COMM_039

ENERGYSOLUTIONS

BCC

HAND DEL
FEB 2 2010
DIV OF RADIATION

CD10-0034

February 2, 2010

Mr. Dane Finerfrock
Utah Department of Environmental Quality
Division of Radiation Control
Room 212, Airport East Business Building (Bldg #2)
168 North 1950 West
Salt Lake City, UT 84116-3085

Subject: Comments on Notice of Change in Proposed Rule UAC R313-25-8.

Mr. Dane Finerfrock:

Energy*Solutions* hereby provides comments on the proposed rule UAC313-25-8, regarding, "License Requirements for Land Disposal of Radioactive Waste – Technical Analysis." Energy*Solutions* opposes adoption for the reasons given in the attachment.

If you have any questions regarding this submittal, please contact me at (801) 649-2000.

Sincerely,

Daniel B. Shrum
Senior Vice President, Regulatory Affairs

Cc: Mr. Peter Jenkins, Chair, Utah Radiation Control Board

ENERGY*SOLUTIONS'* PUBLIC COMMENTS TO THE PROPOSED AMENDMENTS TO UAC R313-25-8 AND THE ACCOMPANYING "*STATEMENT OF BASIS FOR ADMINISTRATIVE RULEMAKING REGARDING DISPOSAL OF SIGNIFICANT QUANTITIES OF DEPLETED URANIUM*"

DAR FILE NO: 33267

February 2, 2010

ENERGY*SOLUTIONS'* PUBLIC COMMENTS TO THE PROPOSED AMENDMENTS TO UAC R313-25-8 AND THE ACCOMPANYING *"STATEMENT OF BASIS FOR ADMINISTRATIVE RULEMAKING REGARDING DISPOSAL OF SIGNIFICANT QUANTITIES OF DEPLETED URANIUM"*

DAR FILE NO: 33267

February 2, 2010

EXECUTIVE SUMMARY

Energy*Solutions* has reviewed the proposed rule regarding depleted uranium ("DU") published for comment by the Radiation Control Board (the "Board") on January 1, 2010 (the "Proposed Rule"). Energy*Solutions* opposes adoption of the Proposed Rule for the following reasons:

1. The Board has failed to recognize and acknowledge that there are existing federal regulatory requirements that ensure the safe disposal of DU at Energy*Solutions'* LLRW facility at Clive, Utah (the "Clive Facility").

2. In failing to do so, the Board has violated the "no more stringent" statute of the Utah Radiation Control Act.

3. The location of the Clive Facility and the DU disposal methods used there are suitable and protective of public health and the environment.

4. In the highly unlikely event that DU disposal at the Clive Facility is shown to pose risks to public health and the environment, mitigation measures are available to eliminate such risks.

5. There are legal arguments and public policy considerations to demonstrate that the Proposed Rule violates applicable law, exceeds the Board's authority, and contravenes sound public policy.

6. Therefore, the Board has failed to demonstrate that the Proposed Rule is needed to protect public health and the environment of the State of Utah.

In the following sections of its comments, Energy*Solutions* elaborates on the technical, legal, and public policy objections identified above. In so doing, Energy*Solutions* relies upon the judgment of several widely acknowledged experts. Each of these experts brings particular expertise to questions raised by the Proposed Rule.

The first point raised as an objection deserves special emphasis because it most clearly illustrates the shortcomings of the Proposed Rule. Under Utah law, the Board "may not adopt rules" that are "more stringent than the corresponding federal regulations which address the same circumstances" unless "it makes a written finding after public comment and hearing and based on evidence in the record that corresponding federal regulations are not adequate to protect public health and the environment of the state." The Board does not base the Proposed Rule on any independent judgment or analysis showing that the current regulations of the Nuclear Regulatory Commission ("NRC") are inadequate to protect public health and the environment. Instead, the Board attempts to justify the Proposed Rule by suggesting that there are no comparable federal rules in place and that the NRC has recognized "the inadequacy of its current regulations."

This clearly is not the case. The NRC has unequivocally declared to this Board that

> Your characterization of NRC's regulations and conclusions regarding their adequacy is in error. Although the current regulations did not consider the disposal of significant quantities of depleted uranium, they are adequate to ensure the protection of the public health and safety.

Letter from Terence Reis, Deputy Director, Division of Materials Safety and State Agreements, Office of Federal and State Materials and Environmental Management Programs, Nuclear Regulatory Commission, to Dane L. Finerfrock, Utah Division of Radiation Control ("DRC"), dated January 21, 2010 ("These regulations were reviewed by comparison to the equivalent Nuclear Regulatory Commission rules in 10 CFR Part 61."), attached as Exhibit A.

This clear and unambiguous declaration by the NRC - the federal agency with jurisdiction over the regulation of radioactive waste - on its own demonstrates that there is no legal basis for the Proposed Rule. As such, the Proposed Rule should not be adopted by the Board.

Additionally, Energy*Solutions* believes that the Board has failed to support the Proposed Rule with a legally sufficient "reason for the change." The Board has also failed to produce "public health and environmental information and studies" that provide justification for the Proposed Rule.

BACKGROUND

Interest of Energy*Solutions*. Energy*Solutions* operates the Clive Facility, a LLRW disposal facility, pursuant to a license issued by the DRC and in accordance with applicable statutes and rules (the "License"). The License authorizes Energy*Solutions* to "receive, store, and dispose by land burial, radioactive material as naturally occurring and accelerator-produced material (NARM) and low-level radioactive waste." License Condition 9.A. DU is within the universe of materials authorized for disposal by the License. DU also meets the criteria for Class A LLRW under the existing rules of the DRC. UAC R313-15-1008.

Proposed Rule. Energy*Solutions* hereby submits its comments on the Proposed Rule and the accompanying "Statement of Basis for Administrative Rulemaking Regarding Disposal of Significant Quantities of Depleted Uranium" ("Statement of Basis"). The Notice of Proposed Rulemaking (Amendment), DAR File No. 33267, dated December 14, 2009 (the "Notice"), was published in the *Utah State Bulletin* on January 1, 2010, attached as Exhibit B.

Omission of Statement of Basis from the Notice. The Statement of Basis was not published in the *Utah State Bulletin.* Rather, the Notice stated that the Statement of Basis was posted on the DRC's website, but a search of the website did not show it. Energy*Solutions* was able to obtain a copy of the Statement of Basis directly from the DRC. Other interested parties and members of the public who may want to submit public comments have not been able to obtain and review the Statement of Basis. As a result, the opportunity afforded interested parties and members of the public to submit public comments has been inadequate and the scope and quality of the comments on the Proposed Rule will be diminished.

Public Comments Submitted by Energy*Solutions*. Energy*Solutions* has assembled a technical team to prepare technical reviews which are summarized below (collectively, the "Technical Reviews"). The Technical Reviews support the conclusion that existing NRC regulations are sufficient to protect public health and the environment, with the result that the Proposed Rule is not needed and does not satisfy the criteria in Utah Code Ann. § 19-3-104(8) and (9). The experts whose reports and analyses comprise the Technical Reviews are:

- **Talisman.** Talisman International, Inc. ("Talisman") is an international nuclear engineering firm located in Washington, D.C. Talisman advises commercial nuclear power reactors, fuel cycle facilities, and high-level and low-level radioactive waste generators and disposal facilities regarding all aspects of licensing and operations. Most of the employees of Talisman are former senior managers at NRC, the U.S. Department of Energy ("DOE"), and utility companies. Talisman's technical review is attached as Exhibit C.

- **Neptune.** Neptune and Company, Inc. ("Neptune") is an environmental consulting firm headquartered in Los Alamos, New Mexico. Neptune specializes in planning, design, and analysis of environmental data in support of decision making and risk assessments involving the management and disposal of high-level and low-level radioactive waste. Neptune has extensive experience with preparing performance assessments at a variety of facilities, including the Nevada Test Site, Los Alamos National Laboratory, and Savannah River Site. Neptune has been engaged by Energy*Solutions* to prepare the performance assessment ("PA") for the Clive Facility. Neptune's technical review is attached as Exhibit D.

- **Enchemica.** Enchemica, LLC's ("Enchemica") chief scientist, Dr. Janet Schramke, PhD, located in Loveland, Colorado, has over 26 years of professional experience in the fields of geochemistry and environmental chemistry, and is a former Senior Research Scientist at the DOE's Pacific Northwest National Laboratory. Dr. Schramke has considerable experience evaluating issues related to low-level, high-level and transuranic radioactive waste disposal, and has been engaged by EPA's Office of Radiation and the New Mexico Environment Department to provide numerous technical evaluations of the Waste Isolation Pilot Plant. She also served as part of the Yucca Mountain Project License Application Review Team for Sandia National Laboratory, providing senior-level reviews of portions of the Safety and Analysis Report submitted to the NRC. Enchemica's technical review is attached as Exhibit E.

COMMENTS

I. THE PROPOSED RULE IS NOT NEEDED TO PROTECT PUBLIC HEALTH AND THE ENVIRONMENT

A. Applicable Legal Standard

The Utah "no more stringent" statute in the Utah Radiation Control Act sets forth the governing legal standard, required findings, and basis for findings.

Legal Standard

- Utah Code Ann. § 19-3-104(8)(a): "*Except as provided in Subsection (9), the board may not adopt rules, for the purpose of the state assuming responsibilities from the United States Nuclear Regulatory Commission with respect to regulation of sources of ionizing radiation, **that are more stringent than the corresponding federal regulations which address the same circumstances***."

- *Id.* § 19-3-104(9): "*The board may adopt rules more stringent than corresponding federal regulations for the purpose described in Subsection (8) only if it makes a written finding after public comment and hearing and **based on evidence in the record** that corresponding federal regulations are not adequate to protect public health and the environment of the state.*"

(Emphasis added).

Required Findings. The Board may not promulgate the Proposed Rule, unless the Board makes the following two findings:

1. The on-going receipt and disposal of DU (above 1 metric ton) - during the period from the effective date of the Proposed Rule until approval by the Executive

Secretary of the DRC of the PA - will constitute a threat to "*public health and the environment of the state*."

2. During the period from the effective date of the Proposed Rule until approval by the Executive Secretary of the PA, "*corresponding federal regulations are not adequate to protect public health and the environment of the state*." Obviously, if the Board cannot make the first finding, it cannot make the second finding.

Basis for Findings. The above findings must be based on "*evidence in the record*" after public notice and comment and a rulemaking hearing. Such evidence must specifically address whether "*corresponding federal regulations are not adequate to protect public health and the environment of the state*."

B. Application of Governing Legal Standard

Before addressing the evidence offered by Energy*Solutions* that demonstrates that no risks to public health and the environment exist from on-going DU disposal, Energy*Solutions* first addresses whether the Board has applied the correct legal standard. This discussion is necessary because the Statement of Basis does not apply the correct legal standard. Under the heading "Standards Governing the Board's Rulemaking Authority," the Statement of Basis merely references the general authority under Utah Code Ann. § 19-3-104(4) but ignores the requirements under Utah Code Ann. § 19-3-104(8)-(9). Statement of Basis at 5. Oddly, the Statement of Basis then states:

> The Board intends to issue a determination, after the public comment period, about whether there are "corresponding federal regulations that are not adequate to protect public health and the environment of the state."

Id. at 11. This would seem to indicate that at the time the Proposed Rule was issued, the Board was not sure which legal standard applies. To assist the Board, Energy*Solutions* respectfully requests that the Board consider the following points.

1. There are "corresponding federal regulations which address the same circumstances"

The NRC characterized the Proposed Rule as "equivalent" to NRC rules 10 C.F.R. Part 61 for compatibility purposes. As NRC further notes, however, the characterization in the Statement of Basis that the NRC regulations are inadequate to protect public health and the environment is "in error." Ex. A at 1.

The Talisman technical review explains in detail how 10 C.F.R. Part 61 covers disposal sites that manage DU, and how the performance objectives and other requirements found in those regulations ensure the protection of public health and the environment (including the inadvertent intruder). Ex. C at 3-5, and 7. The NRC itself summarized in a recent adjudicatory proceeding how Part 61 ensures the protection of public health and the environment:

> [T]he 'bottom line for disposal' of low-level radioactive waste are the performance objectives of 10 CFR subpart C [of Part 61], which set forth the ultimate standard and radiation limits for (1) protection of the general population from releases of radioactivity; (2) protection of the individuals from inadvertent intrusion; (3) protection of individuals during operations; and (4) stability of the disposal site after closure.

In the Matter of Louisiana Energy Services (National Enrichment Services) CLI-05-05, slip opinion at 11, dated January 18, 2005. Attached as Exhibit F.

2. The Proposed Rule is More Stringent than its Federal Counterpart

The Proposed Rule is more stringent than its federal counterpart because it prohibits the disposal of significant quantities of DU unless and until the NRC completes its rulemaking. That prohibition is not reflected in the counterpart regulation in 10 C.F.R. Part 61, which allows disposal of DU as Class A LLRW. A state rule prohibiting disposal of DU at the same time that the corresponding federal rule allows such disposal is *per se* more stringent than the federal rule.

The Talisman technical review also identified the practical consequence of the moratorium proposed by the Board:

> The period of time necessary to gain approval of the performance assessment is unknown, which means in effect that the Radiation Control Board is proposing by rule to ban the disposal of DU for an indeterminate period of time. Consequently, the rule will result in a moratorium lasting at least two years in light of the time it will take to develop a robust performance assessment and the time it will take the State to review it.

Ex. C at 8. The Statement of Basis and rulemaking record provide no support whatsoever for such a moratorium.

3. The Current Regulatory Requirements are Adequate to Ensure the Safety and Suitability of DU Disposal at the Clive Facility

Talisman provides a detailed analysis of the current NRC regulatory requirements in 10 C.F.R. Part 61 that apply to the Clive Facility to ensure the continued safe disposal of DU and other waste. *See* Ex. C at 3-5. Specifically, Part 61 provides that disposal sites must be sited, designed, operated, closed, and controlled so that reasonable assurance exists that exposures to humans are within the limits of the performance objectives.

The performance objectives include: (1) protection of the general population from releases of radioactivity to the general environment as set forth in 10 C.F.R. § 61.41; (2) protection of individuals from inadvertent intrusion into the disposal site after site closure as set forth in 10 C.F.R. § 61.42; (3) protection of individuals during operations of the disposal site as set forth in 10 C.F.R. § 61.43; and (4) the site must achieve long-term stability as set forth in 10 C.F.R. § 61.44.

It is significant that the NRC regulations in Part 61 have been demonstrated to provide adequate protection of public health and the environment for many years, and continue to be relied upon. Notably, Utah has adopted these performance objectives in the Radiation Control Rules, Utah Admin. Code R313-25, and has relied upon the protections provided by Part 61 since 1982. In addition, other states with operating low-level waste disposal sites, *e.g.*, Washington and South Carolina, have also relied on Part 61 for many years. Texas, which is currently in the process of licensing a radioactive disposal site, has also adopted Part 61.

Talisman also observed that Congress has recognized the protective value of the Part 61 performance objectives. Congress recently enacted legislation adopting the Part 61 strategy of demonstrating that radioactive waste disposal meets the performance objectives of Part 61. Specifically, in section 3116 of the National Defense Authorization Act of 2005 (50 U.S.C. § 2601), Congress required DOE in consultation with the NRC to comply with the existing Part 61 performance objectives for disposing waste incidental to reprocessing. In addition, the DOE has adopted the current Part 61 performance objectives in its Waste Management Order 435.1 to implement its health and safety responsibilities under the Atomic Energy Act. Ex. C at 7.

4. The NRC Has Affirmed the Adequacy of its Regulations Adequate to Protect Public Health and the Environment of the State of Utah

In its comments to the Executive Secretary on the Proposed Rule, the NRC explicitly addressed this fourth issue as follows:

> The Statement of Basis also concludes that NRC has recognized "the inadequacy of its current regulations." Statement of Basis at 8. *Your characterization of NRC's regulations and conclusions regarding their adequacy is in error.* Although the current regulations did not consider the disposal of significant quantities of depleted uranium, they are adequate to ensure the protection of the public health and safety. The requirements in 10 C.F.R. Part 61 Subpart C provide the performance objectives that all disposal facility licensees must comply with before disposing of any low-level radioactive waste. The NRC's recommendation to update a site's performance assessment prior to disposal of significant quantities of depleted uranium would ensure that the licensee continues to comply with these requirements; a recommendation to ensure compliance with the existing regulations does not indicate

> that the regulations are inadequate. The NRC's rulemaking effort will clarify these requirements and provide additional guidance to licensees and the Agreement States that are dealing with the disposal of unique waste streams, *but engaging in a rulemaking to update the NRC's regulations does not mean that the current regulations are inadequate to protect the public health and safety while rulemaking is pursued to improve the regulations.*

Ex. A at 1-2 (emphasis added).

The fact that a regulation is under review and is amended does not mean that the original regulation is no longer protective of public health and the environment. As circumstances change and more information becomes available, an administrative agency will reevaluate and modify its rules. Importantly, in this circumstance, the NRC has explicitly stated that the current regulations are adequate to protect public health and the environment while rulemaking is pursued to improve the regulations.

Talisman also addressed this point in its technical review, observing that had the NRC concluded that the current NRC requirements were *not* protective of health and the environment, the NRC would have taken action to prevent the disposal of DU until the rulemaking was completed. *See generally* Ex. C. Such action could have included issuing immediately effective orders under 10 C.F.R. § 2.202 to NRC licensees prohibiting disposal of DU until the rulemaking was completed. The NRC could also have issued orders to Energy*Solutions* and/or other disposal site licensees in Agreement States to prohibit disposal of DU pursuant to the provisions of 10 C.F.R. § 150.15(a)(5) and (b).[1] The fact that the NRC has taken no formal or informal action further confirms that no immediate health and safety concern exists pending the rulemaking.

The technical review prepared by Talisman describes the limited purpose of the NRC rulemaking and why it should not be construed as an admission that 10 C.F.R. Part 61 is inadequate to protect public health and the environment:

> While the rulemaking will clarify the need for a site-specific analysis, it does not indicate that the existing system is flawed or otherwise inadequately protective of public health and safety. Sections 61.12 and 61.13 already require a demonstration that the site and design of the disposal system meet the performance

[1] It is important to note that Section 274 (c)(4) of the Atomic Energy Act of 1974 (42 U.S.C. § 2021), and Article II, paragraph C of the Agreement between NRC and Utah give the NRC primacy in Utah regarding the disposal of "byproduct, source, or special nuclear material as the Commission from time to time determines by regulation or order should, because of the hazards or potential hazards thereof, not be so disposed of without a license from the Commission." Thus, the Proposed Rule and moratorium, if enacted, likely violates the preemptive effect of NRC's regulations.

objectives and, therefore, the NRC rules are protective of public health and safety.

Ex. C at 5.

C. The Technical Reviews Unequivocally Demonstrate that a Moratorium on DU Disposal is Not Needed to Protect Public Health and the Environment

The Technical Reviews demonstrate that a moratorium on DU disposal pending the NRC rulemaking is not needed to protect public health and the environment.

1. The Location of the Clive Facility and the DU Disposal Methods are Suitable and Protective of Public Health and the Environment

Neptune offered the following expert opinion based on its knowledge of the location of the Clive Facility and disposal methods used: "[t]he remoteness of the Clive Facility site and hostile environment for both humans and ecological systems, make it particularly well suited for disposal of large quantities of DU." Ex. D at 4. Neptune also observed that the existing NRC guidance supports the safe disposal of DU at the Clive Facility and provides a level of confidence that the full site-specific PA will confirm the same:

> In October 2008, the Nuclear Regulatory Commission (NRC) prepared "Analysis of Depleted Uranium Disposal" as Enclosure 1 to the SECY-08-0147 [4], which concluded that near surface disposal of large quantities of depleted uranium may be appropriate at disposal depths of at least three meters. Although the NRC has acknowledged that this generic radiological performance assessment should not be relied upon as the sole basis for making site-specific licensing decisions, it does provide useful context for assessing site-suitability. In fact, the NRC relied on just such an approach for development of the classification tables in 10 CFR 61.55, which are based on a generic analysis of potential impacts at a reference site. Based on the 2008 NRC analysis, Neptune's preparation of PAs at other sites, and Neptune's knowledge of site conditions and disposal configurations at the Clive facility, Neptune's collective professional judgment is that a fully quantitative PA can be developed that will demonstrate compliance with applicable standards within a 10,000-year time period for disposal of some quantity of DU.

Id. at 4.

Neptune also confirmed that the future PA it is now preparing for the Clive Facility will adequately address the peak radon concentration:

> Because peak radon activity will occur following about 1,000,000 years into the future, a more qualitative model will also be developed to evaluate ultra-long term performance. This is in keeping both with NRC guidance and our experience at other [LLRW] sites. This approach will be used rather than relying on quantitative dose projections because of the uncertainty associated with evaluating human receptor scenarios that far into the future. This uncertainty is associated both with projecting human behavior and environmental conditions. For example, several ice ages might occur, and recurrences of Lake Bonneville can be expected.

Id. at 5.

Similarly, Enchemica's technical review describes other prior technical analyses of DU disposal at the Clive Facility that confirm Neptune's opinion set forth above:

> Energy*Solutions* has carried out a site-specific analysis applicable to the disposal of large quantities of depleted uranium (DU) at their facility in Clive, Utah (Whetstone 2009). This groundwater transport evaluation was carried out in a manner consistent with previously approved site-specific assessments (Whetstone 2000, 2007), except for the modeling of additional uranium decay chains and extension of the time period to more than 10,000 years after cell closure (Whetstone 2009). Potential environmental effects of DU disposal were addressed by modeling the groundwater transport of radionuclides from the disposal cell to a compliance well at the site. The site-specific analyses included many conservative assumptions that resulted in the overestimation of leaching and transport of DU constituents from the disposal cell to a compliance well. This report reviews the characteristics of DU and summarizes the conservative assumptions and results of the site-specific modeling calculations of groundwater transport that demonstrate large-quantity DU disposal can be safely carried out at the Clive facility.

Ex. E at 1-2.

Enchemica also provided a detailed analysis of conservative assumptions underlying the site-specific groundwater transport assessments for the Clive Facility that support past and future DU disposal. *Id.* at 3-4. This analysis also took into consideration the engineered cover and other cell design features and site specific information to confirm the integrity and geotechnical stability of the current disposal methods. *Id.* at 5. Enchemica concluded:

> Site-specific groundwater transport modeling for waste disposal at the Energy*Solutions* Clive facility has demonstrated that uranium can be safely placed in the disposal cells, even when the waste is assumed to contain uranium isotopic concentrations that greatly exceed plausible concentrations, along with significant concentrations of uranium progeny (Whetstone 2000, 2007, 2009).
>
> The results of these site-specific performance assessments demonstrate that large quantities of DU can be safely placed in the Clive facility, because significant radionuclide transport through the groundwater will not occur. The low rainfall, lack of potable water and saline soils make the site unsuitable for present-day or future habitation. The radon barrier and the intrusion protection function of the engineered cover would provide protection to receptors exposed through a non-resident exposure scenario.

Id. at 6-7.

Accordingly, the best available science and technical analyses demonstrate that large quantities of DU can be safely disposed at the Clive Facility. Moreover, Energy*Solutions* has voluntarily and proactively commenced preparation of an additional PA to demonstrate the same even before the NRC rulemaking concludes.

2. The Existing Technical Analyses Satisfy Current Regulatory Requirements and Ensure the Safety and Suitability of DU disposal at the Clive Facility

The technical review prepared by Talisman appropriately notes the emphasis in 10 C.F.R. Part 61 on technical analyses. Indeed, as it points out, the term performance assessment does not even appear in the regulations. The requirement to perform technical analyses appears in 10 CFR §§ 61.12 and 61.13:

> Sections 61.12 and 61.13 already require a demonstration that the site and design of the disposal system meet the performance objectives and, therefore, the NRC rules are protective of public health and safety.

The technical analyses that have been prepared by Energy*Solutions* and its contractors, as supplemented by the analyses prepared by the NRC in SECY-08-0147, demonstrate the suitability of the Clive Facility for the disposal of DU.

Energy*Solutions* has initiated preparation of a new formal PA both to satisfy the anticipated outcome of the NRC's limited rulemaking and to provide assurance that the disposal of DU at the Clive Facility historically, currently, and in the future has been done in a manner that satisfies the performance objectives of Subpart C. Nonetheless, there exist significant, robust technical analyses that, taken in the aggregate, satisfy 61.12 and 61.13. These analyses are comprised of the studies described above: the Enchemica technical review (Whetstone 2009) and the NRC analyses contained in the SECY, "Analysis of Depleted Uranium Disposal." These technical analyses demonstrate not only the absence of any near-term risk, but the high likelihood that the Clive Facility will be found suitable for the continued disposal of large quantities of DU.

Reliance on the work done by the NRC is in keeping with the historical practice of using generic analyses as a component of demonstrating compliance. Again, as pointed out by Neptune in their technical review, Part 61 is based in part on generic analyses that rely on a reference site. Indeed, the reference relied upon is less suitable than the Clive Facility for the disposal of LLRW.

3. While Highly Unlikely, in the Event the DU Disposed of at the Clive Facility is Determined to Pose a Risk to Public Health and the Environment in the Future, Mitigation Measures are Available to Eliminate Any Risks

Neptune observed in its technical review that

> one erroneous assumption implicit in the Proposed Rule is that a moratorium is needed because once DU is disposed of at the Clive Facility, no mitigation will be possible in the event that a future PA fails to demonstrate compliance. This assumption is incorrect because performance can be successfully enhanced by various forms of mitigation.

Ex. D at 1. Neptune found that mitigating measures that could eliminate risk – in the highly unlikely event that DU disposal posed a risk to public health and the environment – include constructing a thicker cap to reduce radon emissions or removal and relocation of the DU. *Id.* Thus, the Proposed Rule offers no plausible justification for the Proposed Rule.

II. THE PROPOSED RULE VIOLATES STATE LAW

A. The Board's Public Notice Violates State Law by Failing to Make the Statement of Basis Publicly Available

The Utah Administrative Procedures Act requires a Utah state agency to publish in its notice of proposed rulemaking a "rule analysis" which shall contain, among other things, "the purpose of the rule or *reason for the change.*" Utah Code Ann. § 63G-3-301(8)(a) (emphasis added). The Notice represents in its first paragraph that there is a reference to the Statement of Basis:

> For more information, see the Utah Radiation Control Board's "Statement of Basis for Administrative Rulemaking Regarding Disposal of Significant Quantities of Depleted Uranium" at the Division of Radiation Control (DRC) website.

Ex. B.

However, the link to the Statement of Basis does not exist. In addition, if one clicks on the "Public Notices," the only item that comes up is an unrelated agency action pertaining to groundwater protection. Similarly, other links on the DRC webpage do not contain the Statement of Basis. Moreover, using the search function on the DEQ main website similarly fails to locate the Statement of Basis. Without the Statement of Basis being made publicly available, interested parties and members of the public who may wish to submit substantive or technical comments are unable to do so. This is particularly troubling given that the governing law specifically requires that the Board issue "a *written finding* after public comment and hearing and *based on evidence in the record* that corresponding federal regulations are not adequate to protect public health and the environment of the state." Utah Code Ann. § 19-6-104(9). Without interested parties and members of the public being able to provide technical comments on the Statement of Basis, the Board will not have "evidence in the record" to satisfy this rulemaking requirement. In any event, the failure to make the Statement of Basis available violates the requirements of the Utah Administrative Rulemaking Act.

B. The Statement of Basis Fails to Satisfy the Applicable Legal Requirements With Respect to Evidence in the Record Based on "Public Health and Environmental Information and Studies"

Even if the Statement of Basis had been provided to the public as part of the Notice, the Statement of Basis fails to satisfy the applicable legal standards. As indicated above, Utah law requires that the Proposed Rule set forth the *"reason for the change."* Utah Code Ann. § 63G-3-301(8)(a) (emphasis added). That requirement has special meaning in this context because the Board must solicit comments and make a finding based on specific "evidence" that specific aspects of the current federal regulations do not adequately "protect public health and the environment of the state." Utah Code Ann. § 19-6-104(9)(a). In other words, the Board must identify in the Proposed Rule (1) specific aspects of current federal law that are inadequate to protect public health and the environment, *and* (2) how the "public health and the environment of the state" is at risk. This is so that after public comment, the Board can make specific findings that the more stringent state regulation is required to protect public health and the environment based on a complete consideration of relevant "public health and environmental information and studies contained in the record which form the basis for the [B]oard's conclusion." *Id.* § 19-6-104(9)(b).

A careful review of the Statement of Basis demonstrates that the Board has failed to (1) identify *any* specific aspect of NRC's current federal regulations and standards that justify promulgating more stringent regulations (*i.e.*, a moratorium on DU disposal that is permitted under federal regulations), (2) describe how the "public health and the environment of the state" are currently at risk due to operations at the Clive Facility, and (3) identify any "public health and environmental information and studies" that the Board proposes to rely on to support a "finding" that "corresponding federal regulations are not adequate to protect public health and the environment of the state."

Rather than follow the process of setting forth "public health and environmental information and studies" and soliciting comments on its proposed "finding," the Board's Statement of Basis sidesteps these requirements by interpreting NRC actions as follows:

> For this interim period before completion of NRC rulemaking, The [sic] NRC has explicitly recommended that agreement states conduct a new review of performance assessments, prior to disposal of significant quantities of depleted uranium.... NRC has concluded both that its regulations should be changed, and that until its regulations are changed, additional analysis should be conducted on a site-specific basis before depleted uranium is accepted. These decisions constitute a recognition by NRC of the inadequacy of its current regulations.

Statement of Basis at 5 and 8.

The Board's understanding of the NRC's rulemaking is erroneous, as the NRC itself explained: "Your characterization of NRC's regulations and conclusions regarding their adequacy is in error." Ex. A at 1-2. As a consequence, the Proposed Rule lacks the technical support and analysis on which to satisfy the requirements of Utah Code Ann. § 19-6-104(9).

The Board's attempt to sidestep the process required under Utah Code Ann. § 19-6-104(9) can also be based on the genesis of the Proposed Rule. If any board of the Utah Department of Environmental Quality believes that a federal regulation is insufficiently stringent to protect public health and the environment, the board would presumably request that the division staff prepare a technical analysis of the federal rule and the specific operations located within the State to determine if a risk exists to public health and the environment. Once the division provides the board with such analysis, it should publish at least a summary of that analysis in the statement of basis of the proposed rule. During the comment period, interested parties would then submit information and studies addressing the question of whether the existing federal rule is inadequate to protect public health and the environment in Utah, as required by Utah Code Ann. § 19-6-104(8) and (9). As indicated above, the board would normally satisfy Utah Code Ann. § 63G-3-301(8)(a) and the "no more stringent" requirement (which limits the rulemaking authority of every DEQ board) by publishing in the statement of basis for a proposed rule specific information as to which corresponding federal regulations and standards are insufficiently stringent and, the details of how public health and environment are at risk. At the end of the public comment period, the board would then publish a written determination of whether the more stringent rule is legally justified, identifying all supporting "public health and environmental information and studies."

