is also needed and certainly would be helpful to make sound decisions.

Dr. Jonathan Links observed that, even in the absence of evidence, a regulatory agency, such as EPA, has to regulate and enforce. It is desirable to generate evidence-based information, but there is a broad middle ground to expound on principles for the present. He observed that GW stability seems most important, and that the RAC could articulate the principles of what is meant by “stability,” and the Agency could try to operationalize around the technical approach.

Dr. S.Y. Chen observed that this might be viewed as a very simple approach to a very complex process. He thought that a greater question is facilitating understanding the complexity

iv U.S. NRC. 2003. Standard Review Plan for In Situ Leach Uranium Extraction License Applications: Final Report. NUREG-1569. June 2003.

of the issue, and whether we understand much beyond that. Dr. Bernd Kahn rephrased the question as ...”We have information, but do we have good, that is, useful (emphasis added) information?”

Dr. Douglas Chambers observed that we must recognize that we hardly ever have all the data we want. However, we have a lot of data, and we should ask ...”Do they have a decent hydrological or geochemical model?”... Also we could look at the basic principles involved with the physics, chemistry and geochemical modeling. He asked, ...”Can we put reasonable bounds on this (e.g., geochemical model for a 30 mile area)?” He thought that EPA could take a look at a couple of models in different uncertainty bound scenarios. We may discover, for instance, that there may be more data than we give EPA credit for.

There was more discussion on this topic, and Dr. Kahn called for a break at 3:00 pm.

BREAK 3:00 p.m. to 3:25 p.m..

Continued Plenary Discussion of Charge Question #1 Pertaining to Designing and Implementing a Monitoring Network:

The committee re-convened and continued their discussion on Charge Question #1.

Dr. Thomas Borch asked ...”How long is long enough (for monitoring)?”..He thought that good issues are being raised and good discussion is taking place on this charge question. He supports obtaining adequate data for characterizing seasonal variation, and thought that at the outset a bare minimum of one year should be considered. He offered that many areas have long-term meteorological data, and gave examples, such as flooding and potential chelating of radionuclides. He thought that these data combined with other short-term data would be helpful data sets.

Dr. Borch asserted that one very important component to understand is the geological component, and observed that we currently don’t have a good idea regarding the geological component, based on the current review materials provided. He offered that re-oxidation, solubility, reduced forms of molecular uranium with different solubility, both in aqueous and solid phase are important aspects of the geological component. He further observed that the valence state of uranium 6 or uranium 4 does not inform us sufficiently about solubility.

Dr. Elise Striz of the NRC offered that most sites are 600 feet below the ground, while soil samples are typically at the surface.

Dr. Brian Powell asked “Isn’t there a point where pyrite will eventually form in the system, and isn’t there a point where this would be required to show “stability?”

At 3:37 p.m. Dr. Bernd Kahn asked about incidents/accidents. The RAC discussed mitigation measures and examples. Dr. June Fabryka-Martin observed how the standards are set

and could impact on research for alternative solutions. A discussion followed. Dr. Elise A. Striz of the US NRC recognized that there is a potential for new lixivants, and that the NRC would look at technical safety merits in the licensing process. Dr. Bernd Kahn observed that typically there is a long list of ions, some of which he is not familiar with, that is present. He further observed that there is a big difference to regulate to a maximum versus to a distribution, or to an average. Dr. Striz of the NRC responded that they could report wellfield averages or some other approach.

Plenary Discussion of Charge Question #2 – Pre-Operational Monitoring (e.g., models & what is found in other places):

Dr. Thomas Borch and Dr. June Fabryka-Martin are Co-Chairs, and Mr. Bruce Napier and Dr. June Fabryka-Martin are Co-Scribes.

Dr. June Fabryka-Martin offered some overview comments on this topic. She was struck with how site-specific each mine is, and she sees merit to be flexible and not prescriptive. Her second thought on this topic is that it is important to assure consistency among the various regulatory programs. She believes that monitoring and compliance requirements for radionuclides and other hazardous constituents should not be made more complicated than they already are, and that a lot of this is relevant directly to the ISL issue. Her third point is the idea of prioritizing the expected problematic issues, constituents and problem areas needing thoughtful consideration. She postulated that some solutions and requirements will be obvious and there should be consensus right away. We (the SAB/RAC) might need to comment if the characterization phase can lead to better understanding, such as for instance, which mineralization phase might limit the rate of recovery.

Dr. June Fabryka-Martin thought that we (the SAB/RAC) may be looking for such things as geochemical correlations to characterize pre-operational monitoring conditions. A fifth point she wishes to raise follows her discussions with the US NRC representatives, such as when excursions are observed. For instance, for those constituents that might escape from the production area, we will need to look at rates of recovery and the “safe levels” that they need to be below. A sixth point is that it would be helpful to establish very clear data quality objectives (DQOs) early on that are (or should be) used to guide decisions. It may also be helpful if we could identify indicator species for monitoring.

Mr. Bruce Napier seconded the identification and use of DQO approach as a good idea. He believes that it would be very helpful to have a guiding set of principles and DQOs as you start your pre-operational monitoring.

Dr. Thomas Borak offered that he totally agreed with the statements of his colleagues. There are a variety of items to look at, such as redox state, the state of various oxides including manganese, solvents, pyrite, sulfides, the potential for precipitating out arsenic, the anoxic and anaerobic site-specific conditions to solubilize arsenic and a variety of other site-specific chemistry and geology conditions to consider.

Dr. Bernd Kahn asked about the term “sufficient” as far as the data is concerned. That is, when is it “sufficient” with the sample locations chosen for the site conditions to reasonably conclude that we have adequately or “sufficiently” characterized a site? Dr. June Fabryka-Martin doesn’t think that uranium is so much of a problematic pollutant to monitor, characterize and control. Dr. Elise A. Striz of the NRC discussed outlier analyses, including seasonal and temporal variability and the associated data requirements. She observed, in support of Dr. Fabryka-Martin’s observation, that in practice there is not a lot of temporal variability (that is, on-site variability) and she pointed to the existing NRC guidance, NUREG 1569, dealing with the standard review plan for spent fuel dry storage facilities (NOTE: It was suggested that the RAC DFO, Dr. Jack Kooyoomjian, distribute NUREG 1569 to the augmented RAC).

Dr. Tom Borch echoed that the good news is that while there are very little data, the available evidence seems to indicate that there is extremely low variation. Dr. June Fabryka-Martin chimed in to say, “I want to say ...Show me the data.” Dr. William Field agreed that we need to see the data. Dr. S.Y. Chen reaffirmed the need to see the data and offered a scenario of a monitoring well that has a broken pipe. He then asked ...”Will two weeks of monitoring be sufficient to capture this excursion?”and ...”shouldn’t the monitoring period be tighter if such an event occurs?” The general discussion on this topic ended at 4:09 pm.

Plenary Discussion of Charge Question #3 – Post Operational Monitoring & Restoration:

Dr. Douglas Chambers is Lead and Dr. Brian Powell is Scribe. Other Members include Dr. R. William (Bill) Field.

Dr. Douglas Chambers stressed that DQOs are really very important in characterizing baseline conditions and in answering the questions pertaining to post-operational monitoring and restoration. For instance, he asked ...“How do we know that we have achieved a standard?” He felt that the DQOs need to be very clear and very site-specific. He raised further questions such as what should be the criteria for locating the wells, as well as what should be the criteria for characterizing the entire span of the wellfield. He noted that the earlier discussions raised interest in understanding the upper range, and that in Canada, the practice is to spend a lot of time on understanding the cumulative frequency distribution. The practice is to group or prioritize by the nature of the geochemistry. It may be possible to simplify the program, and there may be other levels, if EPA is interested in pursuing in detail, for instance, what “stable” means on different levels. He advised that one can bound things to look at reasonable expectations.

Dr. June Fabryka-Martin observed that there may be existing statistical guidance based on monitoring for trends. Drs. William Field and Brian Powell thought it is possible and desirable to incorporate kinetics and various modeling applications. Dr. Bernd Kahn thought that operational monitoring guidance would be very helpful. Dr. S.Y. Chen agreed with the discussants and thought that modeling is essential and would be helpful and appropriate, and that perhaps in post-closure it might be a more intense effort to assure that site conditions are met.

Dr. Jonathan Links thought that not enough effort has been expended in characterizing the baseline. Dr. Thomas Borch agreed that we need a good baseline in order to have effective post-monitoring. He asserted that we actually need both, and there appears to be a lack of data. Dr. Bernd Kahn thought that we need to get the kinetic data as well as monitoring data.

Plenary Discussion of Charge Question #4 – Suitable Statistical Techniques, and Data Requirements that Would be Applicable for Use with ISL/ISR Mining Applications:

Dr. Daniel Stram is Lead, Dr. Dale Preston is Scribe. Dr. Thomas Borak (initially unassigned, because he was not present) and Dr. Faith Davis are also members of Sub-Group #4 to lead the discussion and writing on this topic.

Dr. Stram observed that the primary item of interest is how many wells you need to be statistically representative. If there is heterogeneity, then clearly you need more wells to characterize the wellfield. Specifically, if you see considerable heterogeneity from one well to another, then likely you will need more wells from which to sample. Also, if there is time variability, then you will need more monitoring as a function of time. The question on characterizing baseline conditions is important. Also, if there is seasonality, probably you would need more than a year of data to characterize it.

Dr. Dale Preston agreed with Dr. Stram's overview and stressed that there is a need to create a more useable data base. He thought that there must be better modeling applications in place to apply to the various scenarios and situations that are expected to occur at such sites in the future. Dr. Faith Davis observed that many of the discussion points that have been made are very conservative.

Dr. Stram suggested that it would be very helpful to require a study to be put in place which has the statistical power to stringently test the null hypothesis. He further advised that there is a need to do the corrections and adjustments to identify the out-of-range values, such as "hotspots," and that setting up the baseline in an adaptive manner would be helpful.