This process was not followed in this case. The DRC has never submitted to the Board any information or documentation suggesting that the federal regulations are inadequate. On the contrary, the DRC and its Executive Secretary have repeatedly provided information to the Board to support the conclusion that DU has been disposed of safely and can be disposed of safely under License Condition 35.[2] The Board simply has chosen not to follow the technical analysis it has already received from the DRC. For this reason, it is critical that the Board disclose to the NRC, the public, Energy*Solutions*, and the customers of Energy*Solutions* what "public health and environmental information and studies" the Board has that support its independent conclusions that "corresponding federal regulations are not adequate to protect public health and the environment of the state." Utah Code Ann. § 19-6-104(9)(a). By failing to do so, the Proposed Rule, if enacted, clearly violates the limitation to its rulemaking authority imposed by the Legislature. *Id.* at § 19-6-104(8).

C. The Board Failed to Satisfy the Procedural Requirement of Receiving Evidence at a Public Hearing

Utah law requires that when adopting rules that are more stringent than corresponding federal regulations, the Board must make "a written finding after public comment and *hearing* and based on *evidence in the record* . . . ." *Id.* at § 19-6-104(9)(a) (emphasis added). No Utah case law exists interpreting this provision or the analogous provision limiting the rulemaking authority of the other DEQ boards. However, from the plain language it appears that commentors must be able to offer both written and oral arguments to the Board in the setting of a formal hearing. Such an approach makes sense for complex rulemakings involving "public health and environmental information and studies." Commentors should be afforded the opportunity to submit detailed technical information represented by the testimony of technical experts who would be subject to further questioning from the Board.[3]

The purpose of a public rulemaking hearing is "to afford interested persons an opportunity to submit written data, views, and arguments regarding why the proposed regulation

---

[2] Furthermore, Energy*Solutions* has already agreed to modifications to its License that include, among other things, ensuring that DU is disposed of at a minimum of 10 feet from the top of the cover. This additional depth will retard the emission of radon at the point in the future that it begins to be generated. Radon is the principal source of potential dose resulting from the decay of uranium. Energy*Solutions* incorporates by reference its prior submissions regarding License Condition 35 and the administrative record of those proceedings – which are already in the possession of the Board and the DRC – into these Comments.

[3] The reference to "record" "evidence" also suggests that the Legislature intended that the public hearing be through a more formal process which could include sworn testimony and cross examination as occurs with some federal agencies which undertake rulemaking through formal adjudication. This point is less clear from the language of the statute.

should or should not be adopted." *Utah Restaurant Assoc. v. Salt Lake City-County Board of Health*, 771 P.2d 671, 674 (Utah Ct. App. 1989) (citation omitted). Thus, commentors for rulemaking under Utah Code Ann. § 19-6-104(9)(a) must be able to present written comments and comments at a public hearing.

The Board held what it referred to as a "public hearing" on January 26, 2010. This event is more properly referred to as a public meeting, given that the Board provided no opportunity for commentors to explain their comments, submit expert testimony to support their comments, or to entertain questions from the Board. Indeed, the hearing was not even open to commentors who intended to present written comments, as explained by the Executive Secretary during the January Board meeting:

> Peter, I need to clarify something for the Board. The January 26 meeting, it's an opportunity for the public to provide [tape cuts out] orally rather than in writing. It is not a meeting where there's going to be dialogue expect to acknowledge somebody would like to speak on behalf of this issue, the comments will be recorded by a court reporter and the transcript will be made available and those comments are treated the same as comments that have been received in writing. So let's make this clear, this isn't going to be a period for debating the merits of what's being discussed. It's an opportunity for oral comments for those people who don't take the time to write them to us. Write and send them to us.

Transcript of January 12, 2010 Radiation Control Board meeting, attached as Exhibit G. Accordingly, the Proposed Rule violated the procedural requirement to hold a meaningful public hearing. The value of the public meeting was further diminished because the majority of the Board was not even present at the meeting to hear comments – only two members attended.

D. The Board Failed to Consider the Impact of the Proposed Rule on Small Businesses.

Nowhere in the Statement of Basis is there any analysis of the impact of the Proposed Rule on small businesses. The Utah Administrative Rulemaking Act requires that the rulemaking agency consider the fiscal impacts of a proposed rule on business and, if there is an expected negative fiscal impact on small business, the agency is required to take certain steps to mitigate that impact. Utah Code Ann. § 63G-3-301(5) and (6).

Cavanagh Services Group ("Cavanagh") is a Utah woman-owned small business in Utah that has contracts with Energy*Solutions* for the loading and transloading of DU for rail shipment to the Clive Facility. The Statement of Basis does not even identify Cavanagh, much less assess the impacts of the Proposed Rule to Cavanagh's business. This omission means that the Statement of Basis is legally defective. Accordingly, the Statement of Basis and the Proposed

Rule should be withdrawn and the proper analysis performed under Utah Code Ann. § 63G-3-301(6).

CONCLUSION

As shown above, the Proposed Rule is fatally flawed because (1) the Board has failed to recognize and acknowledge that there are existing federal regulatory requirements that ensure the safe disposal of the Clive Facility, (2) the Board has violated the "no more stringent" statute of the Utah Radiation Control Act, (3) the location of the Clive Facility and the DU disposal methods used there are suitable and protective of public health and the environment, (4) even in the highly unlikely event that DU disposal at the Clive Facility is shown to pose a risk to public health and the environment, mitigation measures are available to eliminate such risks, and (5) the Proposed Rule violates applicable law, exceeds the Board's authority, and contravenes sound public policy. In sum, the Proposed Rule is not needed to protect public health and the environment of the State of Utah. Accordingly, Energy*Solutions* respectfully requests that the Board vacate the Proposed Rule.

4718523_1.DOC

January 21, 2010

Dane L. Finerfrock, Director
Utah Division of Radiation Control
P.O. Box 144850
Salt Lake City, UT 84114-4850

Dear Mr. Finerfrock;

We have reviewed the proposed changes to the Utah regulations R313-25-8, received by our office on January 6, 2010. These regulations were reviewed by comparison to the equivalent Nuclear Regulatory Commission (NRC) rules in 10 CFR Part 61. We discussed our review of the regulations with you on January 21, 2010.

As a result of our review, we have three comments that have been identified in the enclosure. Please note that we have limited our review to regulations required for compatibility and/or health and safety and the identification of program elements that create conflicts, duplications or gaps in the orderly pattern of regulations on a nationwide basis (See the 1997 Policy Statement on Adequacy and Compatibility of Agreement State Programs). Under our current procedure, a finding that the Utah's regulations meet the compatibility and health and safety categories of the equivalent NRC regulation may only be made based on a review of the final Utah regulations. However, we have determined that if your proposed regulations were adopted, incorporating our comments and without other significant change, they would meet the compatibility and health and safety categories established in the Office of Federal and State Materials and Environmental Management Programs (FSME) Procedure SA-200.

We request that when the proposed regulations are adopted and published as final regulations, a copy of the "as published" regulations be provided to us for review. As requested in FSME Procedure SA-201, "Review of State Regulatory Requirements," please highlight the final changes, and provide a copy to Division of Materials Safety and State Agreements, FSME.

The SRS Data Sheet summarizes our knowledge of the status of other Utah regulations, as indicated. Please let us know if you note any inaccuracies, or have any comments on the information contained in the SRS Data Sheet. This letter, including the SRS Data Sheet, is posted on the FSME website: http://nrc-stp.ornl.gov/rulemaking.html.

The NRC would also like respond to the *Statement of Basis for Administrative Rulemaking*, dated December 1, 2009 which is part of the December 8, 2009 Radiation Control Board Information Packet as posted on your website and e-mailed to Duncan White on December 10, 2009. The Statement notes that the Utah Radiation Control Board "intends to issue a determination . . . about whether there are 'corresponding federal regulations that are not adequate to protect public health and the environment of the state.'" Statement of Basis at 11. The Statement of Basis also concludes that NRC has recognized "the inadequacy of its current regulations." Statement of Basis at 8. Your characterization of NRC's regulations and conclusions regarding their adequacy is in error. Although the current regulations did not consider the disposal of significant quantities of depleted uranium, they are adequate to ensure the protection of the public health and safety. The requirements in 10 CFR Part 61 Subpart C provide the performance objectives that all disposal facility licensees must comply with before disposing of any low-level radioactive waste. The NRC's recommendation to update a site's performance assessment prior to disposal of significant quantities of depleted uranium would ensure that the licensee continues to comply with these requirements; a recommendation to ensure compliance with the existing regulations does not indicate that the regulations are inadequate. The NRC's rulemaking effort will clarify these requirements and provide additional guidance to licensees and the Agreement States that are dealing with the disposal of unique waste streams, but engaging in a rulemaking to update the NRC's regulations does not mean that the current regulations are inadequate to protect the public health and safety while rulemaking is pursued to improve the regulations.

If you have any questions regarding the review, the compatibility and health and safety categories, or any of the NRC regulations used in the review, please contact Kathleen Schneider, State Regulation Review Coordinator at 301-415-2320 (kathleen.schneider@nrc.gov) or Dennis Sollenberger at 301-415-2819 (dennis.sollenberger@nrc.gov).

Sincerely,

/RA R. Lewis for/

Terrence Reis, Deputy Director
Division of Materials Safety and State Agreements
Office of Federal and State Materials
and Environmental Management Programs

Enclosures:
As stated

Enclosures: As stated

Distribution:
DIR RF [10-1]
DCD (SP08)
RErickson, RIV
JKantanic, POC
Utah File

SUNSI Review Complete
☒ Publicly Available ☐ Non-Publicly Available
☒ Non-Sensitive ☐ Sensitive

DOCUMENT NAME: G:\DMSSA\SAISB\REGULATION TOOLBOX\States\Utah\10-1
Incoming Document: ML100110020
To receive a copy of this document, indicate in the box: "**C**" = Copy without attachment/enclosure "**E**" = Copy with attachment/enclosure "**N**" = No copy

OFFICE	ASPB	DWMEP/EPPAD	ASPB	OGC	ASPB:BC	MSSA:DD
NAME	DSollenberger	PBubar	KSchneider	BJones	DWhite	TReis/rxl1
DATE	01/11/10	01/ 21 /10	01/11/10	01/13/10	01/ 21 /10	01/ 21 /10

ML100110047 **OFFICIAL RECORD COPY** **Package ML100110043**

COMPATIBILITY COMMENT ON *UTAH* PROPOSED REGULATIONS

STATE SECTION		NRC SECTION	RATS ID	CATEGORY	SUBJECT and COMMENTS
1	R313-25-8 (2)(a)	61.13	N/A		**Technical analyses** **Definition of Depleted Uranium** To clarify the proposed Utah regulation so that it comports with NRC Comment 3 below, Utah should revise R313-25-8 (2)(a) as follows: (2)(a) Any facility that proposes to land dispose of significant quantities of **concentrated** depleted uranium, more than one metric ton in total accumulation, after [effective date of rule] shall submit for the Executive Secretary's review and approval a performance assessment that demonstrates that the performance standards specified in 10 CFR Part 61 and corresponding provisions of Utah rules will be met for the total quantities of depleted uranium and other wastes, including wastes already disposed of and the quantities of **concentrated** depleted uranium the facility now proposes to dispose. Any such performance assessment shall be revised as needed to reflect ongoing guidance and rulemaking from NRC. For purposes of this performance assessment, the compliance period will be a minimum of 10,000 years. Additional simulations will be performed for a qualitative analysis for the period where peak dose occurs.
2	R313-25-8 (2)(b)	61.13	N/A		**Technical analyses** **Definition of Depleted Uranium** To clarify the proposed Utah regulation so that it comports with NRC Comment 3 below,, Utah should revise R313-25-8 (2)(b) as follows:

	STATE SECTION	NRC SECTION	RATS ID	CATEGORY	SUBJECT and COMMENTS
					(2)(b) No facility may dispose of significant quantities of **concentrated** depleted uranium prior to the approval by the Executive Secretary of the performance assessment required in R313-25-8(2)(a).
3	R313-25-8 (2)(c)	61.13 40.4	N/A	H&S A	**Technical analyses** **Definition of Depleted Uranium** Utah's proposed regulation redefines depleted uranium as "waste with depleted uranium concentrations greater than 5% by weight" and creates conflicts with the definition of depleted uranium in 10 CFR 40.4, which is Compatibility Category A designation. Since the other provisions in R313-25-8 (2) address significant quantities of depleted uranium, the following change would eliminate the conflict: "For purposes of this R. 313-25-8(2) only, <u>concentrated</u> depleted uranium means waste with depleted uranium concentrations greater than 5 % by weight." Utah needs to add the phrase "concentrated" as noted above to R313-25-8 (2)(c) to meet the Compatibility Category A designation assigned to Section 10 CFR 40.4, Definition of Depleted Uranium.

STATE REGULATION STATUS

State: Utah
[1 amendment(s) reviewed is identified by a ★
at the beginning of the equivalent NRC requirement.]

Tracking Ticket Number: 10-1
Date: 1/21/2010

RATS ID	NRC Chronology Identification	Date Due for State Adoption	Incoming Package	Outgoing Package	Notes
[illegible]	Safety Requirements for Radiographic Equipment Part 34 [illegible] (Superceded by 1997-5)	[illegible]/1994	Final [illegible]	No Comments 08/28/2003 [illegible]	Utah has adopted Final Regulations Equivalent to RATS ID: 1997-5.
[illegible]	[illegible] Radiographers Part 34 [illegible] (Superceded by 1997-5)	[illegible]	Not Required	Not Required	Utah has adopted Final Regulations Equivalent to RATS ID: 1997-5.
1991-3	Standards for Protection Against Radiation Part 20 56 FR 23360; 56 FR 61352; 57 FR 38588; 57 FR 57877; 58 FR 67657; 59 FR 41641; 60 FR 20183;	01/01/1994	Final	No Comments 02/10/1998	
1991-4	Notification of Incidents Parts 20, 30, 31, 34, 39, 40, 70 56 FR 64980;	10/15/1994	Final ML032180130	Comments 08/28/2003 ML032400630	
[illegible]	[illegible] Program and Misadministrations [illegible] [illegible] (Superceded by 2002-2)	[illegible]	Not Required	Not Required	Utah has adopted Final Regulations Equivalent to RATS ID: 2002-2.
[illegible]	[illegible] Requirements for Departures from Manufacturer's Instructions [illegible] [illegible]	[illegible]	Not Required	Not Required	These regulation changes are not required to be adopted for purposes of compatibility.

RATS ID	NRC Chronology Identification	Date Due for State Adoption	Incoming Package	Outgoing Package	Notes
1993-1	Decommissioning Recordkeeping and License Termination: Documentation Additions [Restricted areas and spill sites] Parts 30, 40 58 FR 39628	10/25/1996	Final	No Comments 01/08/1997	
1993-2	Licensing and Radiation Safety Requirements for Irradiators Part 36 58 FR 7715	07/01/1996	Final	No Comments 06/14/2000	
1993-3	Definition of Land Disposal and Waste Site QA Program Part 61 58 FR 33886	07/22/1996	Final ML071990559	No Comments 09/04/2007 ML072470237	
[illegible]	Self Guarantee as an [illegible] Mechanism Parts 30, 40, 70 58 FR 68726; 59 FR [illegible]	[illegible]	Not Required	Not Required	These regulation changes are not required to be adopted for purposes of Compatibility.
1994-2	Uranium Mill Tailings Regulations: Conforming NRC Requirements to EPA Standards Part 40 59 FR 28220	07/01/1997	Final ML023100574	No Comments 11/22/2002 ML023290240	
1994-3	Timeliness in Decommissioning Material Facilities Parts 30, 40, 70 59 FR 36026	08/15/1997	Final	No Comments 02/10/1998	
1995-1	Preparation, Transfer for Commercial Distribution, and Use of Byproduct Material for Medical Use Parts 30, 32, 35 59 FR 61767; 59 FR 65243; 60 FR 322	01/01/1998	Final	No Comments 02/10/1998	
1995-2	Frequency of Medical Examinations for Use of Respiratory Protection Equipment Part 20 60 FR 7900	03/13/1998	Final ML071990559	No Comments 09/04/2007 ML072470237	

RATS ID	NRC Chronology Identification	Date Due for State Adoption	Incoming Package	Outgoing Package	Notes
1995-3	Low-Level Waste Shipment Manifest Information and Reporting Parts 20, 61 60 FR 15649; 60 FR 25983	03/01/1998	Final ML071990559	No Comments 09/04/2007 ML072470237	
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
1995-5	Radiation Protection Requirements: Amended Definitions and Criteria Parts 19, 20 60 FR 36038	08/14/1998	Final ML071990559	No Comments 09/04/2007 ML072470237	
1995-6	Clarification of Decommissioning Funding Requirements Parts 30, 40, 70 60 FR 38235	11/24/1998	Final	No Comments 02/10/1998	
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
1996-1	Compatibility with the International Atomic Energy Agency Part 71 60 FR 50248; 61 FR 28724 **(Superceded by 2004-1)**	04/01/1999	Final	No Comments 04/16/1999	
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

RATS ID	NRC Chronology Identification	Date Due for State Adoption	Incoming Package	Outgoing Package	Notes
1996-3	Termination or Transfer of Licensed Activities: Record keeping Requirements Parts 20, 30, 40, 61, 70 61 FR 24669	06/17/1999	Final	No Comments 02/10/1998	Part 30 only
1997-1	Resolution of Dual Regulation of Airborne Effluents of Radioactive Materials; Clean Air Act Part 20 61 FR 65120	01/9/2000	Final ML071990559	No Comments 09/04/2007 ML072470237	
1997-2	Recognition of Agreement State Licenses in Areas Under Exclusive Federal Jurisdiction Within an Agreement State Part 150 62 FR 1662	02/27/2000	Final ML032180130	No Comments 08/28/2003 ML032400630	
1997-3	Criteria for the Release of Individuals Administered Radioactive Material Parts 20, 35 62 FR 4120	05/29/2000	Final ML071990559	No Comments 09/04/2007 ML072470237	
1997-4	[illegible] Shipments and Exemptions Part [illegible] 62 FR [illegible] (Superseded by 2004-1)	02/[illegible]/2000	Not Required	Not Required	These regulation changes are not required to be adopted for purposes of Compatibility. (See SP-[illegible])
1997-5	Licenses for Industrial Radiography and Radiation Safety Requirements for Industrial Radiography Operations Parts 30, 34, 71, 150 62 FR 28947	06/27/2000	Final	No Comments 04/01/1998	
1997-6	Radiological Criteria for License Termination Parts 20, 30, 40, 70 62 FR 39057	08/20/2000	Final	No Comments 06/14/2000	
1997-7	Exempt Distribution of a Radioactive Drug Containing One Micro curie of Carbon-14 Urea Part 30 62 FR 63634	01/02/2001	Final	No Comments 04/16/1999	

RATS ID	NRC Chronology Identification	Date Due for State Adoption	Incoming Package	Outgoing Package	Notes
1998-1	Deliberate Misconduct by Unlicensed Persons Parts 30, 40, 61, 70, 71, 150 63 FR 1890; 63 FR 13773	02/12/2001	Final ML011100015	No Comments 07/31/2001 ML012150220	
[redacted]					
1998-4	Licenses for Industrial Radiography and Radiation Safety Requirements for Industrial Radiographic Operations Part 34 63 FR 37059	07/09/2001	Final ML071990559	No Comments 09/04/2007 ML072470237	
1998-5	Minor Corrections, Clarifying Changes, and a Minor Policy Change Parts 20, 35, 36 63 FR 39477; 63 FR 45393	10/26/2001	Final ML032510947	No Comments 09/16/2003 ML032730694	
1998-6	Transfer for Disposal and Manifests: Minor Technical Conforming Amendment Part 20 63 FR 50127	11/20/2001	Final ML013530478	No Comments 02/07/2002 ML020390486	
1999-1	Radiological Criteria for License Termination of Uranium Recovery Facilities Part 40 64 FR 17506	06/11/2002	Final ML023100574	No Comments 11/22/2002 ML023290240	

RATS ID	NRC Chronology Identification	Date Due for State Adoption	Incoming Package	Outgoing Package	Notes
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
1999-3	Respiratory Protection and Controls to Restrict Internal Exposure Part 20 64 FR 54543; 64 FR 55524	02/02/2003	Final ML013530478	No Comments 02/07/2002 ML020390486	
2000-1	Energy Compensation Sources for Well Logging and Other Regulatory Clarifications Part 39 65 FR 20337	05/17/2003	Final ML012850044	No Comments 12/27/2001 ML020020182	
2000-2	New Dosimetry Technology Parts 34, 36, 39 65 FR 63750	01/08/2004	Final ML052850130	No Comments 10/20/2005 ML052940121	
2001-1	Requirements for Certain Generally Licensed Industrial Devices Containing Byproduct Material Parts 30, 31, 32 65 FR 79162	02/16/2004	Final ML040580276	No Comments 03/08/2004 ML040690493	
2002-1	Revision of the Skin Dose Limit Part 20 67 FR 16298	04/05/2005	Final ML052640263	No Comments 10/18/2005 ML052930360	
2002-2	Medical Use of Byproduct Material Parts 20, 32, 35 67 FR 20249	10/24/2005	Final ML052640263	No Comments 10/18/2005 ML052930360	
2003-1	Financial Assurance for Materials Licensees Parts 30, 40, 70 68 FR 57327	12/03/2006	Final ML062910213	No Comments 11/09/2006 ML063130115	

RATS ID	NRC Chronology Identification	Date Due for State Adoption	Incoming Package	Outgoing Package	Notes
2004-1	Compatibility With IAEA Transportation Safety Standards and Other Transportation Safety Amendments Part 71 69 FR 3697	10/01/2007	Final ML080350285	No Comments 02/26/2008 ML080560403	
2005-1	Security Requirements for Portable Gauges Containing Byproduct Material Part 30 70 FR 2001	07/11/2008	Final ML070370332	No Comments 03/06/2007 ML0706050102	
2005-2	Medical Use of Byproduct Material - Recognition of Specialty Boards Part 35 70 FR 16336; 71 FR 1926	04/29/2008	Final ML062000081	No Comments 08/02/2006 ML062150142	
2005-3	Increased Controls for Risk-Significant Radioactive Sources (NRC Order EA-05-090) 70 FR 72128	12/01/2005	License Condition ML052920243	No Comments 10/20/2005 ML052940078	
2006-1	Minor Amendments Parts 20, 30, 32, 35, 40 and 70 71 FR 15005	03/27/2009	Final ML091540302	No Comments 07/02/2009 ML091730130	
2006-2	National Source Tracking System - Serialization Requirements Part 32 with reference to Part 20 Appendix E 71 FR 65685	02/06/2007	Final ML080370626	No Comments 02/28/2008 ML080590006	
2006-3	National Source Tracking System Part 20 71 FR 65685, 72 FR 59162	01/31/2009	Final ML080370626	No Comments 02/28/2008 ML080590006	
2007-1	Medical Use of Byproduct Material - Minor Corrections and Clarifications Parts 32 and 35 72 FR 45147, 54207	10/29/2010	Final ML091540302	No Comments 07/02/2009 ML091730130	

RATS ID	NRC Chronology Identification	Date Due for State Adoption	Incoming Package	Outgoing Package	Notes
2007-2	Exemptions From Licensing, General Licenses, and Distribution of Byproduct Material: Licensing and Reporting Requirements Parts 30, 31, 32, 150 72 FR 58473	12/17/2010			
2007-3	Requirements for Expanded Definition of Byproduct Material Parts 20, 30, 31, 32, 33, 35, 61, 150 72 FR 55864	11/30/2010			
2007-4	Order Imposing Fingerprinting Requirements and Criminal History Records Check Requirements for Unescorted Access to Certain Radioactive Material NRC Order EA-07-305 72 FR 70901	06/05/2008	License Condition ML080980588	No Comments 05/01/2008 ML081220351	
2008-1	Occupational Dose Records, Labeling Containers, and Total Effective Dose Equivalent Parts 19, 20 72 FR 68043	02/15/2011			
2009-1	Medical Use of Byproduct Material – Authorized User Clarification Part 35 74 FR 33901	09/28/2012			
★ N/A	10 CFR 61.13 and 40.13	N/A	Proposed ML100110020	Comments 01/21/2010 ML100110047	

UTAH STATE BULLETIN

OFFICIAL NOTICES OF UTAH STATE GOVERNMENT
Filed December 02, 2009, 12:00 a.m. through December 15, 2009, 11:59 p.m.

Number 2010-1
January 01, 2010

Kimberly K. Hood, Executive Director
Kenneth A. Hansen, Director
Nancy L. Lancaster, Editor

The *Utah State Bulletin (Bulletin)* is an official noticing publication of the executive branch of Utah State Government. The Department of Administrative Services, Division of Administrative Rules produces the *Bulletin* under authority of Section 63G-3-402.

Inquiries concerning the substance or applicability of an administrative rule that appears in the *Bulletin* should be addressed to the contact person for the rule. Questions about the *Bulletin* or the rulemaking process may be addressed to: Division of Administrative Rules, 4120 State Office Building, Salt Lake City, Utah 84114-1201, telephone 801-538-3764, FAX 801-538-1773. Additional rulemaking information, and electronic versions of all administrative rule publications are available at: http://www.rules.utah.gov/

The information in this *Bulletin* is summarized in the *Utah State Digest (Digest)*. The *Digest* is available by E-mail or over the Internet. Visit http://www.rules.utah.gov/publicat/digest.htm for additional information.

♦ SMALL BUSINESSES: Because this revision does not create new requirements, no change in costs is expected for small businesses.
♦ PERSONS OTHER THAN SMALL BUSINESSES, BUSINESSES, OR LOCAL GOVERNMENTAL ENTITIES: Because this revision does not create new requirements, no change in costs is expected for other persons.

COMPLIANCE COSTS FOR AFFECTED PERSONS: Because this revision does not create new requirements, no change in costs is expected for affected persons.

COMMENTS BY THE DEPARTMENT HEAD ON THE FISCAL IMPACT THE RULE MAY HAVE ON BUSINESSES: This amendment does not create new requirements. Therefore, no additional costs are expected.

THE FULL TEXT OF THIS RULE MAY BE INSPECTED, DURING REGULAR BUSINESS HOURS, AT:
ENVIRONMENTAL QUALITY
AIR QUALITY
150 N 1950 W
SALT LAKE CITY, UT 84116-3085
or at the Division of Administrative Rules.

DIRECT QUESTIONS REGARDING THIS RULE TO:
♦ Kimberly Kreykes by phone at 801-536-4042, by FAX at 801-536-4099, or by Internet E-mail at kkreykes@utah.gov

INTERESTED PERSONS MAY PRESENT THEIR VIEWS ON THIS RULE BY SUBMITTING WRITTEN COMMENTS NO LATER THAN AT 5:00 PM ON 02/01/2010

INTERESTED PERSONS MAY ATTEND A PUBLIC HEARING REGARDING THIS RULE:
♦ 01/20/2010 01:00 PM, Division of Air Quality, Main Conference Room, 150 N 1950 W, Salt Lake City, UT

THIS RULE MAY BECOME EFFECTIVE ON: 03/03/2010

AUTHORIZED BY: Bryce Bird, Planning Branch Manager

R307. Environmental Quality, Air Quality.
R307-101. General Requirements.
R307-101-3. Version of Code of Federal Regulations Incorporated by Reference.

Except as specifically identified in an individual rule, the version of the Code of Federal Regulations (CFR) incorporated throughout R307 is dated July 1, 2009[8].

KEY: air pollution, definitions
Date of Enactment or Last Substantive Amendment: [~~July 2, 2009~~]2010
Notice of Continuation: July 2, 2009
Authorizing, and Implemented or Interpreted Law: 19-2-104(1)(a)

Environmental Quality, Radiation Control
R313-25-8
Technical Analyses

NOTICE OF PROPOSED RULE
(Amendment)
DAR FILE NO.: 33267
FILED: 12/14/2009

RULE ANALYSIS

PURPOSE OF THE RULE OR REASON FOR THE CHANGE: The U.S. Nuclear Regulatory Commission (NRC) has acknowledged the inadequacy of NRC's current rules regarding depleted uranium (DU) and has therefore recommended, while it considers a revision to those rules, that regulators review site-specific performance assessments for facilities that accept DU for land disposal, prior to the disposal of significant quantities of DU. The purpose of this rule is to implement that recommendation. For more information, see the Utah Radiation Control Board's "Statement of Basis for Administrative Rulemaking Regarding Disposal of Significant Quantities of Depleted Uranium," at the Division of Radiation Control (DRC) website.

SUMMARY OF THE RULE OR CHANGE: The proposed rule would require facilities that wish to land dispose of DU to complete and have approved a site-specific performance assessment that demonstrates that the performance standards specified in 10 CFR Part 61 and corresponding provisions of Utah rules will be met. Therefore, the Utah Radiation Control Board, at its 12/08/2009 meeting, voted to amend Section R313-25-8 that requires EnergySolutions or any facility that land disposes significant quantities of DU to submit for review and approval a site specific performance assessment prior to disposal of significant quantities of DU.

STATUTORY OR CONSTITUTIONAL AUTHORIZATION FOR THIS RULE: Subsection 19-03-104(4)

ANTICIPATED COST OR SAVINGS TO:
♦ THE STATE BUDGET: The State of Utah receives fees from licensees that dispose of radioactive waste, including DU, Section 19-3-106. EnergySolutions, L.L.C. is a Utah radioactive waste disposal facility that has stated that it will seek to dispose of DU; if this rule is promulgated, it will be unable to do so until it has completed a site specific performance assessment and had it approved. The financial impacts on waste fees received by the State of Utah, if this rule is promulgated, could be potentially substantial, but are difficult to specify because the impact depends on the following information that is not known that this time: when the rule takes effect; when EnergySolutions will submit a site specific performance assessment and when it will be

approved; when EnergySolutions would otherwise have received shipments of DU for disposal; whether DU waste receipts by EnergySolutions would simply be delayed, or whether there are competitors for DU disposal space such that EnergySolutions could lose receipts altogether.

♦ LOCAL GOVERNMENTS: Tooele County collects impact fees from waste facilities, including EnergySolutions. Tooele County's budget is therefore likely to be affected, but for the reasons described above the specific impact cannot be known at this time.

♦ SMALL BUSINESSES: No small business in Utah will be directly impacted. The only potential sources of substantial quantities of DU for disposal--the United States Department of Energy and privately-held uranium enrichment facilities--are not small businesses and are not located in Utah.

♦ PERSONS OTHER THAN SMALL BUSINESSES, BUSINESSES, OR LOCAL GOVERNMENTAL ENTITIES: The Board is not aware of any direct impact on other entities.

COMPLIANCE COSTS FOR AFFECTED PERSONS: A radioactive waste disposal facility will have to incur the cost of preparing a site-specific performance assessment under this rule, and may also bear the cost of the DRC's review of that performance assessment. The cost of a performance assessment is likely to be over $1,000,000. EnergySolutions had stated, prior to the initiation of this rulemaking, that it was planning to complete such a performance assessment anyway, since NRC rules are likely to require one in the future.

COMMENTS BY THE DEPARTMENT HEAD ON THE FISCAL IMPACT THE RULE MAY HAVE ON BUSINESSES: If a rule is promulgated, one Utah business--EnergySolutions, L.L.C.--will be unable to dispose of DU until it has submitted a site specific performance assessment and the performance assessment has been approved. The financial impacts on EnergySolutions are potentially substantial, but are difficult for the Board to specify because the impact depends on the following information not known to the Board at this time: when the rule takes effect; when EnergySolutions will submit a site specific performance assessment and when it will be approved; when EnergySolutions would otherwise have received shipments of DU for disposal; and whether DU waste receipts by EnergySolutions would simply be delayed, or whether there are competitors for DU disposal space such that EnergySolutions could lose receipts altogether. The financial impacts of this on the state's budget are potentially substantial but, as described above, are difficult to specify. EnergySolutions will also bear the cost of carrying out, preparing, and submitting a performance assessment. The company has budgeted over $1,000,000 for this work.