Dr. Brian Powell agreed that the adaptive approach is needed. Dr. Jonathan Links was supportive of these comments and further suggested that he believes the kinetic modeling and sampling should be linked to one-another, and that multi-resolution that looks at coarser sampling, and then typically goes to finer sampling to capture the details should be in place. He liked Dr. Stram's observations and suggestions in this respect.

Dr. Bernd Kahn observed that the NRC has data requirements for their licensees. Dr. Elise A. Striz from the US NRC commented on the value of pre-operational baseline data.

Dr. Jonathan Links suggested fine sampling at first, because we can use the kinetic models. When kinetics are fast, however, we then need to take more samples over time, and when they are slow, we are able to take less samples over time. He observed that these sampling

frequency requirements are straight-forward and the sampling frequency and sample plan are strictly driven by sampling theory and practice.

Dr Thomas Borch thought that what is needed is a very good approach to establish the extent of heterogeneity, observing that there is a lot of guidance pertaining to surface sampling for different surfaces. The baseline data does not mean that heterogeneity of data indicates a messed up site.

Dr. Kahn observed that normal practice is to obtain on-going baseline data sampling throughout the operation. His observation is that at some sites, many of the monitored sample values are going to be relatively unchanged. Dr. Stram observed that the power calculations for the test of heterogeneity is absent in the Agency's draft report, and it is his opinion that this heterogeneity test needs to be considered.

Dr. Kahn opined that we need to look at trend levels especially at shutdown, and that there may be more suggestions to increase monitoring if you see a problem or changes occurring over time and space. Dr. Stram offered that one challenge is to detect the true "hot spots" over time and space based on what you see. Dr. S.Y. Chen observed that even the baseline measurements vary typically by a factor of 2.

Having received a technical presentation by the Agency staff, and having engaged with the Agency and the participants who were present, and having also received public comments, and the Sub-Groups having engaged in lively plenary discussion on all four charge questions, and there being no additional discussion from the RAC at this time, Dr. Kahn thanked everyone for their participation, and suspended the meeting at 4:49 p.m. to reconvene tomorrow, July 19, 2011 at 8:30 a.m..

RECESS

July 19, 2011:

Reconvene the Meeting^v

Dr. K. Jack Kooyoomjian, Designated Federal Officer (DFO), reconvened the meeting at 8:31 a.m. with opening remarks. As with yesterday's meeting, he introduced himself as the DFO for the Radiation Advisory Committee (RAC) augmented for review of the Agency's Uranium In-Situ ISL/ISR Advisory and explained the purpose of the meeting, indicating that the RAC operates under the requirements of the Federal Advisory Committee Act (FACA) and is chartered to conduct business under the SAB Charter. He further explained that, consistent with FACA and with EPA policy, the deliberations of the RAC are conducted in public meetings in which advance notice is given and where he is present to ensure that the requirements of FACA

v This is a continuation of the meeting begun on July 18, 2011.

are met, including the requirements for open meetings, for maintaining records of deliberations of the RAC, and making available the public summaries of meetings, as well as providing opportunities for public comment.

Members of the public present at this day include those agency staff attendees and public attendees, as well as the RAC participants listed on the front end of these minutes.

PUBLIC COMMENTS: at 8:35 am, Dr. Kooyoomjian requested public comments. None were offered.

At 8:35 a.m., Dr. Kahn, Chair of the augmented RAC, discussed planning the day's activities, re-capped the writing assignments, and proposed a tentative schedule for preparation of the advisory . The following dates were proposed:

Proposed Schedule: (NOTE: A revised schedule was prepared on August 4, 2011)

<u>DATE</u>	<u>ACTIVITY</u>
Aug 9, 2011	Sub-Group 1 st round draft comments to Dr. Kahn;
Aug 30, 2011	Dr. Kahn forwards the 1 st edited draft Advisory to the RAC for comment;
Sept. 6, 2011	Teleconference to review August 30, 2011 Draft
1-4 pm	[NOTE: Dr. Faith Davis out of country; Dr. Links NA Sept 8; Dr. Field NA Sept 7,8 &9; Mr. Napier NA Oct 5 or 6]
Oct 5 or 6, 2011	2 nd Teleconference Call, if needed
Oct 19 or 20 2011	Quality Review Draft prepared for SAB Charter Board review [NOTE: The SAB Charter Board DFO, Dr. Angela Nugent, will schedule this review once the draft is received.]

Dr. Kahn elaborated on the above process for writing and editing the draft SAB/RAC advisory. He asked Mr. Jonathan Edwards of ORIA if they believe that this schedule was responsive to ORIA's timing needs. There was a hanging question on when the National Mining Association (NMA) might have data available to the RAC, and whether any data might be forthcoming from the Natural Resources Defense Council (NRDC) in a timely fashion on in-situ mining remediation.