THE FULL TEXT OF THIS RULE MAY BE INSPECTED, DURING REGULAR BUSINESS HOURS, AT:
ENVIRONMENTAL QUALITY
RADIATION CONTROLROOM 212
168 N 1950 W
SALT LAKE CITY, UT 84116-3085
or at the Division of Administrative Rules.

DIRECT QUESTIONS REGARDING THIS RULE TO:
♦ Dane Finerfrock by phone at 801-536-4250, by FAX at 801-533-4097, or by Internet E-mail at dfinerfrock@utah.gov

INTERESTED PERSONS MAY PRESENT THEIR VIEWS ON THIS RULE BY SUBMITTING WRITTEN COMMENTS NO LATER THAN AT 5:00 PM ON 02/02/2010

INTERESTED PERSONS MAY ATTEND A PUBLIC HEARING REGARDING THIS RULE:
♦ 01/26/2010 06:00 PM, Environmental Quality, 168 N 1950 W, Room 101, Salt Lake City, UT

THIS RULE MAY BECOME EFFECTIVE ON: 03/01/2010

AUTHORIZED BY: Dane Finerfrock, Director

R313. Environmental Quality, Radiation Control.
R313-25. License Requirements for Land Disposal of Radioactive Waste - General Provisions.
R313-25-8. Technical Analyses.

(1) The specific technical information shall also include the following analyses needed to demonstrate that the performance objectives of R313-25 will be met:

[(1)](a) Analyses demonstrating that the general population will be protected from releases of radioactivity shall consider the pathways of air, soil, ground water, surface water, plant uptake, and exhumation by burrowing animals. The analyses shall clearly identify and differentiate between the roles performed by the natural disposal site characteristics and design features in isolating and segregating the wastes. The analyses shall clearly demonstrate a reasonable assurance that the exposures to humans from the release of radioactivity will not exceed the limits set forth in R313-25-19.

[(2)](b) Analyses of the protection of inadvertent intruders shall demonstrate a reasonable assurance that the waste classification and segregation requirements will be met and that adequate barriers to inadvertent intrusion will be provided.

[(3)](c) Analysis of the protection of individuals during operations shall include assessments of expected exposures due to routine operations and likely accidents during handling, storage, and disposal of waste. The analysis shall provide reasonable assurance that exposures will be controlled to meet the requirements of R313-15.

[(4)](d) Analyses of the long-term stability of the disposal site shall be based upon analyses of active natural processes including erosion, mass wasting, slope failure, settlement of wastes and backfill, infiltration through covers over disposal areas and adjacent soils, and surface drainage of the disposal site. The analyses shall provide reasonable assurance that there will not be a need for ongoing active maintenance of the disposal site following closure.

(2)(a) Any facility that proposes to land dispose of significant quantities of depleted uranium, more than one metric ton in total accumulation, after the effective date of this change shall submit for the Executive Secretary's review and approval a performance assessment that demonstrates that the performance standards specified in 10 CFR Part 61 and corresponding provisions of Utah rules will be met for the total quantities of depleted uranium and other wastes, including wastes already disposed of and the quantities of depleted uranium the facility now proposes to dispose. Any such performance assessment shall be revised as needed to reflect ongoing guidance and rulemaking from NRC. For purposes of this performance assessment, the compliance period will be a minimum of 10,000 years. Additional simulations will be performed for a qualitative analysis for the period where peak dose occurs.

(b) No facility may dispose of significant quantities of depleted uranium prior to the approval by the Executive Secretary of the performance assessment required in R313-25-8(2)(a).

(c) For purposes of this R313-25-8(2) only, depleted uranium means waste with depleted uranium concentrations greater than 5% by weight.

KEY: radiation, radioactive waste disposal, depleted uranium
Date of Enactment or Last Substantive Amendment: [~~March 16, 2007~~]2010
Notice of Continuation: October 5, 2006
Authorizing, and Implemented or Interpreted Law: 19-3-104; 19-3-108

Health, Health Care Financing, Coverage and Reimbursement Policy
R414-306
Program Benefits

NOTICE OF PROPOSED RULE
(Amendment)
DAR FILE NO.: 33259
FILED: 12/09/2009

RULE ANALYSIS

PURPOSE OF THE RULE OR REASON FOR THE CHANGE: The purpose of this change is to remove provisions in the rule that other administrative rules already cover. The other purpose is to require the Department to coordinate with other programs to assure enrollment and to provide information to Medicaid applicants and recipients on the availability of services.

SUMMARY OF THE RULE OR CHANGE: This change removes provisions in the rule that other administrative rules already cover. It also requires the Department to coordinate with other programs to assure enrollment and to provide information to Medicaid applicants and recipients. It further removes and updates incorporated materials and makes other minor corrections.

STATUTORY OR CONSTITUTIONAL AUTHORIZATION FOR THIS RULE: Section 26-18-3

TITLE OF MATERIALS INCORPORATED BY REFERENCES:
- ♦ Updates Section 1616(a) through (d) of the Compilation of the Social Security Laws, published by Social Security Administration, 01/01/2009
- ♦ Removes 42 CFR 440.240, published by Office of the Federal Register, 01/01/1999
- ♦ Removes 42 CFR 441.56, published by Office of the Federal Register, 01/01/1999
- ♦ Removes 42 CFR 431.625, published by Office of the Federal Register, 01/01/1999

ANTICIPATED COST OR SAVINGS TO:
♦ THE STATE BUDGET: There is no expected impact to the state budget because this change does not increase or decrease services and does not change eligibility criteria.
♦ LOCAL GOVERNMENTS: This change does not impact local governments because they do not fund or provide Medicare and Medicaid services.
♦ SMALL BUSINESSES: There is no expected impact to small businesses because this change does not increase or decrease services and does not change eligibility criteria.
♦ PERSONS OTHER THAN SMALL BUSINESSES, BUSINESSES, OR LOCAL GOVERNMENTAL ENTITIES: There is no expected impact to persons other than small businesses, businesses, or local government entities because this change does not increase or decrease services and does not change eligibility criteria.

COMPLIANCE COSTS FOR AFFECTED PERSONS: There are no compliance costs to a single Medicaid client or provider because this change does not increase or decrease services and does not change eligibility criteria.

COMMENTS BY THE DEPARTMENT HEAD ON THE FISCAL IMPACT THE RULE MAY HAVE ON BUSINESSES: The requirement to coordinate benefits may have a positive impact on recipients, but the amount of any benefit cannot be quantified. No adverse fiscal impact is expected since service levels and eligibility will not change.

THE FULL TEXT OF THIS RULE MAY BE INSPECTED, DURING REGULAR BUSINESS HOURS, AT:
HEALTH
HEALTH CARE FINANCING,
COVERAGE AND REIMBURSEMENT POLICY
CANNON HEALTH BLDG
288 N 1460 W
SALT LAKE CITY, UT 84116-3231
or at the Division of Administrative Rules.

DIRECT QUESTIONS REGARDING THIS RULE TO:
♦ Craig Devashrayee by phone at 801-538-6641, by FAX at 801-538-6099, or by Internet E-mail at cdevashrayee@utah.gov

INTERESTED PERSONS MAY PRESENT THEIR VIEWS ON THIS RULE BY SUBMITTING WRITTEN COMMENTS NO LATER THAN AT 5:00 PM ON 02/01/2010

TALISMAN

INTERNATIONAL, LLC

TALISMAN'S TECHNICAL REVIEW AND COMMENTS ON THE RADIATION CONTROL BOARD OF UTAH'S PROPOSED RULE GOVERNING THE DISPOSAL OF DEPLETED URANIUM

QUALIFICATIONS

Talisman International, LLC

Talisman personnel are experts in United States Nuclear Regulatory Commission ("NRC") regulatory requirements and have extensive experience with all aspects of licensing and operations of all U.S. commercial nuclear power reactors designs and fuel cycle facilities including current enrichment plant designs, fuel fabrication, radioactive waste facilities, spent nuclear fuel transportation casks, spent nuclear fuel storage cask requirements, and both low-level radioactive waste ("LLRW") and high-level radioactive waste ("HLW") handling and disposal. Almost all of the Talisman experts are former senior NRC managers, senior DOE managers, or senior utility managers. Our NRC experience covers the full spectrum of regulatory activities including licensing, inspection, rulemaking, and enforcement of NRC requirements. In addition to LLRW and HLW management, they have expertise in reactor and fuel cycle operations, physical security and material control and accounting, health physics, transportation, waste disposal, and decommissioning. Further information on the qualifications of the Talisman experts can be found at www.talisman-intl.com.

John Greeves

John Greeves is a Senior Regulatory Safety Consultant to Talisman. Mr. Greeves retired from the NRC as Director, Office of Nuclear Materials Safety and Safeguards, Division of Waste Management and Environmental Protection. He has more than forty years of experience with government and commercial siting, design, licensing, construction and remediation of critical infrastructure facilities including: nuclear power, enrichment, fabrication, used fuel recycle, storage, and radioactive waste management/disposal facilities. His current work includes providing domestic and international advice on licensing and construction of new nuclear power plants and reprocessing facilities.

For more than twenty-five years, Mr. Greeves has provided international consulting advice on environmental remediation and waste management, and is considered one of the leading experts on radioactive and hazardous waste management strategies. While at the NRC, Mr. Greeves directed the Agency's program for licensing, inspection, and regulation to assure safety and quality associated with the management, treatment, and commercial disposal of LLRW, HLW, and power reactor decommissioning. He developed, implemented, and evaluated safety and environmental policies and long-range goals for these activities.

Previously Mr. Greeves managed the NRC's program for licensing and inspection of fuel cycle, industrial and medical nuclear facilities. Prior to joining the NRC in 1974 he worked for Bechtel Power Corporation on the licensing, design, operation and construction of nuclear power plants. Mr. Greeves served on a number of national and international panels regarding nuclear waste management activities. He was NRC's representative to the IAEA Waste Safety Standards Advisory Committee, and participated extensively in the development of the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management. In 1993 and 2001, Mr. Greeves received Presidential Meritorious Rank Awards. Mr. Greeves is a registered Professional Engineer and a member of the American Society of Civil Engineers and Health Physics Society. He holds a Bachelor of Science in Civil Engineering from the University of Maryland, and completed Graduate Studies in groundwater analysis at the University of Maryland and Graduate studies in Business Management at Golden Gate University.

Jim Lieberman

Jim Lieberman has been a Senior Regulatory and Nuclear Safety Consultant to Talisman since his retirement from the NRC in 2004. He has more than 35 years of experience in nuclear regulatory activities and is considered an expert in the regulations and licensing requirements of the NRC. Since retiring from the NRC, Mr. Lieberman has consulted for private firms, DOE, and the NRC on various nuclear regulatory matters including fuel cycle, decommissioning, allegations, safety-conscious work environment, radioactive waste management, Mo-99 production, reactor licensing, and import and export licensing for radioactive material. He was the lead participant in developing the 2009 NEI proposed regulatory framework for a fuel recycling facility and its white paper on high-level waste and waste incidental to reprocessing issues for recycle facilities. He has assisted the DOE on waste determinations at Savannah River, Idaho, and West Valley. He has been an expert witness in several cases.

He retired from the NRC as Special Counsel for Decommissioning and Fuel Cycle activities for which he was lead NRC counsel for license termination and decommissioning issues; LLRW and HLW issues including mixed waste, GTCC waste, EPA ANPR on disposal of LLRW at RCRA sites, and waste incidental to reprocessing; state agreement program matters including regulation reviews and jurisdictional issues between NRC and Agreement States; enrichment activities ("LES" and "USEC"); Fuel Cycle rulemaking, guidance, and licensing actions including mill tailings, source material (definition of source material, jurisdiction, and unimportant quantities) and 11e(2) issues; West Valley (developing and implementing NRC Policy Statement on Decommissioning Criteria); clearance rulemaking; and NEPA.

Mr. Lieberman was also Director of the Office of Enforcement where he was responsible for managing the Commission's enforcement program and was accountable for the Commission's policy statements on enforcement, protection of allegers against retaliation, and safety-conscious work environments. He was directly responsible for rulemakings on Completeness and Accuracy of Information and Deliberate Misconduct and chaired agency-wide review teams on discrimination and enforcement, both of which resulted in significant changes to NRC programs and policies. He also advised Russia and Ukraine on regulatory and enforcement issues. His other assignments at the NRC included being the Assistant General Counsel for Enforcement and Regional Operations.

Mr. Lieberman has received two Presidential Meritorious Rank Awards and two NRC Meritorious Service Awards. He received a BS in Mechanical Engineering from the University of Rhode Island, a M.S. in Thermal Engineering from Cornell University, and a J.D. from George Washington University.

Paul Lohaus

Paul Lohaus is a Senior Regulatory Safety Consultant to Talisman. Mr. Lohaus retired from the NRC as Director, Office of State and Tribal Programs. He has more than thirty-five years of senior staff and management experience covering a broad spectrum of areas in nuclear materials safety including: radioactive materials licensing, inspection, and enforcement; materials security; LLRW management; uranium recovery facility licensing and remediation; decommissioning, and Federal, State, and Tribal relations.

While with the Office of Nuclear Material Safety and Safeguards, Mr. Lohaus directed NRC's safety and environmental protection program for LLRW. He led NRC activities to develop new LLRW regulations, 10 CFR Part 61 Licensing Requirements for Land Disposal of Radioactive Waste, and the supporting technical, environmental, and regulatory analyses for Part 61. He directed NRC's uranium recovery oversight program for remediation of inactive Title I sites and oversight of active and closed Title II sites. He has provided national advice and assistance to States on materials regulation, environmental remediation, and waste management issues and is considered a leading expert on State relations, the Agreement State program, and radioactive waste management issues.

For over 10 years, Mr. Lohaus directed NRC's program of interaction with State and Tribal Governments including the Governor appointed State Liaison Officer Program and the Agreement State Program. He directed NRC's Integrated Materials Performance Evaluation Program ("IMPEP"), which has received recognition both nationally and internationally as a model program. He directed NRC and Agreement State activities to develop and implement increased controls over licensees nationwide which possess high activity sources to ensure safety and security in today's post 9/11 environment.

For more than 10 years, Mr. Lohaus represented NRC on the Board of Directors of the Conference of Radiation Control Program Directors ("CRCPD") and the Organization of Agreement States ("OAS"). He was appointed an emeritus member to the CRCPD, and was awarded the OAS Hall of Fame award in October 2005. Mr. Lohaus received Presidential Meritorious Rank Award recognition and Meritorious Service recognition from the NRC. He holds B.S. and M.S. degrees from the State University of New York.

TECHNICAL REVIEW

I. SUMMARY OF CURRENT COMPARABLE FEDERAL REGULATIONS

Regulatory Background. Regulations promulgated by the U.S. Nuclear Regulatory Commission (NRC) specifically address the disposal of depleted uranium. The applicable federal regulation, found at 10 C.F.R. Part 61, Licensing Requirements for Land Disposal of Radioactive Waste, promulgated by the NRC establish the requirements for land disposal of radioactive waste and the procedures, criteria, and terms and conditions for licenses for the disposal of LLRW containing byproduct, source, and special nuclear material. 10 C.F.R. § 61.3. Depleted uranium (DU), which is the subject of this rulemaking, is source material and is regulated under Part 61. As explained in NRC's comments, no room for disagreement exists that DU is regulated. In fact DU was specifically considered in the development of Part 61.[1] As recently affirmed by the NRC, DU is Class A waste subject to 10 CFR Part 61.[2]

Performance Objectives. Part 61, which the State of Utah has adopted in its Utah Administrative Code at R313-25, is protective of the public health and the environment of Utah. A key part of Part 61 are the four performance objectives in Subpart C of Part 61 that when met ensure the safe disposal of LLRW. Applicants for disposal site licenses and license renewals must demonstrate by technical analyses that these performance objectives have been met. These analyses, which include performance assessments, are reviewed by the licensing authority as part of the licensing process.

Part 61 provides in section 61.40 that disposal sites must be sited, designed, operated, closed, and controlled so that reasonable assurance exists that exposures to humans are within the limits of the performance objectives. The performance objectives are:

1. Protection of the general population from releases of radioactivity to the general environment as set forth in 10 C.F.R. § 61.41.

2. Protection of individuals from inadvertent intrusion into the disposal site after site closure as set forth in 10 C.F.R. § 61.42.

3. Protection of individuals during operations of the disposal site as set forth in 10 C.F.R. § 61.43.

4. The site must achieve long-term stability as set forth in 10 C.F.R. § 61.44.

---

[1] It is recognized that the environmental statements that supported the Part 61 rulemaking did not consider large quantities of DU: *Draft Environmental Impact Statement on 10 CFR Part 61 "Licensing Requirements for Land Disposal of Radioactive Waste,"* U.S. NRC, September 1981; and *Final Environmental Impact Statement on 10 CFR Part 61 "Licensing Requirements for Land Disposal of Radioactive Waste,"* U.S. NRC, November 1982.

[2] *Staff Requirements – Secy-08-0147 – Response to Commission Order CLI-05-20 Regarding Depleted Uranium,* U.S. NRC, March 18, 2009.

Adequacy of Part 61. The existing Part 61 is adequate because the regulations require that performance objectives of Subpart C be met and these performance objectives are protective for both the public and a site intruder. The State of Utah has adopted these performance objectives in Utah Administrative Code.[3] The NRC regulations as codified in Part 61 have been demonstrated to provide adequate protection of public health and safety for disposing of LLRW for many years. NRC and the various states have relied upon the protections provided by Part 61 since 1982. Not only has Utah adopted Part 61, the other states with operating LLRW disposal sites, Washington and South Carolina, also have done so. Texas, which is currently in the process of licensing a radioactive disposal site, also has adopted Part 61. All states that license LLRW disposal sites have adopted Part 61.

The NRC summarized the significance of the performance objectives during a recent adjudicatory proceeding as follows:

> the 'bottom line for disposal' of low-level radioactive waste are the performance objectives of 10 CFR subpart C [of Part 61], which set forth the ultimate standard and radiation limits for (1) protection of the general population from releases of radioactivity; (2) protection of the individuals from inadvertent intrusion; (3) protection of individuals during operations; and (4) stability of the disposal site after closure.[4]

Further evidence that the performance objectives of Part 61, Subpart C, are adequate is demonstrated by the fact that the Proposed Rule references and relies on them. [5]

Specific Technical Requirements. In addition to meeting the above performance objectives, Part 61 has numerous specific technical requirements addressing waste disposal that also must be met, *e.g.*, 61.50, 61.51, 61.52, 61.53, 61.55, 61.56, and 61.57. These technical requirements address siting suitability, disposal design, operational and closure provisions, environmental monitoring, and waste classification and characteristics. These provisions provide for a comprehensive regulatory envelope that together with the performance objectives provides protection to the public health and safety. An important element of these technical requirements is the classification of the radioactive waste. There are three classes: A, B, and C. As noted above, DU is Class A waste. The classification process is described in 10 C.F.R. § 61.55. Depending on the class of waste different requirements of Part 61 apply.

In sum, 10 C.F.R. Part 61 is a comprehensive federal regulation that governs the disposal of LLRW including DU. Utah, as an Agreement State, must adopt requirements that the NRC finds to be adequate for protection of the public health and safety and to be compatible with the

---

[3] R313-25-19, Protection of the General Population from Releases of Radioactivity; R313-25-20, Protection of Individuals from Inadvertent Intrusion; R313-25-21, Protection of Individuals During Operations; and R313-25-22, Stability of the Disposal Site After Closure.

[4] *In the Matter of Louisiana Energy Services* (National Enrichment Services) CLI-05-05, slip opinion at 11, January 18, 2005.

[5] R 313-25-8 (2)(a), Notice of Proposed Rules, DAR Files No. 33267, January 1, 2010.

NRC requirements as provided for under section 274 (d) and (j) of the Atomic Energy Act of 1974 (42 U.S.C. § 2021), which Utah has done by its establishment of Utah Administrative Code at R313-25. While performance assessments, which are the subject of the Proposed Rule, are important tools to predict sufficient protection of public health and the environment, the governing regulations including implementation of the performance objectives and specific technical requirements together impose rigorous controls, giving the Board, workers, and public stakeholders confidence that Clive's operations remain safe.

II. PURPOSE AND SCOPE OF NRC RULEMAKING

Clarification of Part 61 Implementation. Part 61 does not use the term "performance assessment." Rather it requires "technical analyses," which include analyses other than performance assessments. Existing NRC guidance in NUREG-1573 provides that performance assessments are needed to demonstrate that the public is protected from radioactive releases post closure to meet the standards of the performance objective in 10 C.F.R. § 61.41. As noted above, Part 61 requires in sections 61.12 and 61.13 that technical analyses demonstrate that these objectives be met. As a result, to ensure that the technical analyses contain performance assessments, the NRC intends to codify a requirement for conducting a site specific performance assessment. It is doing this by embarking on a limited rulemaking effort to clarify Part 61 implementation for DU. While providing specifically for performance assessments will clarify the need for a site-specific analysis, it does not indicate that the existing system is flawed. 10 C.F.R. § 61.12 and 13 already require the demonstration that the site and design meet the performance objectives and, therefore, are protective of the public health and safety.

In fact, the NRC recently informed Utah that NRC does not consider its regulations to be flawed. As to Utah characterization of the adequacy of the NRC regulations in Part 61 in Utah's *Statement of Basis for Administrative Rulemaking*, dated December 1, 2009, NRC said:

> *Your characterization of NRC's regulations and conclusions regarding their adequacy is in error.* Although the current regulations did not consider the disposal of significant quantities of depleted uranium, they are adequate to ensure the protection of the public health and safety. The requirements in 10 CFR Part 61 Subpart C provide the performance objectives that all disposal facility licensees must comply with before disposing of any low-level radioactive waste. The NRC's recommendation to update a site's performance assessment prior to disposal of significant quantities of depleted uranium would ensure that the licensee continues to comply with these requirements; a recommendation to ensure compliance with the existing regulations does not indicate that the regulations are inadequate. The NRC's rulemaking effort will clarify these requirements and provide additional guidance to licensees and the Agreement States that are dealing with the disposal of unique waste streams, but *engaging in a rulemaking to*

update the NRC's regulations does not mean that the current regulations are inadequate to protect the public health and safety while rulemaking is pursued to improve the regulations.

(Emphasis added).[6] Thus, it is clear that the State cannot rely on the actions of the NRC to base its conclusions that the NRC rule is inadequate. NRC has made it clear that the fact that it is clarifying its rule does not mean the existing rule is inadequate to protect the public health and safety.

NRC Did Not Choose to Impose a DU Disposal Moratorium. The fact that the NRC chose to clarify Part 61 implementation does not in any way suggest that the NRC has concluded that there is an immediate health and safety issue regarding the disposal of depleted uranium. As evidenced by NRC's comments on the Proposed Rules noted above at footnote 6, there is not a current safety issue with the NRC requirements. Nowhere has NRC said that Part 61 is inadequate to protect the public health and safety. If that were the case, NRC would have taken immediate action to prevent the disposal of DU until the rulemaking was completed. Such action could have included issuing immediately effective orders under 10 C.F.R. § 2.202 to NRC licensees prohibiting disposal of DU until the rulemaking was completed. The NRC could also have issued orders to Energy*Solutions* and other disposal site licensees in Agreement States to prohibit disposal of DU pursuant to the provisions of 10 CFR 150.15 (a)(5) and (b). This would be consistent with section 274 (c)(4) of the Atomic Energy Act of 1974 (42 U.S.C. § 2021), and with Article II, paragraphs C of the Agreement between NRC and Utah that provides that the NRC authority in Utah continues as to the disposal of:

> . . . byproduct, source, or special nuclear material as the Commission from time to time determines by regulation or order should, because of the hazards or potential hazards thereof, not be so disposed of without a license from the Commission.

Quite to the contrary, the NRC has taken no formal or informal action suggesting an immediate health and safety concern.

Moreover, NRC has not used its informal actions such as Information Notices, Bulletins, or Regulatory Issuance Summaries to provide regulatory directives to discourage DU disposal pending the NRC rulemaking. Rather, it has made clear that no immediate action is necessary. In public meetings in Salt Lake City, Utah, Staff specifically addressed this point by noting that

---

[6] Letter from Terence Reis, Deputy Director, Division of Materials Safety and State Agreements, Office of Federal and State Materials and Environmental Management Programs, NRC, to Dane L. Finerfrock, Utah DRC, dated January 21, 2010.

they considered and rejected the need to take some near-term action specifically because there is no near-term threat to health and safety.[7]

Prudential Site-Specific Evaluation. Rather than prohibit disposal of DU until the rulemaking is completed or direct that performance assessments be re-reviewed, NRC stated in a "communication document," which is not a regulatory document (either formal or informal), that it would be "prudent" for the site operator and state regulator to review the existing site-specific performance assessment documentation and existing control measures.[8] Utah DRC and Engergy*Solutions* have agreed to amend the license resulting in the implementation of revised License Condition 35. This condition includes burial of DU with a minimum of 10 feet below the top of the cover. It also requires submittal of a performance assessment, in general conformance with the approach used by the NRC in SECY-08-0147 be submitted for review and approval no later than December 31, 2010.

Suggesting that it would be prudent to review existing performance assessments is well within the purview of the regulator under the existing Part 61. NRC further stated that the performance assessment should minimally be reviewed against the initial parameters staff identified in SECY-08-0147. In that regard, it is noted that in SECY-08-0147 the NRC staff concluded after performing a generic performance assessment that for arid sites disposal of large quantities of DU may be appropriate. It recommended burial depths at a minimum of 3 meters which is consistent with the current license conditions for the Clive site, an arid site. As noted above, License Condition 35 already satisfies this requirement. However, as also noted above, nowhere, including in their memorandum to the Commission, has Staff suggested that Part 61 in its current form, is not adequate to protect health and safety.

Congress Has Recognized the Protective Value of Part 61. Congress also has recognized the protective value of the Part 61 performance objectives. Recently, Congress enacted legislation that adopted the Part 61 strategy of demonstrating that radioactive waste meets the performance objectives of Part 61. Specifically in section 3116 of the National Defense Authorization Act of 2005 (50 U.S.C. § 2601), Congress required the U.S. Department of Energy (DOE) in consultation with the NRC to comply with the existing Part 61 performance objectives for disposing waste incidental to reprocessing. In addition, DOE has adopted the current Part 61 performance objectives in its waste management Order 435.1 to implement its health and safety responsibilities under the Atomic Energy Act.

In sum, the performance objectives of Part 61 which underlie the Part 61 disposal requirements are the accepted standard in the United States for the protection of the public health and safety in disposing of LLRW. This same regulatory framework has been adopted by all states with operating or planned LLRW disposal sites and the DOE, which operates LLRW

---

[7] David Esh stated at the September 22, 2009 meeting of the Utah Radiation Control Board that "there isn't an immediate public health and safety concern surrounding this material."

[8] http://www.nrc.gov/about-nrc/regulatory/rulemaking/potential-rulemaking/uw-streams/key-messages.html.

disposal facilities at 10 sites. They are adequate to protect the public. There exists no evidence to the contrary and no basis to conclude otherwise.

III. THE PROPOSED ACTION CONTRAVENES NRC PUBLIC POLICY

The NRC has found that the existing disposal regulations in Utah Administrative Code at R13-25 are compatible with the NRC regulations and are adequate to protect the public health and safety. These regulations are consistent with Part 61 and allow for the disposal of LLRW, which would include DU and other Class A waste, if the performance objectives and other applicable requirements are met. The proposed regulation, if enacted, will deny the disposal of LLRW and create a *de facto* moratorium for the disposal of DU which is inconsistent with federal regulations. This is because the proposed regulation singles out DU from other Class A waste and requires a performance assessment to be submitted and approved before significant quantities of DU are disposed of.[9] The period of time necessary to gain approval of the performance assessment is unknown, which means in effect that the Radiation Control Board is proposing by rule to ban the disposal of DU for an indeterminate period of time. Consequently, the rule will result in a moratorium lasting at least two years in light of the time it will take to develop a robust performance assessment and the time it will take the State to review it.

As explained above, there is no basis for concluding that there is a current or immediate health and safety issue if additional DU is added to the site and that there is clearly sufficient time to take action should later reviews determine such actions are warranted. Furthermore, the NRC has reached the same conclusion regarding the absence of a near-term threat.

[9] The Proposed Rule provides that the performance assessment must be updated to reflect NRC guidance once such guidance is prepared and any requirements that results from NRC rulemakings. It is unclear from the proposed rule language whether the revised performance assessment must be resubmitted if a performance assessment has already been approved and if so, whether additional DU maybe disposed of pending the review of the revised performance assessment.

NEPTUNE AND COMPANY, INC.
8550 West 14th Ave, Suite 100
Lakewood CO 80215
Phone: (720) 746-1803
Fax: (720) 746-1605

NEPTUNE'S TECHNICAL REVIEW AND COMMENTS ON THE RADIATION CONTROL BOARD OF UTAH'S PROPOSED RULE GOVERNING THE DISPOSAL OF DEPLETED URANIUM

QUALIFICATIONS

Neptune and Company, Inc. ("Neptune") is currently in the process of preparing a performance assessment ("PA") for proposed disposal of depleted uranium ("DU") at Energy*Solutions*' low-level radioactive waste facility at Clive, Utah (the "Clive Facility"). This PA will analyze the performance of the site based on the natural and engineered features of the site, the inventory of DU planned for disposal at the site. Energy*Solutions* also has engaged Neptune to review the Proposed Rulemaking Regarding the Disposal of Depleted Uranium issued by the Utah Radiation Control Board (the "Proposed Rule") and to prepare this technical review. Qualifications of Neptune and two of its key personnel for PA work are provided below. Dr. Black and Dr. Tauxe have been involved in PAs for about 15 years. Both of them serve on the Department of Energy ("DOE") Low-level Radioactive Waste ("LLRW") Federal Review Group ("LFRG"), providing technical expertise and technical review of PAs performed for DOE radioactive waste disposal facilities.

Neptune and Company, Inc.

Neptune is an environmental consulting firm formed in 1992 and headquartered in Los Alamos, New Mexico, specializing in the planning, design, and analysis of environmental data in support of decision making using a wide range of data analysis support, environmental risk assessment, quality assurance planning and risk communication. Neptune employs a multi-disciplinary team with expertise in statistics, decision analysis, environmental risk assessment, chemistry, ecology, biology, hydrogeology, and environmental engineering to support a variety of government and private clients. Neptune has extensive experience preparing PAs at a variety of facilities that manage and dispose of radioactive waste, including the Nevada Test Site ("NTS"), Los Alamos National Laboratory ("LANL"), and Savannah River Site ("SRS"). Attached as Exhibits 1-3 is a statement of Neptune's Corporate Qualifications and résumés of the Neptune personnel who prepared this technical review.

Dr. Black and Dr. Tauxe lead Neptune's PA efforts. They have both been involved in PA for about 15 years. They have been supported at Neptune over this time by a team of technical experts that are needed to build PA models. PA modeling is complex and requires expertise in scientific disciplines such as earth sciences, hydrology, engineering, geochemistry, ecology, biology, and dose assessment, and in supporting disciplines such as programming, statistics and probability, regulatory analysis, and quality assurance. The team that Neptune has assembled to conduct PA work has moved the PA process into new areas of fully coupled probabilistic modeling and decision analysis based on the concepts of keeping exposures to the public "as low as reasonably achievable" ("ALARA"). Dr. Black has prepared guidance for DOE on probabilistic PA modeling [1], Dr. Tauxe has contributed to the development of methodologies for the NRC, and both have given technical presentations at several DOE and NRC workshops [2]. The qualifications of Dr. Black and Dr. Tauxe are briefly summarized below.

Dr. Paul Black, PhD

Dr. Black earned a B.S. in statistics from the University of Lancaster (U.K.) in 1981, and an M.S. and Ph.D. in statistics from Carnegie Mellon University (1986 and 1996). The statistics program at Carnegie Mellon emphasized Bayesian statistical decision theoretic approaches to problem solving, an approach that Dr. Black is successfully promoting for DOE's performance assessment and other environmental programs. His direct PA modeling experience includes work at NTS, LANL, and SRS for LLW and transuranic wastes (TRU), where he offers technical expertise and support to the DOE LFRG in their review of various PAs, and development of technical guidance. His efforts have included development of PAs regulated by the U.S. Environmental Protection Agency (EPA), DOE, and NRC..

Dr. Black has managed PA projects at Neptune since 1995. His first foray into the field of PA involved an innovative effort to assess the probability of inadvertent human intrusion into buried LLW at the NTS. This work has led to acceptance of using site-specific knowledge to support such assessments, and to support PA modeling in general. Since that beginning, Dr. Black has gone on to pioneer the use of probabilistic and decision analysis methods, including development of a DOE white paper on the benefits of probabilistic PA modeling, and invited presentations at various DOE workshops covering subjects such as specification of input distributions, elicitation methods, spatio-temporal scaling, correlation effects, and decision analysis in the context of ALARA.

Dr. Black's direct PA work started with the large-scale elicitation study to assess the probability of inadvertent human intrusion into buried radioactive waste at the NTS. This project involved assessment of drilling and subsurface utility scenarios, and included an assessment of institutional controls that might be considered for long-term management of radioactive disposal facilities. The work was published, presented, and received an award, at the DOE Waste Management conference [3]. This led to further involvement in PAs at the NTS, starting with review and ultimate GoldSim modeling of the TRU disposed in the Greater Confinement Disposal (GCD) Boreholes, which had been initiated using different software tools by Sandia National Laboratories ("SNL"), and continuing with development of PAs for the NTS LLW management facilities. In 1999 Dr. Black managed Neptune's efforts to develop a PA for Material Disposal Area G ("MDA G") at LANL. Recently, Dr. Black has analyzed site characterization data that support LANL's MDA G PA. The model was developed in GoldSim and served as the precursor to the current LANL PA model. Dr. Black is also currently supporting Dr. Tauxe in PA development for various waste disposal sites at SRS. Dr. Black has also reviewed PAs for the DOE LFRG, and has been involved in the probability of volcanic hazard assessment for the Yucca Mountain Project, for which he led a small team that performed an elicitation to review and validate the work that DOE had previously performed. His technical expertise, experience and knowledge of the PA process has proven critical in support of decision making for disposal of radioactive waste.

Dr. John Tauxe, PhD, PE

Dr. Tauxe has been working in the earth and environmental sciences and engineering since 1981, and has developed expertise in probabilistic PA, quantitative hydrology and hydrogeology, and in computer programming, concentrating in the modeling of radioactive waste disposal and contaminant fate and transport in the environment.

Dr. Tauxe earned a B.A. in Earth Science from Wesleyan University (1984), and an M.S. and Ph.D. in Civil Engineering from the University of Texas at Austin (1990 and 1994). He is a Registered Professional Engineer in the State of New Mexico. John worked actively in radiological PA for four years at Oak Ridge National Laboratory ("ORNL"), and for over eleven years at Neptune and Company in Los Alamos, New Mexico. He has developed modeling for radioactive waste disposal activities regulated by the EPA, DOE, NRC, and international authorities. Dr. Tauxe has been a critical reviewer of PA activities for the Waste Isolation Pilot Plant, for MDA G at LANL, and for the Mixed Waste Landfill at SNL, and for the GCD Boreholes at NTS. Direct PA modeling experience includes work at ORNL, LANL, NTS, and the SRS, for low-level, high-level, and transuranic radioactive wastes.

Dr. Tauxe serves as PA lead at Neptune, and is a recognized expert in the use of the GoldSim modeling software for developing PA models. He has developed modeling-related guidance for the NRC, and with colleagues at Neptune has developed cutting edge PA modeling methodologies. Neptune's transformative modeling approaches are being adopted at sites across the DOE complex and within the NRC, supporting decision making in the face of uncertainties in waste inventories, engineered barriers, natural contaminant transport processes (waterborne, airborne, and biotically-induced transport, and radioactive phenomena), and in exposures to human receptors.

TECHNICAL REVIEW

I. SUITABILITY OF THE CLIVE FACILITY FOR DISPOSAL OF DU

In October 2008, the Nuclear Regulatory Commission ("NRC") prepared "Analysis of Depleted Uranium Disposal" as Enclosure 1 to the SECY-08-0147 [4], which concluded that near surface disposal of large quantities of depleted uranium (DU) may be appropriate at disposal depths of at least three meters. Although the NRC has acknowledged that this generic radiological performance assessment (PA) should not be relied upon as the sole basis for making site-specific licensing decisions, it does provide useful context for assessing site-suitability. In fact, the NRC relied on just such an approach for development of the classification tables in 10 CFR 61.55, which are based on a generic analysis of potential impacts at a reference site. Based on the 2008 NRC analysis, Neptune's preparation of PAs at other sites, and Neptune's knowledge of site conditions and disposal configurations at the Clive Facility, Neptune's collective professional judgment is that a fully quantitative PA can be developed that will demonstrate compliance with applicable standards within a 10,000-year time period for disposal of some quantity of DU. Consistent with NRC guidance, such a PA would project current conditions and current knowledge about society for the next 10,000 years. The remoteness of the Clive Facility and hostile environment for both humans, for whom there is little evidence of habitation of the area, and ecological receptors, tend to make it well suited for disposal of DU.

To evaluate the performance of the Clive Facility with respect to DU disposal, Neptune has been engaged by Energy*Solutions* to prepare a model using the latest analytical tools (GoldSim [5]) and PA methodologies (probabilistic systems-level modeling). GoldSim was first used to support performance assessment at Yucca Mountain in the 1990s, and GoldSim modeling has continued at Yucca Mountain through this decade. Indeed, GoldSim was initially developed specifically for the Yucca Mountain Project. Neptune started using GoldSim to model the Los Alamos National Laboratory ("LANL") low-level radioactive waste ("LLRW") disposal facility in 1999. This was followed by Neptune's implementation of GoldSim models in support of PAs for DOE's LLW disposal facilities at the Nevada Test Site ("NTS") and the Savannah River Site (SRS).

GoldSim is well-suited for dynamic system-level models that fully couple transport processes, and manage uncertainty through probabilistic specification of models, and subsequent Monte Carlo simulation. Neptune has also developed a generic PA model in GoldSim that is available for public use, which has been downloaded by NRC and other organizations. Neptune will develop a quantitative PA for the Clive Facility using GoldSim, modeling source term, source release, engineered barriers, transport through environmental media, and dose to potential human receptors. The model approach will be based on regulatory guidance (including a DOE white paper on probabilistic modeling), and on standard practices for performing risk/dose assessments. A fully quantitative model will be prepared to model the next 10,000 years.

There are some notable similarities between the Clive Facility and the NTS facilities, one of the sites analyzed by Neptune using GoldSim. The PA models that Neptune has developed for the NTS modeled a hostile desert environment. For example, both areas are hostile environments for humans and ecological receptors, groundwater is unlikely to serve as a drinking water source (for different reasons), and transport of radionuclides is affected by the low rates of precipitation, the high evaporation potential, and the presence of arid lands biota. The NTS PAs developed by Neptune demonstrated compliance for disposal of large quantities of low-level radioactive waste in shallow land burial, some of which produced large amounts of radon. Consequently, it seems reasonable that a quantitative PA for the Clive Facility might demonstrate compliance with performance objectives for disposal of DU.

Because peak radon activity will occur following about 1,000,000 years into the future, a more qualitative model will also be developed to evaluate ultra-long term performance. This is in keeping both with NRC guidance and our experience at other LLW sites. This approach will be used rather than relying on quantitative dose projections because of the uncertainty associated with evaluating human receptor scenarios that far into the future. This uncertainty is associated both with projecting human behavior and environmental conditions. For example, several ice ages might occur, and recurrences of Lake Bonneville can be expected.

The status of human civilization that far into the future, particularly after geologic events, also is uncertain. For example, modern man has not been in the position of surviving a glacial epoch. Nonetheless, it is possible to assess concentrations or activity of radon, uranium and other radionuclides in various media for different possible futures of ice age and Lake Bonneville recurrences, to which any human receptors at that time could be exposed.

Although conditions far into the future are uncertain, it is no more reasonable to assume only negative outcomes than it is to assume positive outcomes. One could imagine scenarios under which ice age and Lake Bonneville effects might be beneficial for the disposal facility (*e.g.*, sediment deposition), as well as scenarios under which the performance of the Clive Facility is adversely affected (*e.g.*, wave action). This will be explored further in the ongoing PA effort based on data and information from available geology, climatic, and hydrology studies of the local Basin and Range province and Lake Bonneville in particular.

An important aspect of this ultra-long term analysis will be to identify and model a set of scenarios that are representative of potential future conditions. This is done by conducting a thorough examination of features, events and processes that are relevant to site performance. For this analysis for the Clive Facility, this might include isostatic rebound effects when a future Lake Bonneville recedes, and different ecological biomes that might occur as conditions change.

II. POTENTIAL MITIGATIVE STRATEGIES

One erroneous assumption implicit in the Proposed Rule is that a moratorium is needed because once DU is disposed of at the Clive Facility, no mitigation will be possible in the event that a future PA fails to demonstrate compliance. This assumption is incorrect because performance might be enhanced by various forms of mitigation. For example, the ongoing PA effort will include a model of the planned engineered cap. However, if the PA for these cap conditions does not demonstrate compliance, mitigation measures can be identified that would show how compliance might be achieved. These could involve using a thicker native clay soil layer to reduce radon emissions, or could involve a thicker layer of riprap to reduce the effects of wave action if the lake rises.

Once the PA model for current conditions is completed and transport and exposure pathways have been identified, the results can be used to inform which additional mitigating measures would be most effective. For example, the PA model could be used to optimize the thickness of various engineered cap layers to mitigate release of radon from the disposal system, or the thickness of the riprap layer to sufficiently reduce the effect of wave action on the Clive Facility. Other possibilities are to increase the depth at which the DU is disposed or reduce the overall amount of DU disposed. Site-specific analyses are very useful not only for understanding site performance, but enhancing site performance.

REFERENCES

1. Crowe, B., Black P.K., and Lee, D.W. *Probabilistic Modeling: Applications to Performance Assessment Maintenance Plan Studies for Low-Level Waste Disposal Facilities*, Paper written for the DOE Low-Level Radioactive Waste Federal Review Group, 2002.

2. NRC, *Integrated Ground-Water Monitoring Strategy for NRC-Licensed Facilities and Sites*, NUREG/CR-6948, 2007.

3. Black, P.K., Moore, B., Crowe, B., Black, K.J., Hooten, M.M., Barker, L.E., and Rawlinson, S.E., *A Common Sense Approach to Assessing the Probability of Inadvertent Human Intrusion at Nevada Test Site Radioactive Waste Management Sites*, Proceedings of the Waste Management Conference, Tucson, AZ, (Best Paper Award), March 1997.

4. U.S. Nuclear Regulatory Commission, *Response to Commission Order CLI-05-20 Regarding Depleted Uranium*, Staff Requirements – Secy-08-0147 – March 18, 2009.

5. GoldSim Technology Group, *GoldSim software: Monte Carlo Simulation Software for Decision and Risk Analysis*, www.goldsim.com

NEPTUNE AND COMPANY, INC.

Improving the Quality of Environmental Decision Making

CORPORATE QUALIFICATIONS

Main Office:
1505 15th St., Suite B, Los Alamos, NM 87544.3063
Tel. 505.662.2121 Fax 505.662.0500

Colorado Office:
8550 West 14th Avenue, Lakewood, CO 80215
Tel. 720.746.1803 or 720.746.1804 Fax 720.746.1605

CORPORATE QUALIFICATIONS SUMMARY

NEPTUNE AND COMPANY is a small business (less than $7 million) that specializes in *planning, designing, and evaluating* environmental activities for a wide variety of environmental problems. Our staff provides hands-on consulting services for environmental management problems in the following areas:

ENVIRONMENTAL STATISTICS

- Facilitate systematic planning for environmental problem solving using EPA's DQO process.
- Develop experimental and sampling designs based on Data Quality Objectives (DQOs).
- Specify Measurement Quality Objectives linked to controlling total study error.
- Conduct statistical data analysis, including geostatistics for spatial data.
- Perform uncertainty analysis.
- Develop proprietary web-based interactive statistical and decision support tool (Guided Interactive Statistical Decision Tools (GiSdT©)) based on open source software.

ENVIRONMENTAL MODELING

- Develop conceptual site models.
- Develop mathematical and probabilistic models of contaminant transport employing a variety of environmental mechanisms and pathways.
- Perform sensitivity analyses to understand data needs and to reduce uncertainty in model predictions.
- Interpret results of environmental modeling to aid in appropriate data collection and decision making.
- Conduct performance assessments for DOE waste sites utilizing probabilistic modeling.

TRAINING AND COMMUNICATION

- Develop and conduct technical training for multi-disciplinary teams related to our niche-expertise.
- Plan and implement Stakeholder involvement meetings.
- Provide support to public outreach.
- Facilitate project meetings to integrate stakeholder input into all phases of the decision making process.

RISK ASSESSMENT

- Develop risk assessment methodologies.
- Perform human health and ecological risk assessments with project-specific sophistication varying from screening-level analyses to probabilistic assessments.
- Perform contaminant fate, transport, and food chain modeling in support of environmental assessments.
- Determine the most appropriate and informative set of measurement endpoints to assess risk to all important trophic levels.
- Provide integration of assessment tools with statistical decision analysis to support risk management.

QUALITY ASSURANCE AND CHEMISTRY

- Provide expertise in the development of facility Quality Assurance (QA), Quality Control (QC), and Environmental Management programs.
- Develop scientifically defensible work plans, sample and analysis plans, QA project plans, and other documentation to integrate QA/QC activities with project/facility objectives. Extensive experience linking DQOs with measurement requirements.
- Analytical program development and assessment. Audit analytical laboratories for routine and specialized projects.
- Environmental technology assessment against quality specifications and efficacy.
- Provide data usability assessments and focused data validation.

ENVIRONMENTAL DECISION ANALYSIS

- Conduct expert elicitation to support decision analytic based problem solving.
- Perform cost/benefit analyses.
- Program and perform probabilistic assessments using Analytica and other software.
- Develop decision support systems.

STATISTICAL CAPABILITIES

PROJECT PLANNING

❖ We provide hands-on assistance to multi-disciplinary teams tasked with planning data collection efforts in support of environmental decision making through:

- Applying the data quality objectives (DQO) process.
- Developing decision rules and decision error tolerances needed for statistical designs.
- Developing decision logic diagrams

STATISTICAL SURVEY DESIGN

❖ We utilize a number of statistical survey design tools and standard statistical software packages to develop sampling and analysis plans designed to provide data of the right type and quality to support decision making, including:

- Probabilistic survey designs *utilizing random, systematic, stratified and composite sampling approaches* to achieve project objectives at the lowest cost.
- *Design and statistical evaluation* of preliminary information to generate more efficient sampling plans.
- *Quality control/quality assessment sampling plans* linked to decision-specific requirements.

IMPLEMENTATION OF SAMPLING AND ANALYSIS PLANS

❖ We work with field teams during sampling campaigns to assist with implementation of phased, iterative and sequential sampling approaches such as used in EPA's Triad Approach.

WEB-BASED STATISTICAL TOOLS

❖ We developed our own proprietary web-based interactive statistical and decision support tool (GiSdT©) based on open source software tools.

STATISTICAL TRAINING

❖ We provide on-site or Live Web statistical training. Past classes include:

- Introductory: Introduction to Applied Statistics, Exploratory and Confirmatory Data Analysis, Hypothesis Testing and Confidence Intervals;
- Design: Experimental Design - One Size of Experimental Unit, Experimental Design – More than One size of Experimental Unit, Sampling Design, and Spatial Sampling Design;
- Model building: Regression and Lack-of-Fit Analyses, Multiple Regression and Model Selection, Nonlinear Models, and Analysis of Covariance and Model Comparison Techniques;
- Spatial: Exploratory, Descriptive and Kriging.

DECISION MAKING

❖ We relate results to specific decision outcomes through:

- Development and application of decision analysis models.
- Communication of statistical results in non-technical language.

STATISTICAL DATA ANALYSIS

❖ We routinely analyze complex environmental data sets through:

- Data preparation, exploratory data analysis, and graphical data presentation.
- Application of classical hypothesis tests and associated power analysis.
- Monte Carlo simulations and geostatistical analyses.
- Data quality assessment including evaluation of statistical assumptions.

ENVIRONMENTAL MODELING CAPABILITIES

ENVIRONMENTAL ASSESSMENT

- ❖ Neptune and Company staff have developed models in support of NEPA environmental assessments for:
  - Release of lands from government and industrial uses to the public.
  - Relicensing of hydropower dams.
  - Siting of waste disposal and wastewater treatment facilities.
  - Forest and watershed management.

ENVIRONMENTAL AND WATER RESOURCES ENGINEERING

- ❖ We have experience in water resources assessment and environmental engineering, including:
  - Assessing the viability of groundwater and surface water resources.
  - Modeling in support of RCRA Feasibility Investigations and CERCLA Feasibility Studies.
  - Surface water modeling in support of
    - NPDES permit limits.
    - Non-point source management decisions.
  - Watershed modeling in support of
    - Watershed restoration and conservation funding prioritization.
    - Forest management and reservoir release optimization.

COMPUTER PROGRAMMING

- ❖ In addition to using off-the-shelf modeling software, customized software is often developed by Neptune to suit any particular need. Software development can be done in a variety of languages and environments, including Java, C, the Microsoft Windows API, FORTRAN, R, S-Plus, Tcl/TK, or BASIC.

RADIOLOGICAL PERFORMANCE ASSESSMENT (PA)

- ❖ We have supported the development of PAs under DOE Orders 5820.2A and 435.1, and under 40 CFR 191 for the disposal of radioactive wastes using the GoldSim modeling platform
- ❖ We have developed innovative methods for probabilistic PA modeling that are regarded as the standard by which other PAs are being measured. We developed Generation 2 of PA models, surpassing the original deterministic modeling, and are currently working on Generation 3, which will take PA modeling to the next level in terms of optimization of disposal, closure and management of PA facilities.

ENVIRONMENTAL MODELING IN GEOGRAPHIC INFORMATION SYSTEMS

- ❖ Our staff have experience in:
  - Environmental data assessment and modeling using the GIS platforms MapInfo, ArcInfo, ArcView and supporting modules.
  - Watershed delineation and classification.
  - Groundwater advection-dispersion modeling of contaminant transport.
  - Watershed restoration and conservation prioritization.

CONCEPTUAL MODELS

- ❖ We use conceptual models as a way of communicating and describing complex fate, transport, and exposure processes with stakeholders.

MODELING TOOLBOX

- ❖ Our toolbox of standard modeling software includes Multimed, MEPAS, HELP, RESRAD, WASP, QUAL2e, HSPF, Surfer, S-Plus, SAS, PRSYM, RiverWare, ArcInfo GRID, the HEC models, GoldSim, GeoEAS, MODFLOW, GWSIM, ShowFlow, HSSM, MOC, TWOLAY, and FTWORK.

QUALITY ASSURANCE AND CHEMISTRY CAPABILITIES

DEVELOPING STATE-OF-THE-SCIENCE QA PROGRAMS

❖ We have extensive experience developing mission-related, comprehensive, and integrated QA programs to meet the needs of organizations involved in the generation of environmental data including:

- Development of Quality Systems for a range of Federal programs
- Documentation and review of Quality Management Plans and supporting documents
- Elicitation of customer needs and development of specifications to include efficient and effective planning for data collection efforts
- Development and application of QA guidance, based on regulatory requirements.
- Training and facilitation in the use of QA planning and assessment tools.
- Development and review of site-specific sampling and analysis plans.
- Development of field quality assessment sampling and analysis specifications.
- Development of quality performance metrics.

AUDITS AND REVIEWS

❖ We plan and conduct on-site process and technical audits
- Audits of analytical laboratories and field operations.
- Comprehensive reviews of existing QA programs to support corrective actions, revisions to QA Program Plans, and major overhauls of out-dated approaches to QA.

ANALYTICAL METHOD DEVELOPMENT

❖ We provide technical support to projects involved in the development and evaluation of new analytical methods and instruments.

SELECTION OF ANALYTICAL METHODS

❖ We provide assistance to environmental data collection design teams in order to ensure that appropriate and cost-effective analytical methods are selected by:

- Helping clients select appropriate analytical methods for specific applications.
- Recommending new and innovative methods available, or methods routinely used for environmental analysis and associated sample preparation procedures.

ANALYTICAL METHOD PERFORMANCE EVALUATIONS

❖ We provide support in the design, application and analysis of performance evaluation studies by:

- Determining the precision, bias and limits of detection for new and existing methods under laboratory and field conditions for matrices of interest.
- Establishing method equivalency/sufficiency to gain regulator acceptance of cost-saving innovative analytical methods for environmental applications.
- Evaluating quality assessment data to determine the contributions of error sources.

SAMPLE AND DATA MANAGEMENT

❖ We evaluate operating procedures in use at different facilities for sample handling, shipping, and chain of custody, as well as electronic reporting and data management in order to identify areas of potential inefficiency or vulnerability, and to provide recommendations for improvements.

RISK ASSESSMENT CAPABILITIES

HUMAN HEALTH RISK ASSESSMENT

- We apply appropriate risk assessment tools to support all phases of environmental decision making including:
  - Calculation of site-specific risk-based screening values.
  - Performance of human health risk assessments that are consistent with applicable regulatory guidance.
  - Use of probabilistic risk calculations to support risk management decisions and cost-benefit analyses.
  - Comparative analysis of the relative risk associated with remedial decision alternatives.
  - Application of a standard toolbox of contaminant transport models (e.g., Multimed, MEPAS, RESRAD, ArcInfo GRID, HSSM, and USGS MOC) that are used to support the analysis of future risk scenarios.
  - Development of project-specific contaminant transport and risk models to support risk management decisions at complex sites.

INTEGRATION WITH STATISTICAL DECISION ANALYSIS

- Our risk assessors work as an integral part of planning teams that help clients produce defensible characterization and remediation plans through our:
  - Extensive experience and success in application of EPA's Data Quality Objectives (DQO) process.
  - Application of DOE Streamlined Approach for Environmental Restoration (SAFER).

ECOLOGICAL RISK ASSESSMENT

- We have a team of ecologists, ecological modelers, and ecotoxicologists that support ecological risk assessment with:
  - Calculation of media-specific risk-based values to support site screening.
  - A coordinated approach to developing general, site-specific, and measurement assessment endpoints that includes the current state of ecological knowledge as well as public and stakeholder involvement to ensure that the results of the ecological risk assessment support decision making.
  - Ecological risk assessments for aquatic and terrestrial ecosystems based on the appropriate regulatory drivers and stakeholder input.
  - Evaluation of ecological inventory, including microbiotic and macrobiotic assessments.
  - Experience in application of EPA's ecological risk assessment guidance.
  - Development and application of specialized tools for arid ecosystems risk assessments.

NATURAL RESOURCE DAMAGE ASSESSMENT

- We facilitate consideration of potential natural resource damages to assist clients in making risk management decisions by:
  - Using our corporate experience in facilitation and public involvement to assist in coordinating trustee meetings.

EXPERT WITNESS CAPABILITIES

TESTIMONIAL SERVICES

- We apply our respective areas of expertise to a variety of cases including:
  - Exposure, dose reconstruction, risk assessment, chemistry, vapor intrusion, model development, statistics
- Our experience includes trial appearances, depositions, and hearings:
  - Environmental and occupational toxic tort cases
  - Statistics and expert opinions on methodology

SAMPLE PROJECTS

- Occupational Risk Assessment for three workers exposed in an electronic manufacturing plant in Atlanta, GA to Formaldehyde, Methanol, Trichloroethane, Butylcellosolve and Dimethylamine via inhalation and dermal absorption. Probabilistic methods were used to calculate dose during the period when the workers daughters, who were born with facial and cranial birth defects, were conceived.

- Environmental Human Health Risk Assessment for Trichloroethlyene in Drinking Water for residents in Tucson, AZ. Both deterministic and probabilistic dose models were developed and used to calculate the total absorbed dose for approximately 300 individual plaintiffs, in two different toxic tort cases.

- Occupational Exposure and Risk Assessment for workers exposed to paint solvents during construction of two Nuclear Power Plants in Texas. Developed and constructed probabilistic model for determination of air concentrations of various hydrocarbon solvents used in formulating surface coating system employed during construction. Used results of exposure model to develop and construct probabilistic dose model used to calculate dose for exemplar plaintiffs.

- Environmental Risk Assessment for 10 exemplar plaintiffs who were exposed to Chromium (VI) in their drinking water. Developed and constructed internal dose model incorporating absorption via ingestion, inhalation and dermal routes. Developed and constructed inhalation shower model to evaluate inhalation of Chromium aerosols

- Statistical analysis of polycyclic aromatic hydrocarbons (PAHs) data at a manufactured gas plant (MGP) in Chicago, Illinois. Our role was to review and challenge statistical fingerprinting methods used by the plaintiff to argue that local PAH concentrations were consistent with background concentrations. Our experience writing PAH background guidance for California-EPA and our statistical expertise were critical for pointing out the deficiencies in the plaintiff's approach. The case was ultimately settled out of court.

EXPERT ELICITATION

- For the Montana National Guard, developed a model of risk from unexploded ordnance (UXO) at the North Helena Valley Site. Modeling involved using data, meta-data and elicitation to build a model for spatial distribution of UXO, potential for exposure and for detonation. The Bayesian model also includes a ballistic model for predicting firing patterns. Approximate cost savings to the National Guard have been estimated to be on the order of $10m.

- A site was modeled for volcanic activity and its likelihood of a disruptive volcanic event. Relatively little data was available, requiring the use of Bayesian models to integrate expert assessment with the data to produce a hazard estimate and the uncertainty associated with the estimate. Elicitation covered spatial aspects of the model such as underlying stress fields, surface extension, lithostatic pressure, impact of volcanic dikes on faults, and the location of previous events, and temporal aspects such as the timing or previous events. The goal is to estimate the probability of volcanic hazard to a waste repository.

Dean Neptune, Ph.D.	P-4	43	Chemist, DQO Process facilitator, Decision Support and QA Specialist
Randall Ryti, Ph.D.	P-4	28	Ecologist/Statistician, DQO Process Facilitator, Ecological Risk Assessor
Daniel Michael, M.S.	P-4	31	Environmental Biologist, Decision Support and QA Specialist, DQO Process Facilitator
Paul Black, Ph.D.	P-4	29	Statistician, Decision Analyst, Elicitation Specialist
Kevin Hull, M.A.	P-4	31	QA Specialist, DQO Process Facilitator
Kelly Black, M.S.	P-4	21	Senior Statistician, DQO Process Facilitator
Wendy Swanson, Ph.D.	P-4	33	Senior Statistician, Graphic Specialist, Statistical Programmer
Tom Stockton, Ph.D.	P-4	28	Environmental Statistician, Probabilistic Modeler
John Tauxe, Ph.D., P.E.	P-4	24	Environmental and Water Resources Engineer, Hydrogeologist, Probabilistic GoldSim Modeler
Ralph Perona, M.S.	P-4	21	Human Health Risk Assessor, Modeler, Diplomat for the American Board of Toxicology
Dave Gratson, M.S.	P-4	25	Senior Chemist, QA Specialist
Mark Fitzgerald, Ph.D.	P-4	17	Senior Statistician
David Brenner, Ph.D.	P-4	25	Senior Chemist, Risk Assessor
Paul Duffy, Ph.D.	P-4	14	Environmental Statistician, Modeler

Kristen Lockhart, M.S.	P-3	18	Mathematician, Data Analyst, Modeler, QA Specialist
Jim Markwiese, Ph.D.	P-3	19	Biologist, QA Specialist, Ecological Risk Assessor
Kathryn Catlett, Ph.D.	P-3	16	Soil Chemist/Mathematician, Probabilistic Modeler
Greg McDermott, M.S.	P-3	20	Ecologist, Ecological Risk Assessor
Doug Bronson, Ph.D.	P-3	15	Statistician, Statistical Programmer
Jennifer Linville, M.S.	P-3	11	Environmental Scientist
Patricia Gallegos, M.S.	P-3	15	Toxicologist/Risk Assessor, Diplomat for the American Board of Toxicology
Michael Balshi, PhD	P-3	10	Environmental Modeler, GIS, Data Analyst
Michelle Wolf, M.S.	P-3	12	Statistician, Ecologist, QA Specialist

Kelly Bennett, M.S.	P-2	8	Toxicologist, QA Specialist
Pasha Minallah, B.S.	P-2	7	Software Engineer, System Administrator
Pam Maestas, B.A.	P-2	13	Technical Editor

Resumes available upon request.

PAUL BLACK

Employment History

Neptune and Company, Inc.

1993 to date: Currently CEO – Statistician and Decision Analyst

Decision Science Consortium

1988 to 1992: Statistician and Decision Analyst

Carnegie Mellon University

1984 to 1988: Research Assistant and Teaching Assistant

Rex, Thompson and Partners

1981 to 1984: Systems Analyst and Programmer

Education and Training

Ph. D., Statistics, Carnegie Mellon University, Pittsburgh, PA, May 1996.

M.S., Statistics, Carnegie Mellon University, Pittsburgh, PA, December 1985.

B.Sc. (with honors), Statistics, University of Lancaster, Lancaster, U.K., June 1981.

Experience Highlights

- Project/Program Management
- Statistics Design and Analysis
- Bayesian Statistics/Decision Analysis
- Expert Elicitation
- Sensitivity Analysis
- GoldSim modeling
- Radioactive Waste Performance Assessment
- Brownfields Decision Support Systems
- UXO decision risk analysis
- Bayesian design for closure of CWA storage
- RCRA/CERCLA risk assessment statistics
- Municipal Waste Disposal
- Open source web-based development of statistics and decision support tools
- Presentation of Statistics Workshops and Training Courses
- Applying QA for statistics and probabilistic modeling applications

Professional Experience

Neptune and Company, Inc.