At 8:57 a.m. Dr. Mary Clark of ORIA offered her thoughts on the availability of preliminary comments and obtaining a consensus draft containing concurring views of the RAC.

The RAC Leads and Scribes offered summary highlights of their views on the view screen in the meeting room for all the participants to view. Some highlights follow:

Charge Question #1 (Designing & Implementing a Monitoring Network):

Dr. Thomas Johnson observed that the initial commentary was written mostly by Dr. Jonathan Links;
Dr. Kahn commented on “seasonality;” and the pros and cons of “seasonality;”
Dr. Kooyoomjian commented on Long Range Vision;
Dr. Kahn commented on the need for representatives of agencies for data analysis, modeling and monitoring;

Charge Question #3 (Post-Operational Monitoring and Restoration):

Dr. Douglas Chambers identified the need for time to discuss the NMA data, the geology, lithography, geologic structure and the NRDC data;
Dr. Douglas Chambers thought that there may be a need to go back on recent information on the generic EIS from the U.S. NRC;

Dr. Elise A. Striz, hydrogeologist with the U.S. NRC asserted that there is a tremendous amount of information at the US NRC. She provided information on 3 sites dealing with restoration, baseline water quality and post facility monitoring. She advised that the US NRC does not have specific regulations. Instead, the NRC regulates by guidance and by dealing with assessments of specific sites. Site-specific operational monitoring is available, and she will do what she can to provide this to the EPA. The NRC has a research arm, but they have not (emphasis added) been able to tap the pre-decisional information.

Dr. Jonathan Links noted that while the raw data from the site might exist in the real world, and there seems to be a lot of data, in actual practice, precious little has actually been compiled to guide recommendations as to what constitutes spatial or temporal schemes that would or might be typical. What is needed is the specific knowledge to make decisions.

Dr. Thomas Johnson discussed trends data and observed that if you don't have the proper assessment, you can't get at the data. Dr. Elise Striz noted that the information at all 3 sites is not in the form of raw data.

Dr. Jonathan Links encouraged a regulatory approach that should work across all sites, such as a meta-analysis across sites, so that broad conclusions can be drawn in order to drive an evidence-based approach. At the present time, in the absence of such an analysis, Dr. Links thought that there is a need to have a completely different approach. It is recommended to base the regulatory approach on a set of guiding principles.

Dr. Douglas Chambers could only partially agree with Dr. Links' recommendation. He observed that there are data available, and Dr. Elise A. Striz of the U.S. NRC had advised that she provided the EPA/ORIA with such data. Dr. Mary Clark of ORIA acknowledged that they have a file of those references, and that they are huge files. They (EPA/ORIA) have references posted in advance and will provide any references needed. There also is a CD containing this information. The EPA/ORIA staff can run off hard copy information and provide this to the DFO (Dr. Kooyoomjian) if you wish.

Dr. Bernd Kahn concluded that what the RAC heard from the NRC staff is not contained in the draft technical report from the EPA/ORIA staff. Dr. Jonathan Links summarized that, to the extent that the data exist, it is the responsibility of the EPA and the NRC to examine the data and incorporate some analysis to inform the regulatory approach.

Dr. Kahn summarized, noting that the information being discussed seems to be sound, and that all parties, including the operators and the regulatory agencies, seem to be following the rules and guidance thus far. Dr. Kahn concluded that what he sees in the report guidance seems logical and sensible, but doesn't appear to be connected to the information that is available. He therefore recommended that there is a need to evaluate the information, but that this need has not yet been met.

Dr. Kenneth S. Czycinski of EPA/ORIA offered the expression "You don't want to see how hotdogs are made." He continued with that analogy, and advised that non-parametric statistics are a little easier to implement, and they (EPA/ORIA) do not have a given preference for a specific set of statistical techniques.

The RAC participants discussed post monitoring data, the analysis of the data and how it should reflect upon the science-based decision making. They recognized that it is important to explain how one reaches a conclusion by connecting the dots. The sense of the Committee was that the logic should be transparent. It was thought that the committee could prepare feedback and pose questions to the Agency in the advisory on those areas that the Agency would do well to consider as it ponders what directions to take on this subject. The reality is that no matter how much data they may have, they will need to rely on the underlying principles. The discussion drifted into the importance of information quality objectives (IQOs) and data quality objectives (DQOs) to be successful in the pursuit of science-based decision-making.

The Dr. Kenneth Czycinski of the ORIA staff posed issues of defining trends in the data and regulatory comparisons. He asked ... "What is driving the data on post-restoration? Do we need a model, and is it essential to the decision-making process?" His conclusion was – "probably not."

A discussion followed on the need to pursue the burden of proof to show why the data are needed to support the decision-making process in the regulatory world. Simply put, data are needed to at least plot the data points to show trends. It was thought that the U.S. NRC has done an excellent job with licensees.