1992 – :Statistician/Decision Analyst, Principal

Principal, co-founder and current CEO of Neptune and Company, Inc. (Neptune), an environmental consulting company that specializes in the technical disciplines of statistics, decision analysis, risk assessment, ecology, environmental modeling, QA and chemistry. Dr. Black has more than 20 years experience applying statistics to a wide range of environmental problems. His academic training at Carnegie Mellon University involved research into foundations of probability theory and competing theories of uncertainty which has resulted in new developments in random set theory that have potentially broad implications for decision theoretic extensions to standard Bayesian analysis. His training at Carnegie Mellon University primarily involved Bayesian methods, which rounded out his statistics education by providing a contrast to his classical statistics training at the University of Lancaster. This background has provided Dr. Black with a complete statistical technical background for his continued work on environmental problems. His first experience of environmental statistics was in his two years with ICF Kaiser, after which Dr. Black became a founding member of Neptune. Dr. Black continues to work on basic research issues in probability theory and decision theory, but with a focus on environmental application. He is the manager of Neptune's Decision Analysis, Modeling and Statistics Group. The main focus of the group is to provide consulting services in environmental decision analysis, covering environmental modeling, cost-benefit (economic) analysis, options analysis, statistics, probability, elicitation, earth sciences, and probabilistic human health and ecological risk assessment. His responsibilities as manager of this group include managing about 12 people who are focused and motivated to efficiently and effectively solve environmental problems, work in a collaborative environment on interesting problems that call for innovative or cutting edge solutions, and managing various projects in which our group is engaged. Responsibilities also include involving our group in professional societies and conferences, Neptune publications and presentations, and proposals, marketing and business development. Active research and development (R&D) efforts include:

- Bayesian statistical decision analysis

  Dr. Black manages Neptune's continuing R&D into Bayesian statistical decision analysis for solving complex environmental problems (e.g., radioactive waste management, remediation options analysis, land use management, aquatic systems management, long term monitoring, closure of chemical warfare agent disposal facilities). The R&D activities involve aspects such as GoldSim modeling, Bayesian statistics applications, decision analysis modeling, probabilistic modeling, elicitation, uncertainty and sensitivity analysis, cost-benefit analysis, and value of information analysis. Recent efforts on sensitivity analysis have resulted in development of innovative methods from the data mining industry for evaluating large simulated data sets, which are typical output of probabilistic environmental modeling; current research into spatio-temporal scaling and associated correlation structures aimed at improving how to build probabilistic models for complex environmental systems; and, development of Bayesian algorithms for sample size calculations that are based on value of information to determine if and how much new data are needed. Dr. Black and his colleagues have also developed innovative methods for performing elicitation of non-linear models in support of probabilistic or Bayesian applications.

- Development of Open Source Web-based software tools:

  Dr. Black manages Neptune's ongoing research and development efforts to create interactive Open Source statistical and decision analysis tools and guidance in a web-based environment. Neptune's architecture is called GiSdT – Guided interactive Statistical decision Tools. GiSdT exists as a public site with statistical tools, and is also used as the basis for many Neptune applications. This development project encompasses decision analysis and statistical guidance, statistical analysis and graphics tools using R, an open source statistical software programming language, web-based tools such as XML/XSL and CSS, GUI development using Java and JavaScript tools, dynamic linking to databases using PostGreSQL, and GIS interfaces using PostGIS and GeoServer. Neptune's Open Source software is available for general use, and is currently used nationally and internationally to support environmental data analysis and decision making. The results of the research described above are usually incorporated into GiSdT or one of the GiSdT applications.

Projects for which Dr. Black has provided statistical support are provided below. Since joining Neptune, Dr. Black has managed many of the projects on which he has worked. In doing so, Dr. Black manages multi-disciplinary teams of statisticians and environmental scientists whose collective aim is to improve the quality of environmental decision-making. The range of statistical analysis methods encompassed by the projects that Dr. Black has performed is very wide-ranging covering both classical and Bayesian statistical approaches to solving environmental problems.

<u>For the NNSA/Nevada Operations Office</u>

- Work covered a 10-year time frame that culminated in production of Bayesian probabilistic models for the low level radioactive waste disposal facilities at the Nevada Test Site (NTS). The probabilistic models that were developed relied on input distributions that were developed using a variety of statistical techniques, including meta-analysis, model abstraction, regression of existing data, and elicitation of single variables and of regression relationships.

- Managed Neptune's efforts to support NNSA/NV facility Performance Assessments (PA) and Composite Analyses (CA) to more realistically model the low-level waste disposal facilities at the NTS. These efforts have included PA/CA modeling efforts for the Area 3 and Area 5 radioactive waste management sites at the Nevada Test Site
- These NNSA/NV models were completed using GoldSim as the platform for the models that were developed, and involved modeling the low-level radioactive waste disposal facilities at the NTS. The work involved building a Bayesian decision framework that includes remediation and management options, inventory characterization, fate and transport, risk assessment, model abstraction from codes such as LANL's FEHM, statistical analysis and elicitation to develop realistic input probability distributions, uncertainty and sensitivity analysis, economic analysis and decision analysis. Statistical methods address upscaling, correlation structures, use of secondary data, meta-analysis, and developing innovative elicitation methods where necessary. The intent of this work was to build a model of the entire environmental system so that it could be applied consistently across the different disposal systems, and then to evaluate the management options for closure design, future disposal and institutional control, using the decision analysis principles of ALARA (as low as reasonably achievable – a DOE construct).
- Managed a project to assess the probability of inadvertent human intrusion (IHI) into buried low-level radioactive waste. Steps included problem structuring, and influence diagram development that depict mechanisms by which inadvertent human intrusion might occur, subject matter elicitation both to finalize structuring of the model and also to formally obtain quantitative subjective matter expert input to fulfill the specifications of the models developed. Project involved probabilistic elicitation, influence diagrams, simulation and propagation of distributions, and uncertainty and sensitivity analysis. Monte Carlo simulations were used to propagate the input distributions through the model to arrive at an output distribution of the probability of IHI.
- Developed probability and elicitation training classes, and trained the subject matter experts in the probability and elicitation techniques to be used during the project to elicit the required knowledge from the experts.
- Developed and participated in stakeholder and public involvement programs, which involved public meetings that were used to help guide the project to ensure stakeholder participation and ultimate agreement on the project outcome.
- Applied the assessment of the probability of inadvertent human intrusion to the low-level waste performance assessment efforts for the Area 5 and Area 3 radioactive disposal facilities at the NTS.

<u>For DOE Headquarters</u>

- Co-authored a position paper for the DOE Federal Low-Level Radioactive Waste Review Group (LFRG) on Bayesian probabilistic modeling. Previous performance assessments performed for DOE have been largely deterministic with the purpose of demonstrating compliance. Now that compliance has been demonstrated at mist DOE sites, a transition is needed to support better decision-making in terms of closure, site management and long term monitoring. This position paper lays out the rationale and processes for moving towards a Bayesian probabilistic modeling paradigm so that resources can be managed more effectively as long term monitoring, site management and closure decisions become the priority.
- Participated in the DOE low-level radioactive waste Federal review group (LFRG) for the LANL MDA G Performance Assessment. Primary roles included review of general model structure and distributional inputs to the MDA G PA model. Also covered the ALARA (decision analysis) components. Model structure issues covered included statistical development of inadvertent human intrusion and environmental modeling components such as soil erosion, radon, plant root

depths, infiltration rates, and exposure scenarios. In the context of the overall results, also reviewed the input distributions and the ensuing uncertainty and sensitivity analysis.

- Participated in a two DOE conference as an invited speaker on various aspects of Bayesian probabilistic modeling for Performance Assessments. Aspects included using statistical methods to develop statistically proper and defensible input distributions, and some more complex statistical issues for this type of modeling such as upscaling and the importance of accommodating correlation structures.

<u>For the DOE Nevada Operations Office and DOE Headquarters</u>

- Managed Neptune and Company's involvement in DOE's guidance on Monitored Natural Attenuation; co-authored the final guidance document; provided Bayesian statistical and decision analytic concepts in the DOE guidance document; broadened the focus of the guidance from groundwater problems to natural attenuation in the vadose zone and from surface processes such as surface water runoff.. Statistical components focused on monitoring network design, statistical analysis of monitoring data, monitoring decisions, and updating of models based on data collected. Project integrates inventory, transport and risk assessment modeling in a statistical framework to support a defensible decision framework for monitoring programs.

<u>For Bechtel Nevada Corporation</u>

- Managed an options (decision) analysis for a contaminated area on the Nevada Test Site. This options analysis was performed by building a Bayesian decision analysis model to evaluate more than 200 different combined options for future management of the site. This complex influence diagram-based model was built with input distributions developed from available data and expert opinion using data analysis, meta-analysis and probabilistic elicitation. The problem arose because of the impact of the Price Anderson Amendments Act (PAAA) on maintenance of power lines that traversed the site. Maintenance of the power lines required that exposure to radioactive levels of contamination must be reduced. Options for reducing the worker risk included various combinations of removal of soil, re-routing the power lines, building roads and causeways that contained the contamination, building fences or posting the site to keep people out, and building retention basins to stop off-site migration of contaminants. Information was obtained on the costs of carrying out the various options. The decision analysis model results were presented in terms of a cost function measured over the course of the next 100 years of potential management of the site. Costs were discounted across time. The most cost effective option included building a road and culverts that allowed contained access to the power lines, coupled with security fences that allowed limited access to potential trespassers. This was a very different option than was first considered by DOE, which involved the much more expensive overall option to remove the contaminated soil with disposal only a few miles away. Approximate cost savings to DOE according to the options analysis were on the order of $20m.

<u>For the Savannah River Site under various contracts to the Savannah River National Laboratory</u>

- Supported development of the Performance Assessment models for disposal of low-level radioactive waste in the Engineered and Slit Trenches at the E-Area Burial Grounds at the Savannah River Site (SRS), and continues to advise modelers on GoldSim implementation and PA methodology. Support involved statistical development of input distributions, and statistical support for model structuring and sensitivity analysis.
- Currently supporting similar activities for the E-Area expansion PA. Statistical distributions are needed for variables including radioactive inventory, release of radionuclides into the environment, transport of the radionuclides through various mechanisms (physical and chemical processes, biotic processes), and characterization of exposure scenarios.

- Supporting statistical activities for development of the F-Area and H-Area Tank Farms (tanks for disposal of radioactive waste), for performance assessments under Section 3116 of the National Defense Authorization Act of 2005.

For Energy Solutions

- Managing a new project to evaluate one of Energy Solutions radioactive waste disposal facilities for the future disposal of depleted uranium. The work entailed is similar to work performed at the NTS and SRS, involving development of models that are supported by development of statistical distributions for the input variables, model evaluation and sensitivity analysis. However, this work is regulated by the Nuclear Regulatory Commission. Initial work has involved research into upscaling and building correlation structures into models that are constructed using differential equations that address transfer between model compartments, development of a conceptual model for the long-term redistribution of the radionuclides in the environment, and development of a quality assurance project plan to support the modeling effort.

For the Electric Power Research Institute

- Managed assessment of the probability of volcanic hazard at Yucca Mountain. The Yucca Mountain site was modeled for volcanic activity and its likelihood of a disruptive volcanic event. Relatively little data are available, requiring the use of Bayesian models to integrate expert opinion with the available data to produce a hazard estimate and the uncertainty associated with the estimate. Elicitation covered spatial aspects of the model such as underlying stress fields, surface extension, lithostatic pressure, impact of volcanic dikes on faults, and the location of previous events, and temporal aspects such as the timing or previous events. Innovative elicitation methods and tools were developed to support the elicitation of the non-linear models needed to specify the model.

For the EPA National Risk Management Research Laboratory (NRMRL)

- Work for NRMRL has spanned 12 years, and has included statistical review of research reports, development of statistical guidance, statistical consulting for NRMRL research projects, preparation and presentation of statistics workshops, and development of innovate interactive open source statistics and decision analysis websites.
- Managing Neptune's project to support repurposing of derelict inner city land in Cleveland. The effort will involve developing a decision analysis framework program that encompasses environmental, social and economic components of optimizing across land use management options. Statistical analysis will be required to build input distributions for the underlying models. The basic philosophy of the model development will be Bayesian, but classical statistics will be used to support specification of input distributions and to explore available data.
- Supporting Neptune's involvement with EPA's Ecological Services Research Program (ESRP) by providing statistical and decision analysis expertise to the Decision Support Framework team.
- Managed Neptune's projects in support of the EPA NRMRL in their efforts to streamline redevelopment of industrially contaminated lands or brownfields. Effort involves developing a Bayesian decision support system that provides a framework for combining information about land use, contaminant characterization, fate and transport, risk assessment, economic analysis, uncertainty and sensitivity analysis, and decision analysis. The goal is to create a web-based Bayesian decision framework that will also provide access to the wealth of supporting information available, expert system advice for navigating the decision support tool, statistical analysis capabilities and presentation capabilities to disseminate information to all stakeholders involved in redevelopment projects (e.g., Brownfields).

- Managed Neptune's efforts for EPA to create an open source web-based system containing statistical guidance and tools in support of NRMRL's research activities. The goal is to use open source software to create a web-based interactive statistics support program both for statistical analysis and graphical presentation, and to encourage proper use of statistical techniques. Components include knowledge base, expert system, analysis and presentation.
- Applying the web-based statistical tools to a project with Waste Management Inc. to evaluate different innovative options for stabilization of municipal solid waste. Control cells and treatment cells have been established for the course of a 5-year project to determine if there are better or more efficient ways to stabilize municipal waste.
- Providing statistical expertise in support of review of various EPA NRMRL research documents ranging from QAPPs and sample designs to research reports. Dr. Black manages Neptune statisticians in support of this ongoing review task.
- Providing statistical expertise on various EPA NRMRL and other EPA research projects. Projects are wide ranging, touching subject areas such as toxicity testing, ecotoxicity, municipal waste management, and other technology development projects.
- Supported preparation of guidance on pre-quality assessment for QAPPs/DQOs for NRMRL research projects, which was aimed at ensuring that NRMRL researchers could develop reasonable QAPPS, and managed development of guidance for modeling projects.
- Managed development of successive workshops on environmental statistics and decision analysis including topics as wide ranging as Data Quality Objectives, Bayesian statistical methods, sample size calculation, non-parametric statistics, transformation, regression, experimental design, detection limits, censored data, decision analysis and probabilistic modeling of environmental fate and transport and risk systems. Workshops were initially presented from 1999-2001. The training has also included case studies as examples of how statisticians, environmental scientists and managers should effectively work together. The workshops have focused on statistical concepts and have purposefully stayed away from statistical jargon, placing the emphasis on effective communication. The series of workshops will be presented again starting in 2009.

<u>For the Nevada Division of Environmental Protection (as a subcontractor to McGinley Associates)</u>

- Managing Neptune's efforts in support of NDEP for the past 10 years. The primary effort is in support of the environmental restoration and redevelopment of a 5,000 acre highly contaminated site in Henderson, Nevada – the Basic Management Inc (BMI) property. The BMI site includes former and ongoing industrial facilities that have caused a wide range of contamination including all classes of chemicals at high concentrations in some parts of the site (e.g., metals, radionuclides, asbestos, pesticides, PCBs, PAHs, dioxins, NAPLs, perchlorate). Dr. Black manages all of the technical support tasks including statistics, chemistry, QA, ecological risk assessment, and human health risk assessment for radionuclides and asbestos. There are a wide variety of tasks and requests by the NDEP, which are delegated by Dr. Black, completed by an individual(s) with the respective area of expertise, reviewed, and delivered.
- Managing development of technical guidance for the NDEP and the responsible parties to follow including SOPs for data collection, electronic data deliverables, data validation, data usability, handling of non-detects, presentation of summary statistics tables, presentation of statistical graphics, implementation of EPA's DQO process for this site and its sub-areas, background comparisons, estimation of UCLs, calculation of asbestos-related risk, evaluation of radionuclide secular equilibrium for specific radionuclide chains, vapor intrusion estimation from soil gas and flux chambers (for radon and VOCs), risk assessment work plans, closure plans, and ecological risk assessment.

- Managing review of documents submitted by the responsible parties seeking closure of the contaminated sites in and around the BMI site. These documents include SAPs, conceptual site models, human health and ecological risk assessments, data reviews, background dataset reports, data validation summary reports (to assess data integrity and consistency), QAPPs, SOPs, risk assessment work plans, and remedial action study plans. These tasks are ongoing and are performed concurrently with other NDEP tasks (e.g., general statistical, chemistry and risk assessment support, database development, and web-based statistical tool development).
- Managing development of a database to house all data collected across the BMI, Henderson site. Data have been collected by five responsible parties and across various environmental media including surface soil, subsurface soil, groundwater, air, soil gas and flux chambers. The back-end database holds over a million records of analytical data. Data is accessed through a query interface which allows users to dynamically narrow the scope of their query using filter lists in combination with a map showing the location of all data points. The database is also supported by the Neptune's GiSdT technology, and provides efficient access statistical tools (e.g., hypothesis testing, EDA, analysis of variance, background comparisons, etc.), and visual presentations of the data, and will ultimately support modeling of the environmental system at this site.
- Managing development of a stand-alone open-source software tool (EnviroGiSdT) for performing statistical testing, including summary statistics, tests for data normality, one-sample and two-sample *t*-tests, background comparisons, testing for secular equilibrium, estimation of UCLs for mean concentrations, analysis of variance, and visual presentation of data. EnviroGiSdT is used by the responsible parties to support site-specific risk assessments.
- Managed Neptune's efforts to provide statistical support to the NDEP including EDA, hypothesis testing, background comparisons, assessment of sample adequacy, UCL calculations, *t*-tests, analysis of variance, tests of proportions, statistical programming, and graphical analysis for visualizing data. Also managed efforts to evaluate data quality, integrity, and consistency; provided review and technical statistical advice to the NDEP on various issues and documents (including technical guidance, industry studies, technical reports, peer-reviewed journal articles, etc.), and development of regular briefings to the NDEP on statistical methodologies used to support the BMI, Henderson.

For the Umatilla Chemical Weapons Depot (as a subcontractor to Vista Engineering)

- Managing continued development of Bayesian statistical sampling designs for the restoration of buildings that stored chemical warfare agents. The cleanup work is being performed under RCRA. The buildings are similar, and the techniques used to remove drums and clean the buildings is the same for each building, providing the opportunity to learn from building to building as the confirmation sampling is performed. Bayesian statistical methods are ideal for this setting of learning and sequential decision making. Consequently, Bayesian methods are being used to design data collection activities at a far lower cost than would otherwise have been required. The first set of buildings were recently approved by the regulators for closure, with concurrent approval of the Bayesian approach to sample design.
- Managed data analysis for the confirmation data reported after cleaning the buildings. Bayesian methods were used to confirm that the Bayesian sample designs were appropriate, to update the Bayesian statistical models, and to recalibrate the sample size formulas for recalculation as necessary.
- Co-authored a presentations and papers on the innovative Bayesian methods that have been applied at the Umatilla Chemical Weapons Depot, with emphasis on their overall effectiveness. This has created general interest in the chemical weapons demilitarization arena.

Statistical support to other State and Local Environmental agencies

- Supporting various environmental and regulatory site characterization efforts in California, Arizona, and Hawaii as part of a risk assessment team consisting primarily of environmental consultants in California.
- In California provided statistical support for more than 20 environmental site characterization and risk assessment projects. These tend to be small sites for which background comparisons and estimation of upper confidence limits are sufficient to support risk assessment.
- Providing statistical support for San Luis Obispo County in their regulatory efforts. The major effort has been at Avila Tank Farm, a site on the coast of California. Review consisted of advising the responsible party on how to characterize background across the several geologies that exist at the site, how to perform background comparisons, and how to best estimate upper confidence limits to support the risk assessments that were performed for about 20 sub-areas at the site.
- Provided statistical support to the risk assessment and site characterization at Camp Navajo in Arizona. Site characterization was complicated by the different geologies across this 75 square mile site, which required consideration of the different background concentration distributions. This was further complicated by the lack of offsite background data, in which case an onsite background dataset had to be identified statistically. Site characterization and risk assessment was performed separately for 45 sub-areas, across the different geological formations.
- In Arizona provided statistical support for various rural sites for which arsenic contamination was the primary concern. The source of the arsenic appeared to be related to pesticide use.
- In Hawaii, provided statistical support for characterization and risk assessment for the Aiea Sugar Mill and a former wood treating facility.

For the Los Alamos National Laboratory Environmental Restoration Project

- Currently managing Neptune's effort to support statistical analysis of some radionuclide data collected by LANL for their Performance Assessment at MDA G. On the face of it, the data collected by LANL do not agree with the outputs from their PA model. However, on closer statistical inspection, the data reveal that the model and the data are in agreement. The issues revolve around proper statistical inspection of analytical data, removing the censoring that is common to analytical data and considering the distribution of the entire dataset.

For the Montana National Guard

- For the Montana Army National Guard, managed development of a model of risk from UXO at the North Helena Valley Site in Montana. UXO related risk is not similar to chemical risk. UXO risks are acute as opposed to chronic. Consequently, a different approach to risk assessment is needed. Modeling involved using data, meta-data and elicitation to build a model to characterize the spatial distribution of UXO, potential for human exposure and for an adverse event (detonation). The Bayesian decision analysis model also includes a probabilistic ballistic model for predicting firing patterns; this is the first time a probabilistic approach has been taken to ballistic modeling. The project segregated areas of the approximately 1,000 acres site according to the probability of finding UXO. Approximate cost savings to the National Guard for site characterization have been estimated to be on the order of $10m.

For US Army Corps under subcontract to Sky Research

- Managing Neptune's efforts to provide statistics, human health and ecological risk assessment support for the characterization of residual chemicals at military sites at which munitions of explosive concern might be present. These chemicals might include lead, other metals, PAHs, and high explosives. Work consists of statistical design, data analysis and human health and ecological risk assessment.

For the US Marine Logistics Base in Barstow, California under subcontract to OTIE

- Managing Neptune's efforts to provide statistics and human health risk assessment support for the characterization of residual chemicals at this military base. The site consists of some industrial facilities, a dumpsite, and a skeet and trap range. Chemicals of concern include lead, PAHs, PCBs, and arsenic. Work consists of statistical design, data analysis and human health risk assessment. The statistical design included incremental sampling, which is the same as composite sampling, but with tens of increments. The data analysis showed that there are issues with incremental sampling that must be addressed in the field and in the laboratory, both during design and field implementation.

For the EPA National Center for Environmental Assessment (NCEA)

- Managed Neptune's efforts to build a Bayesian belief network (BBN) for models of aquatic systems. Specification of the BBN started with literature information, but data gaps became clear, so an effort was undertaken to build model components using expert elicitation. This allowed the BBN to be fully specified.
- Managed Neptune's technical efforts to establish a Bayesian decision framework for evaluating water bodies that may be under biological stress. The holistic approach, based on decision analytic techniques, results in an adaptive decision framework in which uncertainties and decision consequences are quantified. This type of objective, quantitative evaluation is a significant step towards improving current ecological risk assessment practices.
- Supported development of a standalone software product that consists of statistical tools for EPA NCEA's Causal Analaysi/Diagnostic Decision Information System (CADDIS). The tools, called CADStat include box plots, scatter plots, regression, ANOVA, quantile regression, bio-inference, and conditional probability.
- Managed development of the initial prototype of CADDIS.

For the EPA Quality Staff (QS) in the Office of Environmental Information (OEI)

- Developed statistical training materials for non-statistical audiences. Materials covered were presented in terms of statistical concepts, allowing the audience to focus on understanding the essence of the statistical approaches rather than purely the mathematical components. Topics covered included exploratory data analysis (summary statistics and graphics), hypothesis testing, confidence intervals, testing assumptions, lognormal distributions, non-parametric statistics, correlation, regression, temporal analysis, spatial analysis and bootstrapping.
- Developing a white paper on application of Bayesian statistical methods to the Data Quality Objectives process. The intent is to place the DQO process on a more solid foundation it its role of supporting decision analysis.
- Managed development of DataQuest, standalone statistical software for managers. DataQuest was intended to support EPA's Data Quality Assessment process by providing statistical tools for managers or regulators. Although DataQuest was completed in C++, also managed development of the same tools in Neptune's GiSdT architecture.

For EPA Region 5

- Provided statistical support for Region 5 in their regulation of .Neal's Landfill, a site in Indiana that is highly contaminated with PCBs, and is subject to intense regulation involving EPA legal. Worked with EPA and the responsible party to design data collection based on previously collected data. Developed DQOs based on a temporal regression model to determine sample sizes of interest, and performed data analysis of historical data for inputs to the DQO process.

For EPA National Center for Environmental Assessment under subcontract to Abt Associates

- Supported a project to evaluate statistical aspects of EPA's Report on the Environment (ROE). The goals were to determine if uncertainty could be included in ROE estimates, and to determine if the ROE indicators could be regionalized. Research was focused initially on 6 ROE indicators, although the greatest insights were obtained for the Coastal Water Quality Index (CWQI). The CWQI is currently evaluated without uncertainty, and is based on data primarily from a couple of coastal regions. Recommendations were made for how to obtain data that could support estimating uncertainty, revising the CWQI model so that discretization did not adversely affect the value, and on spatial regionalization, which could only occur if data were included from more coastal regions.

For EPA Office of Water under subcontract to SAIC

- Managed statistical review of summary reports on entrainment survival of juvenile fish and fish larvae exposed to power plants. The bulk of the work was based on the EPRI report entitled "*Review of Entrainment Survival Studies: 1970-2000*". The review focused on the statistical aspects of the studies from multiple years including the summary report compilation of available data from the all reports to evaluate the precision of survival estimates and adequacy of study designs to address key physical parameters and questions. The overall goal of the report review was to advise EPA on the utility of existing data for risk based decisions and for setting standards. Statistical review showed problems with the way in which data were combined, did not control or account for confounding factors and overlooked the lack of experimental design in many studies making accurate statistical estimation of survival rates impossible. Draft findings and recommendations were forwarded to SAIC for report submitted to EPA.

For Orange County, California

- Several watersheds or stream systems have been monitored for metal, chemical, and bacterial concentrations. Supported various statistical analysis tasks to assess the stream systems for spatio-temporal changes, and to evaluate effectiveness of changing land use and management practices over time. Multivariate, regression, spatio-temporal, and survival models were used to assess the policy questions of interest.
- Supported development of statistical techniques for monitoring bacteria in the surface water system. Of particular interest is the identification of practices that have lowered bacterial loads, a difficult task since bacteria data is naturally highly variable and often censored (i.e. measured concentrations are often only reported as upper or lower limits).

For the Los Alamos National Laboratory Environmental Restoration Project

- Served as technical team leader for the Statistics/Decision Support Team that supports the LANL Environmental Restoration (ER) Project. Managed meetings of the technical team to consider options for applications of statistical methods for environmentally sensitive sites at LANL, and to promote consistency of technical approaches to site decision making.
- Authored or co-authored statistics related policy documents for the LANL ER Project, on topics such as: the overall decision based approach to problem solving within the LANL ER Project; performing comparisons of environmental samples with background concentration distributions; performing environmental screening assessment; sampling designs to support human health risk assessment; complications arising from chemical detection limits; and, use of quality assurance data within the LANL ER Project.

- Served as technical team leader for the Field Unit 5 and the Townsite. Manage the technical (statistics, chemistry and risk assessment) efforts, including scheduling and budgeting, to promote consistency of technical approaches to site decision making.
- Developed Bayesian decision theoretic approaches for optimal design of environmental data collection studies. Approach requires elicitation of prior distributions through prior predictive distributions, elicitation of loss functions and of the costs of sampling.
- Developed innovative statistical designs, including cost effective use of composite sampling strategies that increase the precision of statistical estimates of interest and decrease the costs associated with sampling and analysis, and double sampling that involves field screening data in the initial phase and laboratory analysis in the second phase, in support of environmental screening and human health risk based decisions.
- Managed development of in-house graphical statistical methods for presentation of environmental data. Methods include exploratory tools based on simple triangulation algorithms and graphical methods for presenting spatial data, including kriging, multi-dimensional kriging and exploratory plots such as bubble plots and intensity plots.
- Managed LANL's efforts to perform a quality control oversight function for all data collected in support of LANL's Environmental Restoration Project.
- Managed Neptune and Company's support to LANL ER in their modeling of TA-54, the main low-level radioactive waste disposal facility at LANL; probabilistic models were developed in GoldSim; managed development of groundwater pathway and biotic transport pathways to model potential contaminant transport from the waste inventory; model projected for 10,000 years; simplified model allowed full probabilistic analysis, sensitivity analysis and uncertainty analysis; managed risk assessment efforts for both groundwater and biotic uptake endpoints; performed elicitation to specify probability distributions for some parameters; work performed for LANL ER under their RCRA permit.
- Provided statistical and decision analysis support for LANL's efforts to integrate environmental closure actions under RCRA for all of LANL's material disposal areas, resulting in production of a draft guidance document for closure decisions and long term monitoring.

<u>For the Los Alamos National Laboratory Waste Management Division</u>

- Responsible for statistical support in developing a sampling plan for radioactive waste that was proposed for shipment to the Waste Isolation Pilot Plant in Carlsbad, New Mexico. Sampling plan involved complex stratified sampling and optimal allocation across strata to ensure that the desired levels of precision can be achieved. This project resulted in the first shipments of radioactive contaminated waste to WIPP. Received awards at the DOE WM conference for this effort.

<u>For the Los Alamos National Laboratory ESH-18 Division</u>

- Supported LANL's efforts to negotiate with the New Mexico Environment Department concerning their proposed approach to sampling watershed in the State of New Mexico and, in particular, at LANL.
- Managed data analysis of existing environmental surveillance data; produced reports showing summary statistics, exploratory data analyses; temporal trends and spatial trends for metals and radionuclide concentrations and physical parameters collected for environmental surveillance at LANL for the past 50 years; responded to review comments from LANL, and managed production of first final report in 1999; report highlights issues associated with historical data, confounding factors such as changes in analytical or sampling protocols, and sparseness of data collected to date, all of which make conclusions tenuous.

- Managed an effort to statistically compare pre and post Cerro Grande Fire data for radioactive isotopes of plutonium, americium, strontium and cesium.
- Managed an effort to compare laboratory performance for data collected by Los Alamos National Laboratory, the State of New Mexico and the EPA.

<u>For the Los Alamos National Laboratory Waste Management Division</u>

- Performed statistical analysis of bioassay data to test efficacy of health and safety programs at LANL's plutonium facility. The initial intent of the study was to view the monitoring design to determine if improvements could be made. A Bayesian solution was jointly pursued with some LANL scientists.

<u>For the Argonne National Laboratory</u>

- Provided statistical support for ANL's human health risk assessment efforts for the Weldon Spring Department of Energy site, including generation of spatial statistical models to determine extent of contamination, and estimation techniques that appropriately account for the shape of the underlying concentration distributions.

<u>For the Rocky Flats Plant</u>

- Reviewed the background study (background concentrations of naturally occurring chemicals in the environment) performed at RFP, including a variety of parametric and non-parametric background comparisons with RFP site data, and simulation studies to determine the combined effect of using several different types of background comparison tests, including t-tests, variations of the Mann-Whitney test that account more appropriately for non-detects in chemical measurements, quantile tests, and slippage tests. Simulations provided comparison of the power of these classical tests, as well as an indication of the overall power of performing all the tests simultaneously.

<u>For the Pacific Northwest National Laboratory</u>

- Developed cost effective strategies for environmental data collection through the use of composite sampling. Prepared a report on the current state of composite sampling and co-authored report on development of further innovative approaches for use of this sampling technique. Reviewed plans for environmental sampling activities at PNL, including analysis of statistical sampling designs proposed for sampling of high-level radioactive waste stored in underground storage tanks.

<u>For the Argonne National Laboratory</u>

- Provided statistical support for the development of a new analytical method for measuring trace levels of metals. Method was based on fluorescence. Although the experiment demonstrated measurements capabilities at low levels, the method did not get to the trace levels desired. Performed statistical experimental design and data analysis for the experimental study.

<u>For the US Geological Survey</u>

- Managed a project to develop a decision analysis tool for the Death Valley Regional Flow System. The intent was to provide insights into the use of water in the arid southwest, and the effect on the aquifers and long term water availability and use when new wells are drilled.

For Scitec Corporation

- Reviewed Government regulations for lead based paint testing with X-ray fluorescence (XRF) instrumentation.
- Designed, developed and implemented sampling plans for evaluation of sources of variability associated with lead concentration measurements collected using the client's XRF instruments. Designs focused on field, instrument, and analytical laboratory sources of variability
- Performed a thorough statistical analysis of the client's XRF spectral algorithms.
- Developed curricula and presentations for the client's training courses.
- Developed elements of a computerized system that will enable optimized designs, data reliability, and decision defensibility for lead surveys using the client's XRF instrument.

Expert Witness

- Provided statistics expertise for the plaintiff in a case concerning contamination from a manufactured gas plant. Expertise provided was in the areas of statistical fingerprinting, background comparisons, and general statistics.

ICF Kaiser

1990 to 1992: Statistician

Technical work consisted of providing statistical support to a variety of environmental projects, ranging from statistical design of surveys and experiments, to statistical analysis of data both from statistically designed projects and from observational data.

National Pesticide Survey

- Responsible for all statistical analyses related to Phase II of the NPS (for the United States Environmental Protection Agency's (EPA) Office of Water and Office of Pesticides and Toxic Substances), including analyses of the relationships among the many variables for which data was collected. The survey involved sampling well water from over 1300 community and domestic wells nationwide, chemical analysis of the water samples for identifying the presence of 127 potential pesticide related contaminants, and collection of demographic information via questionnaires administered to well owners and county agents. The NPS used a complex multi-stage stratified sampling procedure. Developed imputation procedures for handling missing data including "hot-decking" and predictive or regression techniques. Performed statistical analyses to provide simple population estimates, and developed models for examining the relationship between pesticide detection and demographic characteristics. Model development included innovative techniques to counteract problems caused by the small number of detections, including maximum likelihood estimation for mixture models and Bayesian methods.
- Performed a thorough review of the survey design used for the NPS, including comparison of achieved results with prespecified precision requirements, and a full analysis of the consequences of the under reporting of false negative analytical detection rates.
- Performed a human health risk analysis for the analytes included in the NPS. Methods used involved estimating risk distributions through a modified bootstrap approach, after recognizing the type of mixture distributions appropriate for modeling the concentrations.
- Performed a statistical review of EPA's DRASTIC index for ground water vulnerability using data generated in the NPS.
- Performed statistical process control analysis for the temporal aspect of the sample design, followed by a statistical review of the temporal aspect of the NPS sampling design, by comparison of the implemented temporal allocation with modeled random temporal allocation.

National Alachlor Well Water Survey

- For the Monsanto Company National Alachlor Well Water Survey (NAWWS), performed a thorough review of the NAWWS (for EPA's Office of Water and Office of Pesticides and Toxic Substances), including verifying data analyses, and statistical review of the DRASTIC index for ground water vulnerability. Also, performed a human health risk analysis for the analytes included in the NAWWS, similar to that performed for the NPS.

Other environmental projects

- Provided statistical support for a project to determine the adequacy of various procedures for detecting radon in households. The objective was to recommend a particular procedure for radon mitigation based on anticipated precision and cost constraints.
- Developed a Bayesian sampling strategy to determine the extent of residual contamination contained in cement kiln dust. Strategy accounted for rare event phenomena in a finite population.
- Performed an analysis of data from a STAR (Texaco) waste disposal facility in Delaware to determine compliance with Government permitting requirements.

Decision Science Consortium

1988 to 1990: Research Statistician and Decision Analyst

Technical work consisted of providing statistical support to a variety of data collection activities, ranging from statistical design of surveys and experiments, to statistical analysis of data both from statistically designed projects and from observational data, and development of Bayesian methods for elicitation and subsequent survey design.

- Performed basic research into the foundations of probability theory as they are related to other theories of uncertainty, including a comparison of decision theoretic approaches taken by the competing theories. The research resulted in a number of prototype rule and frame based decision aids, some of which were based on the competing theories, including probability theory, while others were purely *ad hoc* or frame based. Project was funded under grants from the National Science Foundation.
- Developed theory to support elicitation of Bayesian prior distribution hyperparameters via the prior predictive distributions for analysis of variance models. Identified a class of conjugate prior distributions that ease the elicitation burden while providing adequate descriptions of an expert's knowledge. Developed an interactive computer program to perform the elicitation. The program continually checks for model validity and elicitation errors to ensure that the resulting prior predictive distribution matches the prescribed analysis of variance model. Implemented a similar program to perform elicitation of a normal linear regression model. Project was funded under grants from the National Science Foundation.
- National Pesticide Survey (NPS): Performed statistical analysis of the NPS for EPA's Office of Water and Office of Pesticides and Toxic Substances, including a thorough review of the DQO process used to design the NPS, Data Quality Assessment, and human health risk assessment.
- Performed similar activities for the Monsanto Company National Alachlor Well Water Survey (NAWWS).

Carnegie Mellon University

1984 to 1987: Teaching Assistant / Research Assistant

- Teaching Assistant - prepared materials and taught undergraduate and graduate courses in introductory statistics, probability theory, and data analysis.

- Research Assistant - researched theories of uncertainty proposed as alternatives to probability theory. Compared representations of the competing theories and effects of those representations on decision theoretic approaches taken by those theories.

Rex, Thompson and Partners

1981 to 1984: Systems Analyst

Work performed centered on development of expert systems for weapons systems, including initial design, and analysis of the real-time expert system operations. The systems were designed for use in real time battle situations to ensure adequacy of equipment supply.

Professional Activities/Honors

American Statistical Association

Society for Risk Analysis

INFORMS

Interface Foundation of North America

Interstate Technology and Regulatory Council

Low-Level Radioactive Waste Federal Review Group

National Association of Ordnance Contractors

US-German Bilateral Working Group

Awards from the DOE Waste Management Conference (1997 and 1999)

Publications

Perona, R., Tauxe, J., and Black, P.K., The Influence of Future Human Behaviors in Performance Assessment, in the Proceedings of the Waste Management Conference, Tucson, AZ, March 2010.

Tolaymat, T.M., Green R.B., Hater, G.R., Barlaz, M.A., Black P.K., Bronson D., Powell, J., Evaluation of Landfill Gas Decay Constant for Municipal Solid Waste Landfills Operated as Bioreactors, Journal of Air & Waste Management, **60**:91–97, 2010.

Gratson, D., and Black , P., J-; Now what – Is there more we can do with qualified data?, proceedings of the National Environmental Monitoring Conference, 2009.

Black, P.K., and Stockton, T.B. Basic Steps for the Development of Decision Support Systems, In Decision Support Systems for Risk-Based Management of Contaminated Sites, Chapter 1, Marcomini, Antonio; Suter II, Glenn Walter; Critto, Andrea (Eds.), Springer Publishing, ISBN: 978-0-387-09721-3, 2009.

Vega, A., Argus, R., Stockton, T, Black, P, Black., K., and Stiber, N. An MCDA Approach to Revitalize Communities and Restore the Environment, In Decision Support Systems for Risk-Based Management of Contaminated Sites, Chapter 9. Marcomini, Antonio; Suter II, Glenn Walter; Critto, Andrea (Eds.), Springer Publishing, ISBN: 978-0-387-09721-3, 2009.

Copeland T.L. and Black, P.K., Duffy, P.A., DeCaprio, A.P., O'Hehir, D.J., and Kerger, B.D.. Comparison of Congener-Specific and Aroclor Quantitation Methods for Assuring Remediation of Polychlorinated Biphenyls and Associated Dibenzofurans at a Former Wastewater Treatment Plant. Presented at the 47th Annual Meeting of the Society of Toxicology, March 16020, Seattle, WA, 2008

Biebesheimer, F., Black P. and Fitzgerald M. Application of Decision Frameworks to Address Uncertainty and Reduce Technical Risk in the I-Block Closure Project. Proceedings of the 10th International Chemical Weapons Demilitarisation Conference, Belgium, 2007.

Tauxe, J., Black P.K., and Cook, J. Approaches and Solutions to Disposition of Wastes Regulated Under 40 CFR 191, Proceedings of the Waste Management Conference, Tucson, AZ, March 2007.

Crowe, B. M., Valentine, G. A., Perry, F. V., and P. K. Black. Volcanism: The Continuing Saga, *In:* "Uncertainty Underground: Yucca Mountain and the Nation's High-Level Nuclear Waste (eds. A. M. Macfarlane and R. C. Ewing), pp. 131-148. The MIT Press, London/Cambridge, 2006.

Data Quality Assessment: A Reviewer's Guide, EPA QA/G-9R, EPA/240/B-06/002, February 2006.

Data Quality Assessment: Statistical Methods for Practitioners, EPA QA/G-9S, EPA/240/B-06/003, February 2006.

Black, P.K., Stockton, T.S., and Tauxe, J. Options Analysis for the Long-Term Management of the Smoky Site, Proceedings of the Waste Management Conference, Tucson, AZ, March 2005.

Crowe, B., Black P.K., Catlett, K., Stockton, T., Sully, M., Tauxe, J., Desotell, L., Shott, G., Yucel, V., Carilli, J., and Pyles, G. Model Evolution of a Probabilistic Performance Assessment for Disposal of Low-Level Radioactive Waste at the Area 5 Radioactive Waste Management Site, Nevada Test Site, Proceedings of the Waste Management Conference, Tucson, AZ, March 2005.

Black, P.K., Bayesian Data Quality Objectives, draft report for the EPA Office of Environmental Information Quality Staff, 2004.

Carilli, J., Crowe, B., Black P.K., Tauxe, J., Stockton, T., and Catlett, K.. Management of the Area 5 Radiocative Waste Management Complex using Decision-based Performance Assessment Modeling, Proceedings of the Waste Management Conference, Tucson, AZ, March 2003.

Crowe, B., Black P.K., and Lee, D. Probabilistic Modeling: Applications to Performance Assessment Maintenance Plan Studies for Low-Level Waste Disposal Facilities, Paper written for the DOE Low-Level Radioactive Waste Federal Review Group, 2002.

Markwiese JT, Vega, AM, Green R, Black P.K.. Evaluation plan for two large-scale landfill bioreactor technologies. *MSW Management* (http://www.forester.net/msw.html). Online publication, November/December Issue: 66-70, 2002.

Crowe, B., Yucel, V., Rawlinson, S., Black P.K., Carilli, J., Colarusso, A., and DiSanza, F. Application of Probabilistic Performance Assessment Modeling for Optimization of Maintenance Studies for Low-Level Radioactive Waste Disposal Sites at the Nevada Test Site, Proceedings of the Waste Management Conference, Tucson, AZ, March 2002.

Stockton, T.S., and Black, P.K., The Utility of Bayesian Hierarchical Modeling for Complex Environmental Problems, Interface, New Orleans, Louisiana, 2000.

Golian, S., Brady, P., Dawson, G., Erdman, J., and Black, P.K., Technical Guidance for the Long-Term Monitoring of Natural Attenuation Remedies at Department of Energy Sites, Department of Energy, Office of Environmental Restoration, October 1999.

Shott, G., Black, P, and Moore, B., Probabilistic Derivation of Waste Concentration Limits for Low-Level Radioactive Waste Disposal at the Nevada Test Site, Proceedings of the Waste Management Conference, Tucson, AZ, March 1999.

Black, P.K., Experiences in Elicitation, Discussion of special edition on "Experiences in Elicitation", The Statistician, The Royal Statistical Society, 1997.

Black, P.K., Moore, B., Crowe, B., Black, K.J., Hooten, M.M., Barker, L.E., and Rawlinson, S.E., A

Common Sense Approach to Assessing the Probability of Inadvertent Human Intrusion at Nevada Test Site Radioactive Waste Management Sites, Proceedings of the Waste Management Conference, Tucson, AZ, (Best Paper Award), March 1997.

Black, P.K., Neptune, M.D., Ryti, R.T., and Hickmott, D.D., Professional Judgment in the Data Quality Objectives Process: A Bayesian Approach to Screening Assessment, the proceedings of the Federal Environmental Restoration III and Waste Minimization II Conference and Exhibition, 1994.

Black, P.K., and Laskey, K.B., Models for Elicitation in Bayesian Analysis of Variance: Implementation and Application, Proceedings of the 150th Meetings of the American Statistical Association, 1989.

Gallaher, B., Mercier, T., Black, P.K., and Mullen, K., EPA/NMED/LANL 1998 Water Quality Results: Statistical Analysis and Comparison to Regulatory Standards, Los Alamos National Laboratory, LA-13682-MS, February 2000.

Golian, S., Brady, P., Dawson, G., Erdman, J., and Black, P.K., Technical Guidance for the Long-Term Monitoring of Natural Attenuation Remedies at Department of Energy Sites, Department of Energy, Office of Environmental Restoration, October 1999.

Black, P.K., Experiences in Elicitation, Discussion of special edition on "Experiences in Elicitation", The Statistician, The Royal Statistical Society, 1997.

Black, P.K., Moore, B., Crowe, B., Hooten, M.M., Black, K.J., Rawlinson, S., and Barker, L.E.. A Common-Sense Probabilistic Approach To Assessing Inadvertent Human Intrusion Into Low-Level Radioactive Waste At The Nevada Test Site. Proceedings of the 1997 Waste Management Conference, Tucson, Arizona, 1997.

Black, P.K., Experiences in Elicitation, Discussion of special edition on "Experiences in Elicitation", The Statistician, The Royal Statistical Society, 1997.

Black, P.K., Geometric Structure of Lower Probabilities, Institute of Mathematics and its Applications, Special Edition on Random Sets, pp. 361-384, J. Goutsias, R. Mahler, H. Nguyen, eds., Springer, 1997.

Adelman, L.A., Bresnick, T.A., Black, P.K., Marvin, F.F., and Sak, S.A., Research with Patriot Air Defense Officers: Examination of Information Order Effects, Human Factors, special issue on Decision Making in Complex Environments, 1996.

Black, P.K., An Examination of the Belief Functions and Other Monotone Capacities, Ph.D. Thesis, Carnegie Mellon University, Pittsburgh, PA, 1996.

Copeland, T.L., Black, P., Resin, R., 1996. Statistical Approaches to Applying Background PAH Data in Defining Remedial Action Objectives. Prepared for Southern California Edison (SCE) for submittal to the California EPA Department of Toxic Substances Control (CalEPA/DTSC). June 1996. (approved by CalEPA/DTSC as site closure methodology for SCE manufactured gas plants: Use of Database of Compiled Polycyclic Aromatic Hydrocarbon Background Sampling. Memorandum from S.M. DiZio, Human and Ecological Risk Division, CalEPA/DTSC to Don Johnson, Site Mitigation Program CalEPA/DTSC, December 16, 1996).

Black, P.K., co-author, Technical Approach to Decision Making for the LANL ER Project, Policy Document, Decision Support Council Statistics Technical Team, Los Alamos National Laboratory Environmental Restoration Project, Los Alamos, NM, January, 1996.

Adelman, L.A., Bresnick, T.A., Black, P.K., Marvin, F.F., and Sak, S.A., Information Order Effects on Expert Judgment, in "Cognitive Systems Engineering for User-Computer Interface Design, Prototyping and Evaluation, S. Andriole and L.A. Adelman, Lawrence Erbaum Associates, Hillsdale, NJ, 1995.

Black, P.K., co-author, LANL ER Project Guidance for Use of Quality Assessment Information, Draft Policy Document, Decision Support Council Statistics Technical Team, Los Alamos National Laboratory

Environmental Restoration Project, Los Alamos, NM, December, 1995.

Black, P.K., Neptune, M.D., Ryti, R.T., and Hickmott, D.D., Professional Judgment in the Data Quality Objectives Process: A Bayesian Approach to Screening Assessment, the proceedings of the Federal Environmental Restoration III and Waste Minimization II Conference and Exhibition, New Orleans, 1994.

Black, P.K., Johnson, L., and Lester, H., Data Quality Objectives for the National Pesticide Survey: Evaluation and Results, the proceedings of the Fourth Annual Ecological Quality Assurance Workshop, Cincinnati, Feb. 26-28, 1991.

Black, P.K., and Laskey, K.B., Hierarchical Evidence and Belief Functions, in Uncertainty in Artificial Intelligence VI (Kanal, L., Levitt, T., and Shachter, R., eds.), North Holland Press, 1990.

Black, P.K., and Laskey, K.B., Models for Elicitation in Bayesian Analysis of Variance: Implementation and Application, Proceedings of the 150th Meetings of the American Statistical Association, August, 1989.

Black, P.K., Is Shafer General Bayes?, presented at, and published in, the Proceedings of the Third Workshop on Uncertainty in Artificial Intelligence, Seattle, Washington, July, 1987.

Software Tools and Websites

Remediation of the BMI Complex. BMIdatabase – ndep.gisdt.org. For the Nevada Division of Environmental Protection. 2009.

Sustainable Management Approaches and Revitalization Tools. SMARTe – www.smarte.org. For EPA's National Risk Management Research Laboratory. 2009.

Guided Interactive Statistical Decision Tools. GiSdT – www.gisdt.org. 2009.

Environmental Guided Interactive Statistical Decision Tools. EnviroGiSdT. For the Nevada Division of Environmental Protection. 2009.

Causal Analysis/Diagnostic Decision Information System Statistical Tools. CADStat. For EPA's National Center for Environmental Assessment. 2009.

DataQuest. For the EPA Office of Environmental Information Quality Staff. 2004.

Statistical Wizard. StatWiz. For the EPA National Risk Management Research Laboratory. 2001.

Reports

Morrissey, M., Black. P., and Fitzgerald, M. Independent Probabilistic Volcanic Hazard Analysis for the Yucca Mountain Region, Technical Report for the Electric Power Research Institute. 2008.

Black, P.K., Catlett, K., Stockton, T., and Neptune, D., Helena Valley Probabilistic Risk Assessment of UXO for the Montana Army National Guard Neptune and Company, Inc. September 2008.

Stoeckle, A et al. P. Black co-author. Uncertainty of ROE Indicators. For the National Center of Environmental Assessment. 2008.

Biebesheimer, F., Black, P., and Fitzgerald, M. Application of Decision Frameworks to Address Uncertainty and Reduce Technical Risk in the I-Block Closure Project. *Umatilla Chemical Depot I-Block Closure Plan*, Hermiston, 2007.

DOE, 2006 (Black, P.K., co-author), Addendum 2 to the Performance Assessment for the Area 5 Radioactive Waste Management Site at the Nevada Test Site, Nye County, Nevada, DOE/NV/11718–

176-ADD2, June 2006

Black, P.K., and Stockton, T.S. Using Knowledge Elicitation to Inform a Bayesian Belief Network of a Stream Ecosystem, Technical Report for the EPA National Center for Environmental Assessment, Neptune and Company, Inc., July 2005.

Stockton, T.S., and Black P.K. Incorporating Empirical Data and Expert Judgment in Bayesian Belief Networks: A Case Study, Technical Report for the EPA National Center for Environmental Assessment, Neptune and Company, Inc., September, 2004.

Black, P.K., Black, K.J., Stahl, L.P., Hooten, M.M., Stockton, T. S., and Neptune, M.D., Assessing the Probability of Inadvertent Human Intrusion at Nevada Test Site Radioactive Waste Management Sites: Final Report, Department of Energy, Report Number DOE/NV-593-Vol. I. March 2001.

Hooten, M.H., Markweise, J.T., Myles, T.G., Black, P.K., and Ryti, R.T., A Literature Review of Biotic Components, Processes, and Characteristics Central to Biotic Transport Modeling of Soils at the Nevada Test Site, Technical Report for the Department of Energy Nevada Operations Office, Neptune and Company, Inc., May 2001.

Black, P.K., T. Stockton, J. Tauxe, A. Schuh, and R. Shuman. Nevada Test Site Smoky Site Decision Analysis. Report prepared by Neptune and Company, Inc. for Bechtel Nevada, Las Vegas, Nevada, 2001.

Gallaher, B., Mercier, T., Black, P.K., and Mullen, K., EPA/NMED/LANL 1998 Water Quality Results: Statistical Analysis and Comparison to Regulatory Standards, Los Alamos National Laboratory, LA-13682-MS, February, 2000.

Black, P.K., Lancaster, V., Carlson, D., and Black K.J., Statistical Analysis of Radionuclide and Metal Data for Sediment and Water Samples Collected at or Near Area G, Report prepared for Los Alamos National Laboratory, Environmental Surveillance Group, December 1999.

Kosiewicz, S.T., Michael, D.I., Black P.K., Triay, I.R., and Souza, L.A.,, Sampling and Analysis Validates Acceptable Knowledge on LANL Transuranic, Heterogeneous, Debris Waste or "Cutting the Gordian Knot That Binds WIPP", LANL (USA), 1999.

Kosiewicz, S.T., Michael, D.I., Black P.K., Triay, I.R., and Souza, L.A., "Confirmatory Sampling and Analysis Plan of Acceptable Knowledge for TA-55-43, Lot No. 01," Los Alamos National Laboratory Report, LA-UR-98-5861, Los Alamos, NM 87544, December 1998.

Kosiewicz, S.T., Michael, D.I., Black P.K., Triay, I.R., and Souza, L.A., "Sampling and Analysis Project Validates Acceptable Knowledge on TA-55-43, Lot No. 01," Los Alamos National Laboratory Report, LA-UR-98-5874, Los Alamos, NM 87544, December 1998.

Black, P.K., Black, K.J., Hooten, M.M., Mathai, L.P., and Neptune, M.D. _Assessing the Probability of Inadvertent Human Intrusion at Nevada Test Site Radioactive Waste Management Sites: Final Report. Technical Report 94-014-03-07, Neptune and Company, Inc., Los Alamos, New Mexico, 1997.

Black, P.K., Black, K.J., Hooten, M.M., Mathai, L.P., and Neptune, M.D. Assessing the Probability of Inadvertent Human Intrusion at Nevada Test Site Radioactive Waste Management Sites: Summary of Subject Matter Expert Input. Technical Report 94-014-03-06, Neptune and Company, Inc., Los Alamos, New Mexico, 1996.

Black, K.J., Black, P.K., and Neptune, M.D.. _Assessing the Probability of Inadvertent Human Intrusion at Nevada Test Site Radioactive Waste Management Sites: Summary of the Second Subject Matter Expert Elicitation Session. Technical Report 94-014-03-05, Neptune and Company, Inc., Los Alamos, New Mexico, 1996.

Neptune, M.D., Black, P.K., Mathai, L.P., Carlson, D.K., Black, K.J., and Hooten, M.M., Assessing the Probability of Inadvertent Human Intrusion in Support of Performance Assessments for Nevada Test

Waste Disposal Areas: Influence Diagrams, Technical Report No. 94-014-03-02, Neptune and Company, Inc., July, 1996.

Neptune, M.D., Black, P.K., and Mathai, L.P., Assessing the Probability of Inadvertent Human Intrusion in support of the Fernald OU4 byproduct Waste Performance Assessment: Work Plan, Technical Report No. 94-014-03-01, Neptune and Company, Inc., April, 1996

Black, P.K., and Carlson, D.K., Weldon Spring Southeast Drainage: Data Quality Assessment for Support of Risk Based Decisions, Technical Report No. 94-014-01-01, Neptune and Company, Inc., September, 1996.

Black, P.K., and Carlson, D.K., Weldon Spring Southeast Drainage: Correlation Analyses for Radionuclide and Field Screening Data, Technical Report No. 94-014-01-02, Neptune and Company, Inc., September, 1996.

Johnston, T.E., Fairfield, E.F., Soper, S.A., Black, P.K., and Neptune, M.D., Fluorescent Quantitation of Ultra-trace Heavy Metals, Technical Report No. 94-024-01-01, Neptune and Company, Inc., September 1995.

Kelly, E.J, Michael, D.I., Campbell, K.S., and Black, P.K., Proposed Framework and Demonstration of the Data Quality Assessment Process at the Rocky Flats Environmental Technology Site, Technical Report prepared for the Rocky Flats Environmental Technology Site, March 1995.

Black, P.K., Neptune, M.D., Black K.J., Johnston, T.E., and Sweedy, K.L., Preliminary Report on Stage I of the Denver Housing Authority Field XRF Study, Technical Report, Neptune and Company, Inc., October 1994

Black, P.K., Lancaster, V.A., and Neptune, M.D., Preliminary Report on the Richland Wall Field XRF Study, Technical Report, Neptune and Company, Inc., October 1994

Black, P.K., and Laskey, K.B., Application of Predictive Elicitation Models for Bayesian Analysis of Variance, independent research report, 1994.

Black, P.K., Borghi, L., and Lorber, M., Estimating Atrazine Exposure and Risk Using Data from the National Survey of Pesticides in Drinking Water Wells: A Case Study, Clement Associates, Fairfax, VA, May, 1992.

Black, P.K., Borghi, L., and Lorber, M., National Survey of Pesticides: Exposure and Risk Report, Clement Associates, Fairfax, VA, May, 1992.

Black, P.K., and Eddy, W.F., Models of Inexact Reasoning, Technical Report 351, Department of Statistics, Carnegie Mellon University, Pittsburgh, Pennsylvania, 1986.

Workshops and Courses

Black, P.K., Fitzgerald, M., Statistical Workshops (exploratory data analysis, regression, ANOVA, confidence intervals and hypothesis tests), presented for EPA National Risk Management Research Laboratory, September, 2009.

Black, P.K., and Fitzgerald, M., Bayesian Data Quality Objectives, online course presented at statistics.com, February 2009.

Black, P.K., and Duffy, P.A., Statistical Workshops (Data Quality Objectives, exploratory data analysis, statistical tests, tests for assumptions, confidence intervals, transformations, non-parametric statistics, censored data, bootstrapping, correlation and regression, temporal data analysis), presented for EPA National Risk Management Research Laboratory, August 2001.

Black, P.K., Lancaster, V.L., Stockton, T.S., Statistical Workshops (exploratory data analysis, detection limits, non-linear modeling, environmental modeling), presented for EPA National Risk Management Research Laboratory, June 2000.

Black, P.K., Lancaster, V.L., Duffy, P.A., Statistical Workshops (experimental design, ANOVA, Parametric and non-parametric methods, hypothesis testing and confidence intervals, regression analysis and goodness-of-fit tests), presented for EPA National Risk Management Research Laboratory, July 1999.

Black, P.K., Lancaster, V.L., Duffy, P.A., Statistical Workshops (confidence intervals, hypothesis tests, ratio statistics, parametric and non-parametric tests, ANOVA), presented for EPA National Risk Management Research Laboratory, March 1999.

Black, P.K., Lancaster, V.L., Duffy, P.A., Statistical Workshops (experimental design, observational studies, sample size calculations, ratio statistics), presented for EPA National Risk Management Research Laboratory, January 1999.

Presentations

Black, P.K., Fitzgerald, M., and Gratson, D., Using radionuclide Secular Equilibrium Calculations in Human Health Risk Assessments, in the Proceedings of the Association of Environmental Health and Sciences, 2010.

Black, P.K., Catlett, K., Stockton, T., Youmans, C., and Neptune, D., Helena Valley: Probabilistic Risk Assessment of MEC for Montana ARNG, presented at the Annual Meetings of the UXO Forum, 2009.

Black, P.K., Perona, R., Vega, A., Stockton, T., Black, K., and Argus, R. SMARTe: Supporting Evaluation of Reuse Options and Overcoming Obstacles to Revitalization. Presentation at the MidWestern States Risk Assessment Symposium, Indianapolis, 2009.

Black, P.K., Catlett, K., Stockton, T., Youmans, C., and Neptune, D., Helena Valley UXO Decision Analysis, presented at the Annual Meetings of the National Defense Industrial Association, Environment, Energy Security and Sustainability Symposium, 2009.

Black, P.K., Catlett, K., Stockton, T., Youmans, C., and Neptune, D., Helena Valley Probabilistic Risk Assessment of MEC for Montana ARNG, presented at the Annual Meetings of the National Environmental Workshop, 2008.

Black, P.K., Catlett, K., Stockton, T., and Youmans, C., UXO Risk Mitigation using Ballistic Models in a Bayesian Decision Analysis Framework, presented at the Annual Meetings of the Society for Risk Analysis, 2008.

Black, P.K., Stockton, T.S., Tauxe, J., and Catlett, K., Constructing Defensible Input Distributions, presented at a special meeting of the DOE Low-Level Radioactive Waste Federal Review Group, September 2008.

Black, P.K., How to Construct Defensible Input Probability Distributions, presented at a special meeting of the DOE Low-Level Radioactive Waste Federal Review Group, March 2008.

Black, P.K., The Roles of Uncertainty Analysis and Sensitivity Analysis in Real World Decision Making, presented at a special meeting of the DOE Low-Level Radioactive Waste Federal Review Group, March 2008.

Copeland, T.L., Black, P.K., Duffy, P.A., DeCaprio, A.P., O'Hehir, D.J., and Kerger, B.D. Comparison of Congener-Specific and Aroclor Quantitation Methods for Assuring Remediation of Polychlorinated Biphenyls and Associated Dibenzofurans at a Former Wastewater Treatment Plant. Presented at the 47th Annual Meeting and ToxExpo, Society of Toxicology, March 16-20, Seattle, WA, 2008.

Black, P.K., SMARTe: A Decision Support System for Site Revitalization, presented at the Annual Meetings of the Society for Risk Analysis, 2007.

Black, P.K., and Fitzgerald, M., Bayesian Data Quality Objectives?, presented at the Joint Statistical Meetings, Salt Lake City, 2007.

Tauxe, J.D., P.K. Black, and Hanušík, V., A Systems Modeling Approach for Performance Assessment of the Mochovce National Radioactive Waste Repository, Slovak Republic, 2007 General Assembly of the European Geosciences Union, Vienna, Austria, Geophysical Research Abstracts, Vol. 9, 05821, 2007.

Tauxe, J.D., and P.K. Black, Radioactive Waste Disposal in Hydrologically-Challenged Environments: Opportunities for Waste Disposal Resource Optimization, 2006 Fall Meeting of the American Geophysical Union, San Francisco, California, December 11-15, 2006.

Black P., Stockton, T., and Crowe, B., A Decision Management System for DOE LLW Disposal Facilities at the Nevada Test Site, Presented at the Annual Meetings of INFORMS, 2005.

Black, P.K., and Stockton, T.S. Using Knowledge Elicitation to inform a Bayesian Belief Network model of a Stream Ecosystem, North American Benthological Society, 2005.

Stockton, T.S., P.K. Black, J.D. Tauxe, and K.M. Catlett, Environmental Modeling and Bayesian Analysis for Assessing Human Health Impacts from Radioactive Waste Disposal, 2004 Fall Meeting of the American Geophysical Union, San Francisco, California, December 13-17, 2004.