Dr. Elise Striz of the NRC advised the participants that they (the NRC) have a presentation on "Lessons Learned" in this subject area, and she volunteered to provide it to the Agency and the RAC DFO. The materials were provided on the evening of the first day (See U.S. NRC "Lessons Learned")¹⁰. See also background information hotlinks for post closure of Uranium In-Situ Leach/In-Situ Recovery (ISL/ISR) sites.¹¹

Dr. Jonathan Links commented on what he thought should have been done in this process. He perceived that there may be a profound disconnect. He would have preferred to have seen the Agency do a modeling exercise and include more data, and would have approached the issue of space and time with recommendations for sampling data. His view is that the current draft technical report is currently an ad hoc approach without a physical model framework.

Dr. June Fabryka-Martin countered with the suggestion to just change the tense of Dr. Link's comments from what they (the Agency) should have done, to what they should do next. She offered an example highlighting the need to consider enough sulfide, because it would be dropping out. Dr. Douglas Chambers observed that we have been fixated on a list of analytes. He suggested that what we should be focusing on are ... "What are the contaminants of concern?" and ... "What are the constituents that should be focused upon a site-by-site basis?"

Dr. Mary Clark of ORIA stressed that the draft technical document is a compilation of the technical issues, and the Agency considers this process which they are now undertaking with the SAB/RAC as an advisory. In order to get the most usefulness out of the advice and collective wisdom of the convened and augmented RAC, she observed that the advisory is structured toward the charge questions.

Dr. S.Y. Chen observed that unlike the consultation, the SAB seeks consensus advice in the advisory process. Dr. Bernd Kahn observed that ORIA asked the RAC very simple, direct questions, and we are saying that you have to understand what you are dealing with.

Dr. Mary Clark took a minute to summarize and advised that the Agency was looking for comments and suggestions around those primary areas in the charge questions. She heard each panelist offer suggestions to provide advice, even though they saw less rather than more detail in the draft technical report.

Mr. Thomas Peake referred to Attachment B, of the draft technical report pertaining to post-restoration stability monitoring case histories, and noted that the data are a summary of events. He asked ... "As we get more data, then where should we go?" He postured that perhaps the data are not necessarily in the form that we can best use. However, this is an advisory, and as we look at the data, hopefully we can get a better handle on the excellent points being made by the SAB/RAC. The process is not fully developed as yet by the Agency, and that is precisely why this is an advisory with the SAB. He thought that the current process makes sense, and he agrees that we need to bring ourselves back to the questions being asked.

Dr. Jonathan Links observed that initially with reference to what we were being asked, we cannot begin to comment on the approach, and we cannot say with certainty what statistical information is actually available for us at this point to base our comments on. Dr. Mary Clark agreed with this.

Dr. Kahn made a general comment that the RAC, or any science advisory group or body, to be most useful, has the desire to be involved as early in the process as possible. He further

observed that the reality is if we (the RAC in this case) are brought in early in the process, then the Agency needs to leave the review materials in the framework of the advisory precisely as we are doing here.

Dr. William Field remarked that he felt this discussion has been tremendously helpful today, compared to where we were yesterday. He felt we (the RAC) are getting a better sense of the big picture, and asked the Agency staff, ...”What technical parameters would you like us to examine?” Dr. S.Y. Chen chimed in to ask ...”Are we on the right track?” Dr. Bernd Kahn also chimed in remarking ..”You can mine our advice for whatever is useful to you in this advisory.”

BREAK The participants took a break at 10:19 a.m. and reconvened at 10:45 a.m..

Dr. Kahn reconvened the meeting at 10:45 am. He noted that this is an important area. At this juncture, no additional comments were offered for issues relating to Sub-Group 3 pertaining to post-operational monitoring and restoration, so he asked Sub-Group CQ #4 to lead the discussion.

Sub-Group CQ #4 – Statistics, Data Requirements and Use:

Lead is Dr. Daniel Stram, and Scribe is Dr. Dale Preston. Other members are Dr. Thomas Borak and Dr. Faith Davis.

Dr. Stram observed that much of the draft technical report gives advice for analysis of data for an individual well. However, he concluded that none of the data currently appear to address the design for the ideal number of wells needed to be statistically representative at a site. Other terms that appear to need more discussion include “seasonality,” “heterogeneity,” and how they should be dealt with. Additional discussion took place on options for how to address seasonality, such as with more frequent sampling spaced out over a reasonable time frame, and use of the adaptive approach. For instance, one starts with the initial number of wells, and computes the coefficient of variation and estimates parameters needed. If the power is low, then there may be a need to add more wells.

A suggestion was made pertaining to the multiple comparison problem. Sample variation should be large enough for comparisons of interest. The difference, or “delta” is somewhat large, but the idea is to make the power great enough for comparison of multiple tests

Dr. June Fabryka-Martin cautioned that if there are temporal trends in the wells, they may not be seasonal. She advised that one could look at variability and precipitation data. Dr. Stram acknowledged that would be a regression approach, and that it could be more complex. There was a discussion on these points.

Dr. Morgan raised issues regarding the situation where a couple of wells may be identified as outliers. Dr. Stram advised that the issues may be compounded by the species of compounds observed, and that it is important to make sure that these observations are not

outliers. Dr. Stram suggested that observation of such trends may be more “forgiving” in the post-operational period for stability monitoring. He suggested that the next level may be to go to the US NRC as the party which grant the licenses, to deal with these sorts of issues, but that the US NRC may want to take a “Wait and See” position and it may be appropriate to sort this all out at that level.

Dr. Kahn offered that there may be all sorts of analytes going up and down and they may not be important in the big picture sense for making a decision on the matter at hand pertaining to stability assessment. He thought that probably there should be some idea of a “restrained analyte collection.”

Dr. Dale Preston thought that it is important to process things that do need data, and to stabilize things on site, and that the monitoring methods could be improved over time. Dr. June Fabryka-Martin thought that if there is a spatial trend in the data, then she asked ...”How does that get handled statistically to see if it is actually stabilized?”

Dr. Stram offered the observation that testing for heterogeneity between wells and the effect of injection may not be uniform over every well, and that what might be needed when you can’t accept heterogeneity as the hypothesis, is to stop and ask...”What would be the next level of action by the U.S. NRC?”

Dr. Kahn thought that you may find an actively different portion of the site and that vigorous mining activity means real time and active change on site as the mining operation takes place. Dr. Stram observed that if there is a strong outlier, this raises a flag or question and needs to be dealt with to decide if it should be accepted or should be remedied.

Dr. Links observed that there is a place to utilize spatial statistics and/or partial correlations, and that retaining some mapping information and capability provides the opportunity for some partial spatial correlation, and the use of statistics at least to upgrade your power (that is, statistical resolution) and ability to seek better understanding of the patterns being observed by the monitoring. Dr. Dale Preston added that finding spatial information in a standardized way to make decisions would be helpful.

Dr. June Fabryka-Martin thought that data showing pre-disturbance may be more important than post-disturbance data. She further observed that horizons of the ore flow path of water through different formations may not be simple 2-dimensional x-y variability. Dr. Borch thought that we probably should better define what we mean by heterogeneity, and that these factors may be different in pre- and post- determinations.

Dr. S.Y. Chen offered that from a regulatory compliance perspective, there is the point-of-compliance, and there may be a huge minimum and maximum range. He advised that range is being defined by the observed baseline, and demonstrating compliance involves considerations of both the baseline and the range observed.

Dr. Stram thought that, in terms of the big changes (delta), the amount of change that you are trying to detect is important. For instance, just showing that the mean is in the previous range does not necessarily answer the broader question regarding stability. Dr. S.Y. Chen offered the thought that demonstration of regulatory compliance is an important regulatory distinction and endpoint by itself.

Dr. Stram advised that the first test should be for heterogeneity, noting that right now people can be released from responsibility and literally walk away from the site once compliance is demonstrated, and this leads you to have the incentive to try to figure out what to do so that these patterns are better understood.

Dr. William Field reminded the participants that the RAC had fruitful discussions yesterday on non-parametric and parametric statistics.

Dr. Daniel Stram observed that clinical trials are designed in order to decide whether serious elevation should occur on some issues, for instance where sampling errors or outliers might have an undue influence on test results.

Dr. Kahn posed the following question...”is an outlier really an outlier, or is it a warning sign?” Dr. Dale Preston suggested that the answer could really be assisted with a modeling phase and more parametric model-based approaches. Dr. Douglas Chambers advised that we should be looking at statistical-based parameters to focus on. A discussion followed on results at nearby wells, the use of different analytes, and which analytes might, should, or ought to be looked at. Other priorities dealt with constituents of concern, and how close do you go to the “bright line?” A discussion followed on such topics as adaptive indicators, and predicting what variables might be important.

Dr. Brian Powell asked” When you see a leak, is it the responsibility to find a technically defensible basis for these numbers?” There is a need to better understand the observations and provide technical justification. Discussion followed on other related issues, such as when to re-sample, and what the underlying assumptions might be. Dr. Elise A. Striz of the NRC advised that speciation also is an issue deserving some attention. She thought that there is a need to distinguish between the activity of licensing for proceeding with mining activity and specific restoration requirements. Dr. Kahn acknowledged Dr. Powell’s and Dr. Striz’s comments and the discussion that followed, and recognized that there are a variety of restoration choices and scenarios that could be addressed.

Dr. Kenneth Czycinski advised that there are situations where the applicant/licensee may violate the GW protection standard. Dr. June Fabryka-Martin reminded the participants that the regulations apply to thorium as well.

At 11:43 a.m., Dr. Kahn asked each of the four Sub-Groups on the augmented RAC to provide an outline of their commentary thus far before they leave this afternoon. He asked for this so he might have a better sense of what items they think need to be further addressed. He

then encouraged the Sub-Groups to conduct a writing session in place concurrently in the meeting room so that they might have the opportunity to coalesce their consensus thoughts.

WRITING SESSION: From 11:45 a.m. to 12:15 p.m., the Sub-Groups conducted a writing session on the four charge questions.