Black, P.K., Catlett, K., Hooten, M., Stockton, T., Sully, M., Tauxe, J., Desotell, L., Shott, G., Yucel, Y., Crowe B., and Carilla J., Model Evolution and Status of the Probabilistic Performance Assessment Model for the Area 5 RWMS, Nevada Test Site, presented at the GoldSim User's Conference, Seattle, Washington, 2002.

Crowe, B., Black P., Yucel, V., and Colarusso, A., Probabilistic Performance Assessment Models for Low-Level Radioactive Waste Disposal Sites at the Nevada Test Site, Presented at the Annual Meetings of the Society for Risk Analysis, December 2003.

Tauxe, J.D., P.K. Black, B.M. Crowe, and D.W. Lee, Modeling Uncertainty: Realism vs Conservatism in Radiological Performance Assessment, 2003 NGWA Midsouth Focus Conference • Subsurface Monitoring & Modeling Issues, Nashville, TN, September 18-19 2003.

Crowe, B., Black P., and Tauxe, J., GoldSim Modeling Progress and Decision Analysis for Managing Disposal of LLW Radioactive Waste, Nevada Test Site, GoldSim Users Conference, June 2003

Black, P.K., Risk Assessment: Impact of Changes in Technology, presented at the Annual Meetings of the New Mexico Water Quality Control Commission and Lawyers Conference, Santa Fe, 2003.

Tauxe, J., P. Black, J. Carilli, K. Catlett, B. Crowe, M. Hooten, S. Rawlinson, A. Schuh, T. Stockton, V. Yucel, Evaluation and Quantification of Uncertainty in the Modeling of Contaminant Transport and Exposure Assessment at a Radioactive Waste Disposal Site, Eos Trans. AGU, 83(47), Fall Meeting Supplement, Abstract NG12B-1033, 2002.

Stockton, T.B., Black, P.K. Data Mining of Environmental Models for Sensitivity Analysis. Presented at the GoldSim User's Conference, Seattle, Washington, 2002.

Black, P.K., Catlett, K., Hooten, M., Stockton, T., and Tauxe, J., A GoldSim Model of Intermediate-Depth Radioactive Waste Disposal at the Nevada Test Site. Presented at the GoldSim User's Conference, Seattle, Washington, 2002.

Crowe, B., P. Black, J. Tauxe, V. Yucel, S. Rawlinson, A. Colarusso, F. DiSanza, Regulatory Requirements and Technical Analysis for Department of Energy Regulated Performance Assessments of Shallow-Trench Disposal of Low-Level Radioactive Waste at the Nevada Test Site, 2001 Fall Meeting of the American Geophysical Union, San Francisco, CA, December 10-15, 2001

Stockton, T.B., Black, P.K. 2001. Data Mining of Environmental Models for Sensitivity Analysis. Presented at Interface 2001, Costa Mesa, California.

Hooten, M.H., Markweise, J.T., Myles, T.G., Black, P.K., Crowe, B., and Colarusso, A., Biotic Components, Processes and Characteristics Central to Biotic Transport Modeling of Soils at the Nevada Test Site, presented at the Annual Meetings of the Society of Risk Analysis, 2001.

Markweise, J., Hooten, M.H.,, Black, P.K., Crowe, B., and Colarusso, A., Modeling Biointrusion into Buried Low-Level Radioactive Waste at the Nevada Test Site, presented at the Annual Meetings of the Society of Environmental Toxicology and Chemistry, 2001.

Stockton, T.S., and Black, P.K., The Utility of Bayesian Hierarchical Modeling for Complex Environmental Problems, Interface, New Orleans, Louisiana, 2000.

Stockton, T.S., Black, P.K. 2000. Bayesian Analysis of Buried Radioactive Waste Disposal. Presented at Interface 2000, New Orleans, Louisiana.

Black, K.J., T.R. Fogg,, T McFarland. and P.K. Black, Towards Cost Effective Use of Field Screening Data, presented at Annual Meetings of the Society for Risk Analysis, 1997.

Black, P.K., Pitfalls of Site Characterization, presented at the Joint Statistical Meetings, Anaheim, 1997.

Black, P.K., K.J. Black. D.K. Carlson, J.F. Fisk, C.A. Newton, and T. R. Fogg, Towards Cost Effective Use of Field Screening Data, Presented at the Technology and Innovation in Education Conference, Santa Fe, 1996.

Pesin, R., Copeland, T., Black, P., and Carlson, D. Application of Background Data in Defining Remediation Action Objectives. Presented at the National Meeting of the Society for Risk Analysis, New Orleans. December, 1996.

Black, P.K., Lewis, J.L., and Newton, C.A., A Bayesian Decision Theoretic Approach for Sample Design to Support Risk Assessment Decisions, presented at the Annual Meeting of the Society for Risk Analysis, Hawaii, December, 1995.

Black, P.K., Neptune, M.D., Black K.J., Johnston, T.E., and Sweedy, K.L., Preliminary Report on Stage I of the Denver Housing Authority Field XRF Study, Presented at the Scitec Corporation Annual Technical Sessions, 1994

Black, P.K., Campbell, K.S., and Michael, D.I., Composite Sampling Methods, presented at a Composite Sampling Workshop sponsored by the Department of Energy, June, 1994.

Black, P.K., Methods for 'Conditioning' on Sets of Joint Probability Distributions Induced by Upper and Lower Marginals, presented at the 149th Meetings of the American Statistical Association, New Orleans, Louisiana, August, 1988.

JOHN TAUXE, PhD, PE

Employment History

Neptune and Company

1998 to date: Senior Environmental Engineer

Oak Ridge National Laboratory

1994 to 1998: Research Staff Member, Center for Energy and Environmental Analysis, Energy Division

University of Texas at Austin

1988 to 1994: Research Assistant and DOE Environmental Restoration/Waste Management Fellow, Environmental and Water Resources Engineering Division, Department of Civil Engineering

Oak Ridge Institute for Science and Education

1991: Visiting DOE Fellow to the WIPP Performance Assessment Group at Sandia National Laboratories, under the DOE ER/WM Fellowship, managed by ORISE

Ocean Drilling Program

1984 to 1988: Marine Technician and Laboratory Manager

Lamont-Doherty Earth Observatory

1981, 1982: Field Technician for LDEO at the Experimental Lakes Area, Ontario, Canada

1982 to 1983: Marine Technician with the SeaMARC I marine side-scan sonar mapping team

Commissariat a l'Énergie Atomique

1979: Stagière (Nuclear Medicine Research Assistant), Division de Biologie, Saclay, France

Experience Highlights

- Radioactive waste performance assessment
- Hydrologic and hydrogeologic modeling
- Environmental modeling with GoldSim and in geographic information systems (GIS)
- Computer programming in C and Java
- Licensed Professional Engineer in the State of New Mexico

Education, Training, and Certification

B.A., Earth Science, Wesleyan University – Earth and Environmental Sciences, Middletown, Connecticut, 1984

M.S., Civil Engineering, University of Texas at Austin – Environmental and Water Resources Engineering, Austin, Texas, 1990

Ph.D., Civil Engineering, University of Texas at Austin – Environmental and Water Resources Engineering, Austin, Texas, 1994

Trained NEPA Professional, Modules 1 and 4, 1995

Licensed Professional Engineer in the State of New Mexico, since 1999

Professional Experience

Dr. John Tauxe has been working in the earth and environmental sciences and engineering since 1981, and has developed expertise in quantitative hydrology and hydrogeology, and in computer programming, concentrating in the modeling of contaminant fate and transport in the environment. His professional experience is broad, however, including marine geology, radiolimnology, water resources assessment, hydropower systems modeling, regulatory interpretation, metrication, watersheds identification and mapping, radiological performance assessment, and training of environmental professionals.

➢ **Environmental and Performance Assessment Modeling**

Dr. Tauxe has developed a variety of environmental models for contaminant transport, risk assessment, performance assessment, feasibility studies, and many ancillary products, using programming languages, spreadsheets, process models such as MODFLOW, and the GoldSim systems analysis software package.

Sandia National Laboratories (SNL) Waste Isolation Pilot Plant (WIPP) Performance Assessment (PA) Group As a U.S. Department of Energy (DOE) Environmental Restoration and Waste Management Fellow, John aided the WIPP PA Group at SNL by providing a critical review of regional hydrogeological data obtained from wells, and by participating in workshops for defining appropriate statistical approaches for groundwater modeling at the WIPP.

DOE Office of Waste Management Federal Facility Compliance Act Disposal Workgroup As a member of this workgroup, John devised the basic hydrogeological framework and the performance evaluation spreadsheet model for evaluating and comparing the performance of fifteen DOE mixed low-level radioactive waste (MLLW) disposal sites across the DOE Complex.

Oak Ridge National Laboratory (ORNL) Solid Waste Storage Area (SWSA) 6 Performance Assessment (PA) John was lead hydrogeologist for this PA, which determined the amount of low-level radioactive waste (LLW) that could safely be disposed at the Interim Waste Management Facility at SWSA 6 in Melton Valley.

ORNL SWSA 6 Composite Analysis (CA) for the White Oak Creek Watershed John was lead hydrogeologist and principal author for this comprehensive CA, which evaluated potential future risks resulting from all disposed and expected residual radioactive materials at ORNL.

ORNL Class L-II Disposal Facility (CIIDF) PA John was lead hydrogeologist for the proposed CIIDF in Bear Creek Valley. This PA resulted in facility design changes that would improve long-term performance of the facility.

ORNL Bethel Valley RCRA Feasibility Investigation (RFI) John performed hydrogeological and radionuclide contaminant transport analyses as part of an investigation into the feasibility of various remediation techniques for Bethel Valley under the Resource Conservation and Recovery Act (RCRA).

ORNL impoundments evaluation As a member of the ORNL Impoundments Consolidation Cell Engineering Team, John helped to evaluate the feasibility of consolidating radioactive sludges to aid in closure of on-site impoundments.

Nevada Test Site (NTS) Area 3 and Area 5 Radioactive Waste Management Sites (RWMS) Models John was the technical lead for the GoldSim modeling in support of the LLW PAs for the Area 3 and Area 5 RWMSs at NTS. In addition to providing analyses critical to the PA, the models are used to evaluate candidate waste streams and inform operational decisions for the RWMSs. The Area 5 RWMS Model received technical approval without revision by the DOE LLW Federal Review Group (LFRG).

NTS Greater Confinement Disposal (GCD) Boreholes Model John was the lead programmer for the design and development of a contaminant transport model for transuranic radioactive (TRU) wastes in the GCD boreholes at NTS, using the GoldSim systems modeling platform.

Los Alamos National Laboratory (LANL) Technical Area (TA)-54 RCRA Feasibility Investigation (RFI) John was a core developer for the probabilistic environmental contaminant transport and future risk assessment model for MDAs G, H, and L at LANL in support of the TA-54 RFI, using RIP and GoldSim probabilistic contaminant transport and risk assessment modeling platforms.

Navy Environmental Restoration Sites (Alameda Annex) John designed and constructed a GoldSim model to evaluate contaminant fate and transport from the West Beach Landfill at the former Naval Air Station Alameda in San Francisco Bay.

NTS Smoky Site Options Analysis John supported the development of a probabilistic decision model that analyzed various options for remediation of the contaminated Smoky Site at NTS. This effort identified the most cost-effective solution for maintaining access to critical electrical power lines that intersected contamination resulting from the testing of nuclear weapons. The GoldSim systems analysis software and the ArcView geographic information system were used in the analysis.

Savannah River National Laboratory LLW Projects John developed the preliminary GoldSim PA model for disposal of LLW in the Engineered and Slit Trenches at the E-Area Burial Grounds at the Savannah River Site (SRS), and continues to advise modelers on GoldSim implementation and PA methodology.

Savannah River Site Tank Farm Closure Project John is working with SRS to develop GoldSim models to evaluate uncertainty in the modeling of the closure of the F-Area and H-Area Tank Farms under Section 3116 of the National Defense Authorization Act of 2005.

VÚJE, Inc. and *DBE Technology GmbH* John assisted in the design and development of a GoldSim PA model for the Mochovce National Radioactive Waste Repository in the Slovak Republic.

➢ **Software Development**

Ocean Drilling Program As a Marine Technician and manager of the shipboard paleomagnetics laboratory aboard the *D/V JOIDES Resolution*, John developed software for the control of laboratory instrumentation and for the processing of scientific data. Languages included VAX and DEC BASIC, FORTRAN, and DEC Command Language (DCL).

University of Texas at Austin, Center for Research in Water Resources John designed and developed a graphical interface for groundwater modeling using C and the Microsoft Windows v2.1 API. This program, dubbed ShowFlow, demonstrates how DOS-based groundwater contamination computer programs can be easier to run, providing forms for the entry of input data, and generating graphs of the numerical output.

EPA's Office of Research and Development (ORD) John extended the ShowFlow interface to operate the Hydrocarbon Spill Screening Model (HSSM), producing HSSM-WIN, EPA's first program based on what was then called the Microsoft Windows environment. This program has received extensive use, and has also been translated into Spanish.

Environmental Systems Research Institute (ESRI) John designed and developed a collection of groundwater contaminant transport operators for the ArcInfo geographic information system (now ArcGIS) using a combination of C and FORTRAN. These operators, called DarcyFlow, ParticleTrack, and PorousPuff, were originally built into the Grid raster GIS module of ArcInfo version 7.0, and are now part of the Spatial Analyst module of ArcGIS.

EPA's National Exposure Research Laboratory (NERL) John designed and developed a collection of Java classes for the manipulation and statistical analysis of oceanographic and meteorological data from environmental buoys and stations maintained by the National Oceanic and Atmospheric Administration (NOAA). This work supported an EPA project to evaluate remediation options for marine oil spills.

U.S. Nuclear Regulatory Commission (NRC) In support of the development of an Integrated Groundwater Monitoring Strategy for the NRC, John wrote a Generic Performance Assessment Model using the GoldSim systems analysis software. This Model is intended as a public domain demonstration piece, and has been used by NRC and others as a template for developing PA models in GoldSim.

EPA's Office of Environmental Information Conceptual design of a web-based Quality Management Plan system for the EPA's Office of Environmental Information.

➢ **Environmental and Water Resources Engineering**

Edwards Underground Water District (EUWD) and the LBJ School of Public Affairs at the University of Texas at Austin John served as a hydrogeologist on the Technical Advisory Panel for Water Resources Development and Management of the Edwards Aquifer Region, in association with the EUWD.

ORNL Center for Energy and Environmental Analysis John lead the effort to digitize and classify over 900 watersheds of various orders on over 20,000 hectares (50,000 acres) surrounding the Oak Ridge Reservation. These are available for research and study in a geographic information system format.

Los Angeles County Department of Public Works (LACDPW) John was part of a team of researchers at ORNL who developed an environmental data management system for the LACDPW in an effort to effectively manage stormwater effluents as mandated by LA County's Municipal Stormwater Permit, a National Pollutant Discharge and Elimination System (NPDES) permit.

Federal Energy Regulatory Commission (FERC) and ORNL Environmental Sciences Division (ESD) John was lead water resources engineer for an Environmental Impact Statement to evaluate reservoir release requirements for fish at the New Don Pedro Project in California. His role was to evaluate claims by the Modesto and Turlock Irrigation District that irrigation demands could not be met by groundwater sources alone.

FERC and ORNL ESD, in cooperation with the Center for Advanced Decision Support for Water and Environmental Systems (CADSWES) John served as water resources engineer evaluating the efficacy of modified reservoir operations for five dams of the Missouri-Madison Project in Great Falls, Montana. Using the PRSYM software (now RiverWare), John validated reservoir operations that would allow for greater flexibility in managing flows for downstream fish populations while continuing to provide sufficient hydroelectric power. This model was updated in 2007 to the GoldSim modeling platform.

➢ **Policy Development**

LANL, Material Disposal Areas Guidance John served on a team of professionals to write a guidance document for decision making regarding the disposition of the MDAs at LANL.

DOE Order 435.1 Review John participated in the review cycle for development of the DOE Order 435.1 Radioactive Waste Management.

NRC's Office of Nuclear Regulatory Research John consulted as the PA expert in the development of an Integrated Groundwater Monitoring Strategy.

➢ **Critical Review**

LANL MDA G Performance Assessment (PA) John performed a critical review of the 1997 PA for LANL's MDA G, the Laboratory's only operating LLW disposal site. He later reviewed an updated PA model for the site in 2006, providing suggestions for improvements in the model before its presentation to DOE's LFRG.

LANL MDA AB John participated in critical review of interim remediation activities at LANL's MDA AB, Technical Area 49, the site of legacy radioactive contamination from past underground nuclear safety tests.

Vadose Zone Journal John is a requested peer reviewer for papers submitted to the *Vadose Zone Journal*.

U.S. Civilian Research & Development Foundation (CRDF) John has been requested to review several projects regarding environmental and water resources engineering and GIS for the CRDF, a nonprofit organization that promotes international and scientific collaboration.

EPA's Technical Integration Office (TIO) John conducted a critical review of dense non-aqueous phase liquids (DNAPL) site characterization technologies for the EPA's TIO.

- **Quality Assurance System Design**

EPA's Office of Environmental Information John has consulted to the OEI to design and develop electronic systems for managing EPA Policies, Orders, Procedures, Quality Management Plans, and similar quality assurance documents. These web-accessible quality management systems will promote effective implementation, use, and maintenance of quality documents for the Agency.

EPA NERL John developed a Software Quality Assurance Plan for the development of new software for analyzing environmental buoy data (see Software Development above).

EPA Toxics Release Inventory (TRI) John contributed to the development of a Quality Management Plan for the TRI Petition Review Process.

- **Laboratory Analysis and Technical Assistance**

Ocean Drilling Program (ODP) Shipboard Paleomagnetics Laboratory John served as a laboratory manager and principal technician for the geomagnetics laboratory on board the *D/V JOIDES Resolution* for ODP, serving on eleven expeditions to the Atlantic, Arctic, Indian, Pacific, and Southern Oceans.

Lamont-Doherty Earth Observatory (LDEO) radiolimnology laboratory at the Experimental Lakes Area (ELA), Canada John operated LDEO's radiolimnology laboratory at the ELA, constructing and installing scientific research field equipment, obtaining and processing samples, and performing general laboratory maintenance. Studies compared the mobility and behavior of stable and radioactive isotopes of metal cations in response to changes in pH in lakes, and evaluated rainwater samples for the occurrence of atmospheric radionuclides.

LDEO SeaMARC I Team John participated in six sea-floor mapping expeditions on the Atlantic and Pacific Oceans using the SeaMARC I side scan sonar and deep ocean photographic equipment to study geomorphology and structure of mid-ocean ridges and continental slopes.

Commissariat a l'Énergie Atomique, Division de Biologie John performed laboratory animal vivisection and radiological tissue analysis in support of nuclear medicine studies of the fate of radiolabelled phosphorous compounds in the body. Work was performed at the Service Hospitalier Frédéric Joliot in Orsay, France.

- **Training and Instruction**

University of Texas at Austin, Continuing Engineering Studies, College of Engineering John helped develop materials for short courses in groundwater contamination from petroleum hydrocarbons.

NRC Office of Nuclear Regulatory Research John developed modules for workshops on the Integrated Groundwater Monitoring Strategy.

John is currently developing an advanced course in environmental modeling using GoldSim.

Software Programming Products

Tauxe, J.D., *ShowFlow: A Practical Interface for Groundwater Modeling*, Thesis for Master of Science in Civil Engineering, The University of Texas at Austin, Austin, Texas, December 1990 (http://showflow.tauxe.net)

Tauxe, J.D., *HSSM-WIN: A Windows Interface for the Hydrocarbon Spill Screening Model*, A computer program designed and written for the United States Environmental Protection Agency, 1992 (http://www.epa.gov/ada/csmos/models/hssmwin.html)

Tauxe, J.D., *New Operators for Groundwater Advection-Dispersion Calculations in GRID (now Spatial Analyst ArcGIS): DarcyFlow, ParticleTrack, PorousPuff, and PorousPlume* , contract programming performed for Environmental Systems Research Institute (ESRI), Redlands, CA, 1994 (http://www.esri.com/software/arcgis/extensions/spatialanalyst/index.html)

Tauxe, J.D., *Porous Medium Advection-Dispersion Modeling in a Geographic Information System*, Doctoral Dissertation in Civil Engineering, Center for Research in Water Resources Technical Report No. 253, Bureau of Engineering Research, The University of Texas at Austin, Austin, Texas, May 1994 (http://www.neptuneandco.com/~jtauxe/abs_phd.html)

Tauxe, J.D., K.M. Catlett, M. Hooten, *A Model of Contaminant Transport from Greater Confinement Disposal Boreholes 1-4 at the Area 5 RWMS of the Nevada Test Site Using GoldSim*, Neptune and Company, Inc., Los Alamos, NM, November, 2001 (http://www.neptuneandco.com/goldsim/gcd)

Tauxe, J.D., *TestBuoyData* and *BuoyDataViewer*, a collection of Java classes for the manipulation of NOAA oceanographic environmental buoy data, designed and written for the U.S. EPA, Neptune and Company, Inc., Los Alamos, NM, December, 2001

Tauxe, J.D., *SunCalc*, a Java application for calculating times of sunrise and sunset, designed and written for the U.S. EPA, Neptune and Company, Inc., Los Alamos, NM, December, 2001 (http://www.neptuneandco.com/~jtauxe/SunCalc/SunCalc.html)

Tauxe, J.D., K. Catlett, M. Hooten, R. Perona, T. Stockton, and M. Sully, *A Radiological Performance Model of the Area 5 Radioactive Waste Management Site, version 4.0*, Neptune and Company, Inc., Los Alamos, NM, September, 2006

Tauxe, J.D., K. Catlett, M. Hooten, R. Perona, T. Stockton, and M. Sully, *A Radiological Performance Model of the Area 3 Radioactive Waste Management Site, version 2.0*, Neptune and Company, Inc., Los Alamos, NM, September, 2006

Publications

U.S. Department of Energy (DOE), *Environmental Assessment: Lease of Parcel ED-1 of the Oak Ridge Reservation by the East Tennessee Economic Council*, DOE/EA-1113, U.S. Department of Energy, Oak Ridge Operations, Oak Ridge, TN, 1996

DOE, *Performance Evaluation of the Technical Capabilities of DOE Sites for Disposal of Mixed Low-Level Waste, Volume 2: Technical Basis and Discussion of Results*, DOE/ID-10521/2, and Volume 3: Site Evaluations, DOE/ID-10521/3, Sandia National Laboratories, Albuquerque, NM, March 1996

Federal Energy Regulatory Commission, *Final Environmental Impact Statement, Reservoir Release Requirements for Fish at the New Don Pedro Project, California, FERC Project No. 2299-024*, FERC-EIS-0081F, Federal Energy Regulatory Commission, Washington, DC, July 1996

Oak Ridge National Laboratory (ORNL), *User Requirements Report for an Environmental Data Management System in Support of the Los Angeles County NPDES Municipal Storm Water Permit*, Oak Ridge, TN, February 1997

ORNL, *Conceptual Solution Report for an Environmental Data Management System to Support the Los Angeles County NPDES Municipal Storm Water Permit*, Oak Ridge, TN, February 1997

ORNL, *Performance Assessment for the Class L-II Disposal Facility*, ORNL/TM-13401, Oak Ridge, TN, March 1997

ORNL, *Composite Analysis for Solid Waste Storage Area 6*, ORNL/6929, Oak Ridge, TN, September 1997

ORNL, *Performance Assessment for Continuing and Future Operations at Solid Waste Storage Area 6*, ORNL/6783/R1, Oak Ridge, TN, September 1997

Tauxe, J.D., *Watersheds of the Oak Ridge Reservation in a Geographic Information System*, ORNL/TM-13618, Oak Ridge, TN, May 1998 (http://www.neptuneandco.com/~jtauxe/orrwater)

DOE, *Final Environmental Assessment: Lease of Land and Facilities Within the East Tennessee Technology Park, Oak Ridge, Tennessee*, DOE/EA-1175, U.S. Department of Energy, Oak Ridge Operations, Oak Ridge, TN, November 1997

ORNL, *Draft Remedial Investigation of the Bethel Valley Watershed, Oak Ridge National Laboratory, Oak Ridge, Tennessee*, ORNL, Oak Ridge, TN, March 1998

Los Alamos National Laboratory (LANL), *DRAFT RFI Report for Material Disposal Areas G, H, and L at Technical Area 54*, LA-UR-99-4635, LANL Environmental Restoration Project, Los Alamos, NM, September 1999

IR Site 2 Remedial Investigation Report Alameda Point (Draft), for Southwest Division Naval Facilities Engineering Command, Neptune and Company, Inc., Los Alamos, NM, December 2000

Nevada Test Site Smoky Site Decision Analysis, Neptune and Company, Inc., Los Alamos, NM, January 2001

Tauxe, J.D., *User's Guides for TestBuoyData and BuoyDataViewer*, Neptune and Company, Inc., Los Alamos, NM, December, 2001

Tauxe, J.D. and J.M. Green, *Documentation of Java Classes for the Manipulation of Oceanographic Data*, Neptune and Company, Inc., Los Alamos, NM, December, 2001

Mercier, T.M. and J.D. Tauxe, *Quality Assurance Report for Java Classes Developed for the Manipulation of Oceanographic Data*, Neptune and Company, Inc., Los Alamos, NM, December, 2001

DOE, 2006, *Addendum 2 to the Performance Assessment for the Area 5 Radioactive Waste Management Site at the Nevada Test Site, Nye County, Nevada*, DOE/NV/11718–176-ADD2, June 2006

DOE, 2007, *E-Area Low-Level Waste Facility DOE 435.1 Performance Assessment*, WSRC-STI-2007-00306, Washington Savannah River Company, Aiken, SC

U.S. Nuclear Regulatory Commission (NRC), 2007, *Integrated Ground Water Monitoring Strategy for NRC-Licensed Facilities and Sites*, NUREG/CR-6948, NRC, Washington, DC, November 2007

Presentations

Weaver, J.W. and J.D. Tauxe, *Hydrocarbon Spill Simulation Modeling: Use of a Graphical Interface*, U.S. EPA 4th Annual Nationwide Conference on Underground Storage Tanks, Ft. Lauderdale, Florida, November 5-8, 1991

Tauxe, J.D., D.R. Maidment, and R.J. Charbeneau, *Contaminant Transport Modeling Using New GRID Operators*, Proceedings of the Twelfth Annual ESRI User's Conference, Palm Springs, California, June 8-12, 1992

Charbeneau, R.J., J.W. Weaver, J.D. Tauxe, B.K. Lien, *A Screening Model for Subsurface Hydrocarbon Spills*, American Society of Agronomy 84th Annual Meeting, Agronomy Abstracts, p. 79, Minneapolis, Minnesota, November 1-6, 1992

Tauxe, J.D., *Porous Medium Advection-Dispersion Modeling in a Geographic Information System*, 1993 Spring Meeting of the American Geophysical Union, Baltimore, Maryland, May 24-28, 1993

Tauxe, J.D., *Porous Medium Advection-Dispersion Modeling in a Geographic Information System*, Second International Conference/Workshop on Integrating Geographic Information Systems and Environmental Modeling, Breckenridge, Colorado, September 26-30, 1993

Wang, J.C., Tauxe, J.D., and D.W. Lee, *Estimation of Contaminant Transport in Groundwater Beneath Radioactive Waste Disposal Facilities*, Eleventh Proceedings of Nuclear Thermal Hydraulics, pp. 120–128, 1995 American Nuclear Society Winter Meeting, San Francisco, California, October 29 – November 2, 1995

Tauxe, J.D., D.W. Lee, J.C. Wang, and G.P. Zimmerman, *A Comparative Subsurface Transport Analysis for Radioactive Waste Disposal at Various DOE Sites*, 1995 Fall Meeting of the American Geophysical Union, San Francisco, California, December 11-15, 1995

Tauxe, J.D., *A Probabilistic Physical Systems Model of Multipathway Contaminant Transport for Assessment of Future Risk*, 1999 Fall Meeting of the American Geophysical Union, San Francisco, CA, December 13-17, 1999 (http://www.neptuneandco.com/~jtauxe/agu99/)

Tauxe, J.D., *A Probabilistic Exposure Assessment of Radioactive Waste Disposal: Coupling Vadose Zone Contaminant Fate and Transport With Risk Assessment*, 2000 Fall Meeting of the American Geophysical Union, San Francisco, CA, December 15-19, 2000 (http://www.neptuneandco.com/~jtauxe/agu00/)

Crowe, B., P. Black, J. Tauxe, V. Yucel, S. Rawlinson, A. Colarusso, F. DiSanza, *Regulatory Requirements and Technical Analysis for Department of Energy Regulated Performance Assessments of Shallow-Trench Disposal of Low-Level Radioactive Waste at the Nevada Test Site*, 2001 Fall Meeting of the American Geophysical Union, San Francisco, CA, December 10-15, 2001

Tauxe, J., P. Black, J. Carilli, K. Catlett, B. Crowe, M. Hooten, S. Rawlinson, A. Schuh, T. Stockton, V. Yucel, *Evaluation and Quantification of Uncertainty in the Modeling of Contaminant Transport and Exposure Assessment at a Radioactive Waste Disposal Site*, Eos Trans. AGU, 83(47), Fall Meeting Supplement, Abstract NG12B-1033, 2002 (http://www.neptuneandco.com/~jtauxe/agu02/)

Tauxe, J.D., P.K. Black, B.M. Crowe, and D.W. Lee, *Modeling Uncertainty: Realism vs Conservatism in Radiological Performance Assessment*, 2003 NGWA Midsouth Focus Conference • Subsurface Monitoring & Modeling Issues, Nashville, TN, September 18-19 2003 (http://www.neptuneandco.com/~jtauxe/ngwa03/)

Tauxe, J.D., *Development of a Probabilistic Performance Assessment Model to Support Environmental Decision Making*, 2004 Meeting of the Geological Society of America, Denver, Colorado, November 7-10, 2004 (http://www.neptuneandco.com/~jtauxe/gsa04/)

Tauxe, J.D., *Probabilistic Radiological Performance Assessment Modeling and Uncertainty*, 2004 Fall Meeting of the American Geophysical Union, San Francisco, California, December 13-17, 2004 (http://www.neptuneandco.com/~jtauxe/agu04/)

Stockton, T.S., P.K. Black, J.D. Tauxe, and K.M. Catlett, *Environmental Modeling and Bayesian Analysis for Assessing Human Health Impacts from Radioactive Waste Disposal*, 2004 Fall Meeting of the American Geophysical Union, San Francisco, California, December 13-17, 2004 (http://www.neptuneandco.com/~jtauxe/agu04/)

Tauxe, J.D., and P.K. Black, *Radioactive Waste Disposal in Hydrologically-Challenged Environments: Opportunities for Waste Disposal Resource Optimization*, 2006 Fall Meeting of the American Geophysical Union, San Francisco, California, December 11-15, 2006 (http://www.neptuneandco.com/~jtauxe/agu06/)

Tauxe, J.D., P.K. Black, and Hanušík, V., *A Systems Modeling Approach for Performance Assessment of the Mochovce National Radioactive Waste Repository, Slovak Republic*, 2007 General Assembly of the European Geosciences Union, Vienna, Austria, Geophysical Research Abstracts, Vol. 9, 05821, 2007 (http://www.neptuneandco.com/~jtauxe/egu07/)

Tauxe, J.D., *Modeling Hydropower Dam Operations With Environmental Constraint*, 2007 GoldSim User Conference, San Francisco, California, October 2007

Professional Activities/Honors

Member of American Society of Civil Engineers

Member of American Geophysical Union

Elected to Phi Kappa Phi Honor Society

Peer reviewer for the *Vadose Zone Journal*

Enchemica LLC
2335 Buckingham Circle
Loveland, Colorado 80538
(970) 203-0179

ENCHEMICA'S TECHNICAL REVIEW AND COMMENTS ON THE RADIATION CONTROL BOARD OF UTAH'S PROPOSED RULE GOVERNING THE DISPOSAL OF DEPLETED URANIUM

QUALIFICATIONS

Dr. Janet Schramke, PhD

Dr. Schramke has over 26 years of professional experience in the fields of geochemistry and environmental chemistry. She received a BS in Geology and Mineralogy from the University of Michigan and a PhD in Geochemistry and Mineralogy from The Pennsylvania State University. She was employed for approximately 11 years as a Research Scientist and Senior Research Scientist at the U.S. Department of Energy's (DOE's) Pacific Northwest National Laboratory. She has been employed as a Senior Geochemist/Principal Geochemist as a private sector consultant since 1995. Dr. Schramke has authored more than 35 publications, including peer-reviewed journal articles, conference proceedings, and publicly available technical reports. Dr. Schramke is a licensed Professional Geologist in the State of Wyoming.