LUNCH: From 12:15 p.m. to 1:21 p.m., the RAC and participants took a lunch break.

At 1:21 p.m., the RAC re-convened and reported out to the entire body present on the highlights of their draft written responses to the charge questions.

Sub-Group CQ #1: Designing & Implementing A Monitoring Network:

At 1:27 p.m., Dr. Thomas Johnson discussed the conceptual flow chart/road map on how to put things together to build the regulation for tracking and assessing each individual site. It was thought that a range from 6 months to 2 years of data may be enough, but it is clearly dependent on actual site-specific circumstances for generating baseline data. The blueprint will evolve as we prepare our materials, and each group will have a framework for decision points.

Sub-Group CQ #2: Pre-Operational Monitoring:

Dr. Thomas Borch cited p. 17 in the draft Technical Document, Section 4.2 pertaining to Baseline Conditions. He outlined the following points:

- Have to come up with parameters with regard to water chemistry,
- Have to do this for every site on a site-by-site basis,
- At each site, need to determine GW flow characteristics, because that flow will be disturbed in the mining process,
- Will have to undertake a probe of parameters, such as Eh, pH, etc. Eh measurements will work well if you do not have oxygen present. Desire to do this in an inexpensive and fast manner. Could plot a stability line. Can do this for selenium and arsenic. It is important to monitor the salts,
- All the iron & manganese contributes to a change in Redox.
- Timing is an issue. For how long should we monitor?

Dr. June Fabryka-Martin advised to consider downhill potential escape routes, commenting on the density of fluids, and how to present data summary tables so that they are more informative for the decision-makers.

Dr. Thomas Borch advised that microbial activity would have to be better understood in consort with those other issues raised in determining stability of the contaminants of concern. He suggested that stability favors speciation patterns and conditions that you want to maintain.

Dr. Brian Powell observed that both Sub-Groups 2 & 3 have similar approach and characterization tasks. Dr. William Morgan had a question pertaining to uranium.

Sub-Group CQ #3: Post-Operational Monitoring and Restoration:

Dr. Douglas Chambers and Dr. Brian Powell presented an outline of items they thought should be included and were entitled “Items to be Included in the Written Report.” They discussed the following:

- The use of confidence levels, and
- The underlying concepts of hydrochemistry to be captured in the hydrogeological models,
- The importance of kinetics and geochemical models,
- The importance of iron chemistry, because of different sorptive capacities, and
- The rate of dissolution and dissolution kinetics that can be incorporated.

Dr. Douglas Chambers suggested that the key to understanding outliers includes such items as characterizing spatial variability, physical/chemical information and statistical analysis of the data. He suggested that we would have pre-specified analytes that need to be analyzed. They flagged the key analytes that likely should be analyzed, and this includes iron, manganese and others that will tell a lot about what is going on in the groundwater chemistry and soil conditions. Considerable kinetics occurs in the “first flushes” and you need measurements early-on.

Dr. Thomas Borch stressed that it is extremely important to establish the conditions and measure immediately (i.e., monitor early and as often as needed). A discussion followed on these points. Mr. John Schmidt of Chemco asked for clarification on the dynamics of moving huge volumes of water through the ground water. He cited a facility in Nebraska which has 4 to 5 wells.

Sub-Group CQ #4: Statistics, Data Requirements and Use:

Dr. Daniel Stram made the following summary observations, remarking that most of these points have been stated before:

- The statistics proposed are reasonable,
- The non-parametric approach is reasonable for immediate purposes,
- As understanding of processes improves, parametric modeling may enhance the analysis,
- Spatial heterogeneity of post and pre- differences are not fully addressed,
- The draft technical document currently has no guidance of what to do if you reject the hypothesis of homogeneity,
 - He offered suggestions for multiple comparisons pertaining to analytes and to paired wells in pre- and post- periods, and
 - He offered suggestions to address seasonality and other issues.

Dr. June Fabryka-Martin raised additional points concerning seasonality, water levels, pressure pulses and other issues. Dr. Elise A. Striz of the NRC observed that the states pay attention to water level and water data. Dr. June Fabryka-Martin noted the importance of the variability of the water level in the before and after scenarios. Dr. Stram recognized that the focus is usually on the composition of the water.

Dr. Kenneth Czyscinski indicated that right now there is no specific regulatory requirement pertaining to uranium in-situ ISL sites. Dr. June Fabryka-Martin remarked on the main differences between the confined and unconfined aquifers. Dr. Brian Powell referred to page 15, Section 3.4 of the Draft Technical Report pertaining to post-operational monitoring (phases 3 through 5).

ROUNDTABLE DISCUSSION:

At 2:34 p.m., Dr. Kahn asked to go “around-the- table” for highlights raised by the members, and the RAC participants offered the following response highlights:

Dr. S.Y. Chen -	He thought the specifics of the discussion points raised today (July 19 th) have been very helpful, and he believes we (the Committee) are on the right track for providing concrete information that will be helpful for decision-making.
Dt Thomas Johnson -	Passed
Dr. Jonathan Links -	Passed
Dr. Thomas Borch -	He viewed this face-to-face session as “brain-storming,” and open discussion, and he can see that we need to pin down some of the definitions and terminology. He thought the review of the four Charge Questions was very helpful in formulating our recommendations.
Dr. June Fabryka-Martin:	Passed
Mr. Bruce Napier:	Passed
Dr. William Morgan	Passed
Dr. Douglas Chambers:	Passed
Dr. Brian Powell:	He thought this session was very productive and helpful, and is looking forward to working with the Committee to further refine the comments within the advisory.

At 2:37 p.m., Mr. John Edwards thanked the Committee for their time, effort and very useful dialogue. He personally appreciated their expansive and candid remarks on this topic, and thought, that even without a written advisory at this juncture, his view is that this session has been incredibly valuable. He hopes that the RAC has gotten a sense that ORIA has used the strongest science possible. As some of the committee have eluded to, this exercise has been a different venue as an advisory. He also reflected positively on the useful advice that has come forth from the RAC in the past on such exercises as the Blue Book, MARSSIM, MARLAP, and MARSAME where the science issues really do matter. He looks forward to seeing the draft advisory and recommendations.

Dr. Mary Clark also thanked the RAC participants, and noted that while the staff has been relatively silent in this portion of the meeting, they were paying attention and listening to the advice being offered. She then remarked that they are looking forward to seeing a public near-consensus draft around the August 30th time frame.

Concluding Remarks and Adjournment:

Dr. Kahn offered brief concluding remarks, thanked the EPA/ORIA staff for their collegial exchange, and also thanked the participants from the public. Dr. Kahn thanked the RAC members for their contributions, and advised that he looked forward to the exercise ahead for producing the advisory. He also thanked Dr. Vu and Dr. Kooyoomjian for their hospitality and for providing a forum for productive dialogue. There being no further business to discuss, the meeting was adjourned at 2:45 pm.

Respectfully Submitted:

Certified as Accurate:

_____/S/_____
K. Jack Kooyoomjian, Ph.D.
Designated Federal Official
Radiation Advisory Committee (RAC)
Augmented for Uranium In-Situ ISL/ISR
Advisory

_____/S/_____
Dr. Bernd Kahn, Chair
Radiation Advisory Committee (RAC)
Augmented for Uranium In-Situ ISL/ISR
Advisory

NOTE AND DISCLAIMER: The minutes of this public meeting reflect diverse ideas and suggestions offered by Panel members during the course of deliberations within the meeting. Such ideas, suggestions and deliberations do not necessarily reflect consensus advice from Panel members. The reader is cautioned not to rely on the minutes to represent final, approved, consensus advice and recommendations offered to the Agency. Such advice and recommendations may be found in the final advisories, commentaries, letters or reports prepared and transmitted to the EPA Administrator following the public meetings.

MATERIALS CITED

The following materials can be accessed through the SAB Website at (www.epa.gov/sab) at the following hotlink

(<http://yosemite.epa.gov/sab/sabproduct.nsf/MeetingCal/D507AC611B41CE638525786900470305?OpenDocument>)

¹ Roster of Radiation Advisory Committee (RAC) Augmented for Uranium In-Situ ISL/ ISR Advisory;

² Federal Register Notice Announcing the Meeting (FR Vol 76, No. 121, p. 36918), Thursday, June 23, 2011;

³ Charge memo from the Agency requesting the review: Advisory Review of the Draft Technical Report – Considerations Related to Post-Closure Monitoring of Uranium In-Situ Leach/in-Situ Recovery (ISL/ISR) Sites;

⁴ Agenda for July 18 and 19,2011 Meeting;

⁵ EPA Rulemaking Context: Introduction to SAB Advisory on Post-Closure Monitoring of Uranium In-Situ Leach/Recovery (ISL/ISR) Sites;

⁶ Considerations Related to Post-Closure Monitoring of Uranium In-Situ Leach/Recovery Sites – An Advisory; Briefing presented to EPA Science Advisory Board Radiation Advisory Committee. Presented by U.S. Environmental Protection Agency, Office of Radiation and Indoor Air, Radiation Protection Division, July 18, 2011;

⁷ Draft Technical Report “Considerations Related to Post-Closure Monitoring of Uranium In-Situ Recovery (ISL/ISR) Sites,” Radiation Protection Division, Office of Air and Radiation, U.S. EPA, June 2011;

⁸ Public comments by Mr. Donovan Porterfield, July 3, 2011;

⁹ Public Comments from Dr. Richard Abitz, July 19, 2011;

¹⁰ U.S. NRC, ISR Application and Licensing Actions: Hydrogeology Lessons Learned,” Elise A. Striz, Ph.D., Hydrogeologist, Uranium Recovery and Licensing Branch, US Nuclear Regulatory Commission.

¹¹ Hotlinks for Post Closure Monitoring of Uranium In-Situ Leach/In-Situ Recovery (ISL/ISR) Sites.