Dr. Schramke has considerable experience evaluating issues related to radioactive waste disposal, including low-level, high-level and transuranic waste. Her experience includes providing technical assistance on geochemistry-related issues to the U.S. Environmental Protection Agency's Office of Radiation and Indoor Air (EPA ORIA). Dr. Schramke has performed numerous Waste Isolation Pilot Plant (WIPP) technical reviews and evaluations for EPA ORIA. Other issues addressed for EPA ORIA have included the potential inclusion of radioactive materials in recycled products and the groundwater mobility of radionuclides at RCRA disposal sites. Dr. Schramke has also provided technical support on WIPP geochemistry issues for the New Mexico Environment Department. Dr. Schramke served as part of the Yucca Mountain Project License Application Review Team for Sandia National Laboratory, providing senior-level reviews of portions of the Safety and Analysis Report submitted to the U.S. Nuclear Regulatory Commission.

Dr. Schramke has considerable work experience related to the mobility of uranium and other radionuclides in groundwater. Examples of this experience include: evaluation of waste form and co-disposed waste constituents on radionuclide release and mobility in groundwater, the effects of high-ionic strength groundwater on radionuclide and metals attenuation, and the effects of groundwater chemistry and microbial activity on uranium remediation at in situ uranium mine sites.

1.0 Introduction

Energy*Solutions* has carried out a site-specific analysis applicable to the disposal of large quantities of depleted uranium (DU) at their facility in Clive, Utah (Whetstone 2009), attached as Exhibit 1. This groundwater transport evaluation was carried out in a manner consistent with previously approved site-specific assessments (Whetstone 2000, 2007); except for the modeling of additional uranium decay chains and extension of the time period to more than 10,000 years after cell closure (Whetstone 2009). Potential environmental effects of DU disposal were addressed by modeling the groundwater transport of radionuclides from the disposal cell to a compliance well at the site. The site-specific analyses included many conservative assumptions that resulted in the overestimation of leaching and transport of DU constituents from the disposal cell to a compliance well. This report reviews the characteristics of DU and summarizes the conservative assumptions and results of the site-specific modeling calculations of groundwater transport that demonstrate large-quantity DU disposal can be safely carried out at the Clive facility.

2.0 Radiological and Chemical Properties of Depleted Uranium

Uranium can exist in natural, enriched, or depleted form. Natural uranium is ubiquitous in the environment and consists of a mixture of isotopes (Table 1). Natural uranium, like most naturally occurring elements, can be present in soils at a range of concentrations. Typical soil uranium concentrations are a few parts per million (ATSDR 1999). Low-grade uranium ore deposits generally have uranium concentrations from about 0.03 to 0.25% (Finch 2003). Uranium also occurs in higher-graded deposits, such as the McArthur River and Cigar Lake deposits in Canada, which have average grades of 17% and 21% U_3O_8, respectively (Cameco 2009).

Enriched uranium is produced by separation of uranium isotopes to enhance the concentrations of uranium-234 and uranium-235. Depleted uranium is a byproduct of the enrichment process and contains lower proportions of uranium-234 and uranium-235 and a slightly higher percentage of uranium-238 than natural uranium (Table 1). Because the concentrations of higher-activity isotopes have been reduced, the specific activity of DU is only about 60% of the specific activity of natural uranium (Table 2). Consequently, the radiological hazard of DU at the time of disposal is less than that of natural uranium. The radiological hazards of both natural uranium and DU are considered to be low because of their low specific activities (ATSDR 1999).

Table 1. Isotopic Compositions of Natural and Depleted Uranium and Isotopic Half-Lives of Uranium Isotopes (WHO 2001, Meinrath et al. 2003, ANL 2005)

Isotope	Natural Uranium (%)	DU (%)	Half-life (years)
Uranium-232	0	0	72
Uranium-233	0	0	160,000
Uranium-234	0.0054	Approximately 0.001	245,500
Uranium-235	0.72	0.2 to 0.3	704,000,000
Uranium-236	0	0	23,000,000
Uranium-238	99.27	99.7 to 99.8	4,470,000,000

Table 2. Specific Activities of Uranium Isotopes, Natural Uranium, Depleted Uranium and Source Term Used in the Site-Specific Analysis (WHO 2001, ANL 2005, Whetstone 2009)

Isotope/Material	Specific Activity (Bq/mg)	Specific Activity (pCi/g)
Uranium-232	792,000,000	2.2×10^{13}
Uranium-233	363,000	9,800,000,000
Uranium-234	231,000	6,237,000,000
Uranium-235	80	2,160,000
Uranium-236	2,390	65,000,000
Uranium-238	12.4	335,000
Natural Uranium (metal)	25.4	686,000
Natural Uranium (U_3O_8)	21.5	582,000
DU (metal, freshly prepared)	14.8	400,000
DU (U_3O_8, freshly prepared)	12.6	339,000
DU (UO_2, freshly prepared)	13.0	352,000
Total Uranium Source Term	792,000,000	2.2×10^{13}

The radioactivity of natural uranium at secular equilibrium (i.e., all progeny are in equilibrium) will remain constant for an extremely long time, although the uranium will eventually decay to stable lead isotopes. DU will become slightly more radioactive with time because of the production of radioactive progeny by decay. During the first year after DU separation, the activities of immediate progeny (thorium-234, protactinium-234m and thorium-231) reach equilibrium. Following this initial in-growth, the activity of DU remains approximately constant for over 1,000 years until in-growth of protactinium-231 becomes significant (WHO 2001). Peak activity of DU would be expected about 1,000,000 years after separation (NRC 2008) but would not exceed the activity of natural uranium.

Because the chemical hazard of uranium does not depend on its isotopic composition, DU has the same chemical toxicity as natural uranium (WHO 2001). The environmental behavior of DU and natural uranium, including solid phase solubility and adsorption, are also the same.

Because the progeny produced by radioactive decay are different elements, their environmental mobilities are not the same as uranium and were addressed by the site-specific transport modeling.

3.0 Site-Specific Analyses of Depleted Uranium Disposal at the Clive Facility

The site-specific groundwater transport assessments for the Clive facility (Whetstone 2000, 2007, 2009) included a number of conservative assumptions, resulting in overestimations of the transport of uranium isotopes and their progeny. Key elements of these assessments that incorporated conservative assumptions include: 1) source term concentrations and constituent release, 2) disposal cell design and infiltration modeling, 3) vertical and horizontal transport modeling, and 4) the site standards/groundwater protection levels ("GWPLs") used in the evaluations.

3.1 Source Term and Constituent Release

The source term concentrations of uranium isotopes in the groundwater transport assessments carried out for the Energy*Solutions* Clive facility included a number of conservative assumptions (Whetstone 2000, 2007, 2009). The activities of uranium-232, uranium-234, uranium-236 and uranium-238 were assumed equal to the specific activities of each isotope. This assumption is equivalent to assuming that the concentration of each isotope is equal to the concentration present when the entire source term is composed solely of that isotope as metallic uranium. Because the waste form cannot be completely composed of all four of these isotopes at the same time, use of these activities in the site-specific assessments is extremely conservative. The assumed activities are also conservative because disposed DU will be a uranium oxide (U_3O_8 or UO_2) rather than metallic uranium, which would result in even lower uranium activity (Table 2).

Uranium-233 and uranium that is enriched in uranium-235 are special nuclear materials (SNM). Energy*Solutions* was granted an exemption allowing their possession of waste containing SNM (NRC 1999); this exemption states that concentrations in individual waste containers at the Energy*Solutions* site must not exceed 75,000 pCi/g for uranium-233 or 1,900 pCi/g for uranium-235. Accordingly, the groundwater transport assessments used source-term concentrations of uranium-233 and uranium-235 equal to these maximum SNM concentrations.

Uranium-232, uranium-233 and uranium-236 are not naturally occurring isotopes and are not present in DU, so the source-term activities of these isotopes used in the groundwater transport assessments are extremely conservative. The total activities of the combined uranium isotopes used in the site-specific groundwater transport assessment exceed the expected total activities in DU by many orders of magnitude (Table 2).

Sixteen isotopes were modeled in the site-specific assessment based on six decay chains for uranium (Whetstone 2009). The isotopes modeled included six uranium isotopes (Table 1), nine isotopes important in the decay chains (americium-234, curium-244, plutonium-238, plutonium-239, plutonium-240, plutonium-242, radium-226, thorium -230 and thorium-232) and potassium-40 to provide a comparison to previous modeling results. The source term concentrations for thorium-230 and potassium-40 were set equal to their specific activities, which far exceeds their likely concentrations as the DU or any other waste accepted at the site will never consist solely of these materials. The source term concentrations for the remaining decay-chain isotopes were set equal to the maximum concentrations allowed for Class A waste (40 CFR 61.55, Table 1). Because waste typically has radionuclide concentrations well below the Class A limits, the assumed concentrations are conservatively overestimated.

The waste container life was conservatively assumed equal to zero in the site-specific groundwater transport analyses. It was also assumed that release rates from the waste form remained constant until the source concentration was totally mobilized. This is a conservative assumption because release rates would be expected to decline as the source concentrations decreased. The release rates were calculated from sorption coefficients (K_ds) for the radionuclides that were conservatively selected to be the lowest values available in the literature, except for radionuclides with site-specific values (Whetstone 2000). Thus, the source term and constituent release calculations used either site-specific information or conservative, bounding values where site-specific information was not available to provide conservatively high estimates of constituent release rates.

3.2 Cell Design and Infiltration Modeling

The engineered cover on the Class A disposal cells at the Energy*Solutions* Clive facility is a multi-layer system. From bottom to top, the components of the cover include a two-component compacted clay radon barrier (2 ft), lower granular filter zone (0.5 ft), sacrificial soil layer (1 ft), upper granular filter zone (0.5 ft), and erosion (rock rip rap) barrier layer (1.5 ft). The minimum thickness of the engineered cover is 1.7 meters (5.5 ft). The site-specific evaluations of groundwater transport (Whetstone 2000, 2007, 2009) included the effects of the cover on infiltration. The Class A disposal cells are lined with a 2-foot-thick layer of compacted clayey native soil, which was also included in the site-specific analyses (Whetstone 2000, 2007, 2009).

The calculations performed for the Clive facility used infiltration rates modeled from site-specific weather data, including evapotranspiration, temperature, precipitation and solar radiation data, as well as landfill soil and design data (Whetstone 2000, 2007, 2009). The site-specific modeling was based on a very conservative approach that ultimately overestimated the amount of infiltration that would enter the disposal cells. Energy*Solutions*' Clive facility is located in an area with evaporation rates several times higher than precipitation rates. Based on the site characteristics, it is highly unlikely that incident precipitation will infiltrate through the cover and enter the disposal cell.

3.3 Vertical and Horizontal Groundwater Transport Calculations

The vertical and horizontal groundwater transport calculations used the conservative calculated site-specific infiltration data, and site-specific or conservative K_d, hydraulic conductivity, hydraulic gradient, and effective porosity data (Whetstone 2000, 2000, 2009). These calculations incorporated the effects of the many Clive facility features that limit release of uranium isotopes and other radionuclides to the groundwater and transport to the compliance well, including extremely low infiltration and groundwater flow rates and the presence of soil constituents that will remove uranium and other radionuclides from leachate and groundwater by sorption.

The site-specific groundwater transport calculations were carried out for time periods of up to 12,000 years (Whetstone 2009). Results from these transport calculations were used to evaluate concentrations at the groundwater table underneath the disposal cell and at the compliance well. Results of the transport modeling calculations showed that none of these modeled radionuclides would exceed the GWPLs at the compliance well within the 10,000-year period of performance, even though many extremely conservative assumptions were used in the evaluations (Whetstone 2000, 2007, 2009).

3.4 Performance Standards

The performance standards for protection of the general public from releases of radioactivity to the general environment (groundwater, surface water, air, soil, plants or animal) or to an inadvertent intruder are specified in 10 CFR 61.41 and 10 CFR 61.42. The concentrations released must not result in an annual dose to any member of the general public greater than 25 mrem to the whole body, 75 mrem to the thyroid, and 25 mrem to any other organ. The GWPLs used in the Energy*Solutions* site-specific modeling calculations (Whetstone 2000, 2007, 2009) are included in the site groundwater quality discharge permit (No. UGW450005). These GWPLs are based on a dose limit of 4 mrem from consumption of site groundwater, which is much less than the regulatory standards.

The GWPLs used in the groundwater transport assessments are based on the assumption that site groundwater can be used as drinking water. Although drinking water standards were used in the assessment of radionuclide transport from the disposal cell, the site groundwater is not a realistic source of drinking water because of its high salinity and the low yield of the aquifer. Indeed, groundwater concentrations at some site wells exceed the GWPLs by an order of magnitude due to the naturally occurring background levels of a variety of naturally occurring constituents.

4.0 Lack of Public or Inadvertent Intruder Receptors at the Clive Facility Site

Federal regulations for near-surface land disposal of low-level waste are provided in 10 CFR 61. In the original risk analysis carried out to support development of 10 CFR 61, two types of receptors were defined: a public receptor who engages in residential, agricultural, or other activities at the boundary of the disposal site, and an inadvertent intruder who engages in these activities on the disposal site (NRC 2008). It was assumed that these residential, agricultural or other activities were consistent with current regional practices (NRC 2008). Because of low rainfall, high groundwater salinity, low aquifer yield and salinity of the site soils, many of the potential pathways used in the 10 CFR 61 risk assessment do not exist at the Energy*Solutions* Clive facility site. For example, site groundwater cannot be used for drinking water or crop irrigation. These site conditions have precluded human habitation in the past and make future human habitation and associated exposure pathways extremely unlikely.

In addition to the natural characteristics that preclude a public receptor or inadvertent intruder at the Clive facility site, the engineered disposal cell cover would limit the potential radon dose to any transient receptor. The uppermost portion of this cover is composed of rip rap that limits erosion and serves as an intrusion barrier.

5.0 Summary and Conclusions

Site-specific groundwater transport modeling for waste disposal at the Energy*Solutions* Clive facility has demonstrated that uranium can be safely placed in the disposal cells, even when the waste is assumed to contain uranium isotopic concentrations that greatly exceed plausible concentrations, along with significant concentrations of uranium progeny (Whetstone 2000, 2007, 2009). The chemical risks associated with DU are the same as natural uranium and the radiological risks of DU are likely to be much smaller than those assessed by the groundwater transport calculations. These site-specific calculations included a number of conservative assumptions that resulted in the overestimation of radionuclide transport through the groundwater to the compliance well location.

The results of these site-specific performance assessments demonstrate that large quantities of DU can be safely placed in the Clive facility, because significant radionuclide transport through the groundwater will not occur. The low rainfall, lack of potable water and saline soils make the site unsuitable for present-day or future habitation. The radon barrier and the intrusion protection function of the engineered cover would provide protection to receptors exposed through a non-resident exposure scenario.

6.0 References

ANL (Argonne National Laboratory). 2005. *Uranium Human Health Fact Sheet.* August 2005. Accessed January 15, 2010 at http://www.ead.anl.gov/pub/doc/Uranium.pdf

ATSDR (Agency for Toxic Substances and Disease Registry). 1999. *Toxicological Profile for Uranium.* U.S. Department of Health and Human Services, Public Health Service, September. Accessed April 17, 2009 at http://www.atsdr.cdc.gov/toxprofiles/tp150.pdf

Cameco. 2009. *Mining Overview.* Accessed April 17, 2009 at http://www.cameco.com/mining/

Finch, W.I. 2003. *Uranium- Fuel for Nuclear Energy 2002.* U.S. Geological Survey Bulletin 2179–A, 18 p. Accessed April 17, 2009 at http://pubs.usgs.gov/bul/b2179-a/B2179-A-508.pdf

Meinrath, A., P. Schneider, and G. Meinrath. 2003. Uranium Ores and Depleted Uranium in the Environment, with a Reference to Uranium in the Biosphere from the Erzgebirge/Sachsen, Germany. *Journal of Environmental Radioactivity* 64:175-193.

NRC (U.S. Nuclear Regulatory Commission). 1999. Order to exempt Envirocare of Utah, Inc. from certain NRC licensing requirements for special nuclear material. May 21, 1999, *Federal Register* 64(98):27826-27828.

NRC (U.S. Nuclear Regulatory Commission). 2008. *Response to Commission Order CLI-05-20 Regarding Depleted Uranium.* SECY-08-0147. October 7, 2008.

Whetstone Associates. 2000. *Revised Western LARW Cell Infiltration and Transport Modeling.* Prepared for Envirocare of Utah, Salt Lake City, Utah, July 19, 2000.

Whetstone Associates. 2007. *EnergySolutions Class A South Cell Infiltration and Transport Modeling.* Prepared for Energy*Solutions* LLC, Salt Lake City, Utah, December 7, 2007.

Whetstone Associates. 2009. *Uranium Fate and Transport Modeling, 10,000 Years, for EnergySolutions Class A Cells.* Memorandum from Susan Wyman, Whetstone Associates, to Dan Shrum, Energy*Solutions*, October 30, 2009.

WHO (World Health Organization). 2001. *Depleted Uranium Sources, Exposure, and Health Effects.* WHO/SDE/PHE/01.1, Department of Protection of the Human Environment, Geneva, April 2001.

Whetstone Associates

Technical Memorandum

To:	Dan Shrum, EnergySolutions	**4101M**
From:	Susan Wyman, P.E., P.G.	
Date:	**October 30, 2009**	
Subject:	Uranium Fate & Transport Modeling, 10,000 years, for EnergySolutions Class A Cells	

Whetstone Associates performed fate and transport modeling of uranium and daughter products for the Energy*Solutions* Class A cell, Class A North, and Class A South disposal cells for a period of over 10,000 years after cell closure. The modeling was performed using the PATHRAE-RAD model (Merrell, et al, 1995). The methodology and input parameters were identical to the previously approved Class A cell modeling (Whetstone, 2000) except that six uranium decay chains were modeled and the model output time was extended to 12,000 years (2,000 years beyond the time period of interest).

Model Input Parameters

The PATHRAE model was run using the input parameters described in the Class A Cell modeling report (Whetstone, 2000), including infiltration rate, path length, moisture content, vadose zone velocity, and aquifer velocity. Six decay chains for uranium were modeled:

1. Cm-244 → Pu-240 → U-236
2. Pu-240 → U-236 → Th-232
3. Am-243 → Pu-239 → U-235
4. Pu-238 → U-234 → Th-230 → Ra-226
5. Pu-242 → U-238 → U-234
6. U-238 → Th-230 → Ra-226

Sixteen isotopes were modeled, including six uranium isotopes (U-232, U-233, U-234, U-235, U-236, and U-238), nine isotopes important in the decay chain calculations (Am-243, Cm-244, Pu-238, Pu-239, Pu-240, Pu-242, Ra-226, Th-230, Th-232), and one isotope as a comparison to previous modeling results (K-40). All 16 isotopes listed in Table 1 were modeled in both the vertical and horizontal modeling runs. In previous modeling (Whetstone, 2000), only Am-243 and K-40 were carried forward to the horizontal modeling, because none of the uranium species arrived at the water table within 1,000 years.

Source concentrations in the model were set at the maximum concentrations for Class A waste (10 C.F.R. 61.55). This approach is conservative, because it assumes that all of the waste is received at the highest concentrations for all constituents. In reality, many waste streams received at the facility will be well below the Class A low-level radioactive waste limits for specific nuclides. Maximum waste concentrations in pCi/g were converted to Ci/m^3 using the average waste bulk density of 1,800 kg/m^3.

Table 1. Modeled Isotopes

#	ELEMENT	NUCLIDE	Maximum Concent. (pCi/gm)	Maximum Concent. (Ci/m^3)	K_d (L/Kg)	1/2 life		Modeled
49	Americium	Am-243	10000	0.018	1	7370	y	✓
50	Curium	Cm-244	10000	0.018	93.3	18.1	y	✓
43	Plutonium	Pu-238	10000	0.018	10	87.7	y	✓
44	Plutonium	Pu-239	10000	0.018	10	24110	y	✓
45	Plutonium	Pu-240	10000	0.018	10	6564	y	✓
47	Plutonium	Pu-242	10000	0.018	10	373300	y	✓
55	Radium	Ra-226	10000	0.018	10	1600	y	✓
36	Thorium	Th-230	2.06×10^{10}	37130.4	10	75380	y	✓
37	Thorium	Th-232	110000	0.198	10	1.405×10^9	y	✓
N/A	Uranium	U-228	440000000	792	6	9.1	m	no (1)
N/A	Uranium	U-230	440000000	792	6	20.8	d	no (1)
70	Uranium	U-232	2.20×10^{13}	39650400	6	68.9	y	✓
54	Uranium	U-233	75000	0.135	6	159200	y	✓
38	Uranium	U-234	6210000000	11178	6	245500	y	✓
39	Uranium	U-235	1900	0.00342	6	703800000	y	✓
40	Uranium	U-236	64720000	116.496	6	23420000	y	✓
41	Uranium	U-238	336260	0.605268	6	4470000000	y	✓
N/A	Uranium	U-depleted	370000	0.666	6			no (2)
N/A	Uranium	U-natural	680000	1.224	6			no (2)
138	Potassium	K-40	7003370	12.606	0.15	1277000000	y	✓

N/A = not applicable, nuclide was not modeled
(1) U-228 and U-230 were not modeled, due to short half lives.
(2) U-natural and U-depleted are included in the specific isotopes modeled.

The model was run for both the top slope (0.265 cm/yr infiltration) and side slope (0.364 cm/yr infiltration) conditions. The infiltration rates, moisture contents, aquifer hydraulic properties, and transport distances used in the fate and transport modeling for uranium species are applicable to the Class A cell, Class A North, and Class A South disposal cells listed in Table 2 because the limiting case with the highest infiltration rate (0.364 cm/yr) and shortest transport distance (90 feet to the compliance well) are included in the modeling. PATHRAE model input parameters for the top slope are shown in Table 3 and for the side slope are shown in Table 4.

Table 2. Infiltration Rates for Class A Cell Models

Disposal Cell	HELP Infiltration Model Run	Description	Infiltration (in/yr)	Infiltration (cm/yr)	Reference
Class A Top Slope	T1	Class A (WLARW) Top slope, base case, 540 ft length, 3% slope	0.104	0.265	Whetstone (2000)
Class A Side Slope	SP1-R3	Class A (WLARW) Side slope, frost protected, 160 ft length, 747' effective length, 20% slope	0.143	0.364	Whetstone (2000)
Class A North Top Slope	Same as Class A	Same as Class A	0.104	0.265	Same as Class A
Class A North Side Slope	Same as Class A	Same as Class A	0.143	0.364	Same as Class A
Class A South Top Slope	T6	Top Slope, 740 ft length, 2.1% slope	0.1087	0.276	Whetstone (2007)
Class A South Side Slope	11E2-S18c	Side-slope, frost prot. layer, 18" filter, L=924 ft, with run-on	0.113	0.286	Whetstone (2007)

Table 3. 10,000-Year Uranium Modeling Source Concentrations, K_ds, and Fractional Release Rates for on LLRW Top Slope (0.265 cm/yr Infiltration)

Waste Characteristics:	Infiltration Rate:	0.00265	m/yr
	Waste Thickness:	1	M
	Waste Moisture Content:	0.058	cm^3/cm^3
	Waste Bulk Density:	1.8	gm/cm^3
Soil Characteristics:	Soil Thickness:	4.432	M
	Soil Moisture Content:	0.094	cm^3/cm^3
	Soil Bulk Density:	1.566	gm/cm^3
Aquifer Characteristics:	Aquifer Porosity	0.290	cm^3/cm^3
	Hydraulic Conductivity:	7.67E-04	cm/sec
	Gradient:	1.00E-03	m/m
	Aquifer Velocity:	0.8341	m/yr
	Aquifer Flux Rate:	0.2419	$m^3/m^2/yr$

Pathrae Number	Compound	Symbol	Maximum Concent. (pCi/g)	Maximum Concent. (Ci/m^3)	Distribution Coefficient (K_d) (ml/gm)	Fractional Release Rate (1/yr)	Waste Retardation Factor	1/2 life (Years)
49	Americium	Am-243	10,000.00000	1.80E-02	1	1.43E-03	17.660	7370
50	Curium	Cm-244	10,000	1.80E-02	93.3	1.58E-05	1555.338	18
43	Plutonium	Pu-238	10,000	1.80E-02	10	1.47E-04	167.596	88
44	Plutonium	Pu-239	10,000	1.80E-02	10	1.47E-04	167.596	24110
45	Plutonium	Pu-240	10,000	1.80E-02	10	1.47E-04	167.596	6564
47	Plutonium	Pu-242	10,000	1.80E-02	10	1.47E-04	167.596	373300
55	Radium	Ra-226	10,000	1.80E-02	10	1.47E-04	167.596	1,600
36	Thorium	Th-230	20,628,000,000	3.71E+04	10	1.47E-04	167.596	75,380
37	Thorium	Th-232	110,000	1.98E-01	10	1.47E-04	167.596	14050000000
70	Uranium	U-232	22,028,000,000,000	3.97E+07	6	2.44E-04	100.957	68.9
54	Uranium	U-233	75,000	1.35E-01	6	2.44E-04	100.957	159200
38	Uranium	U-234	6,210,000,000	1.12E+04	6	2.44E-04	100.957	245500
39	Uranium	U-235	1,900	3.42E-03	6	2.44E-04	100.957	703,800,000
40	Uranium	U-236	64,720,000	1.16E+02	6	2.44E-04	100.957	23,420,000
41	Uranium	U-238	336,260	6.05E-01	6	2.44E-04	100.957	4470000000
138	Potassium	K-40	7,003,370	1.26E+01	0.15	8.08E-03	3.499	1,277,000,000

Table 4. 10,000-Year Uranium Modeling Source Concentrations, K_ds, and Fractional Release Rates for on LLRW Side Slope (0.364 cm/yr Infiltration)

Waste Characteristics:	Infiltration Rate:	0.00364	m/yr
	Waste Thickness:	1	M
	Waste Moisture Content:	0.061	cm^3/cm^3
	Waste Bulk Density:	1.8	gm/cm^3
Soil Characteristics:	Soil Thickness:	4.432	M
	Soil Moisture Content:	0.096	cm^3/cm^3
	Soil Bulk Density:	1.566	gm/cm^3
Aquifer Characteristics:	Aquifer Porosity	0.290	cm^3/cm^3
	Hydraulic Conductivity:	7.67E-04	cm/sec
	Gradient:	1.00E-03	m/m
	Aquifer Velocity:	0.8341	m/yr
	Aquifer Flux Rate:	0.2419	$m^3/m^2/yr$

Pathrae Number	Compound	Symbol	Maximum Concent. (pCi/g)	Maximum Concent. (Ci/m^3)	Distribution Coefficient (K_d) (ml/gm)	Fractional Release Rate (1/yr)	Waste Retardation Factor	1/2 life (Years)
49	Americium	Am-243	10,000.00000	1.80E-02	1	1.43E-03	17.660	7370
50	Curium	Cm-244	10,000	1.80E-02	93.3	1.58E-05	1555.338	18
43	Plutonium	Pu-238	10,000	1.80E-02	10	1.47E-04	167.596	88
44	Plutonium	Pu-239	10,000	1.80E-02	10	1.47E-04	167.596	24110
45	Plutonium	Pu-240	10,000	1.80E-02	10	1.47E-04	167.596	6564
47	Plutonium	Pu-242	10,000	1.80E-02	10	1.47E-04	167.596	373300
55	Radium	Ra-226	10,000	1.80E-02	10	1.47E-04	167.596	1,600
36	Thorium	Th-230	20,628,000,000	3.71E+04	10	1.47E-04	167.596	75,380
37	Thorium	Th-232	110,000	1.98E-01	10	1.47E-04	167.596	14050000000
70	Uranium	U-232	22,028,000,000,000	3.97E+07	6	2.44E-04	100.957	68.9
54	Uranium	U-233	75,000	1.35E-01	6	2.44E-04	100.957	159200
38	Uranium	U-234	6,210,000,000	1.12E+04	6	2.44E-04	100.957	245500
39	Uranium	U-235	1,900	3.42E-03	6	2.44E-04	100.957	703,800,000
40	Uranium	U-236	64,720,000	1.16E+02	6	2.44E-04	100.957	23,420,000
41	Uranium	U-238	336,260	6.05E-01	6	2.44E-04	100.957	4470000000
138	Potassium	K-40	7,003,370	1.26E+01	0.15	8.08E-03	3.499	1,277,000,000

Model Results

Vertical Model Results

Vertical PATHRAE modeling was performed for the 0.265 cm/yr top slope and the 0.364 cm/yr side slope. The top slope modeling results indicate that five of the seven uranium species (U-234, U-235, U-236, and U-238) would exceed Ground Water Protection Levels (GWPLs) at the water table directly beneath the embankment in 5,000 – 8,300 years after cell closure (Table 5). Uranium concentrations at the water table under the top slope area of the cell would peak at approximately 19,000 years after cell closure, below the top slope. U-232 and U-233 have relatively short half lives, and would not arrive at the water table at concentrations exceeding GWPLs.

The side slope modeling results indicate that five of the seven uranium species (U-234, U-235, U-236, and U-238) would exceed GWPLs at the water table directly beneath the embankment in 3,600 – 6,000 years after cell closure (Table 6). Uranium concentrations at the water table under the side slope area of the cell would peak at approximately 13,000 years after cell closure, below the side slope.

A complete listing of output times and concentrations at the water table is provided in Table 7 for the top slope and Table 8 for the side slope. All 16 constituents were carried forward from the vertical modeling into the horizontal modeling.

Table 5. Peak Concentrations (pCi/L) and Time to Exceed GWPL at the Water Table, 0.265 cm/yr Top Slope Vertical PATHRAE Model Results for Uranium and Progeny

NUCLIDE	TIME TO EXCEED (Year)	PEAK CONCENTRATION (Ci/m^3)	PEAK CONCENTRATION (pCi/L)	PEAK YEAR
Am-243	1,200	3.14E-03	3.14E+06	3,262
Cm-244	-1	---	---	> 102,000
Pu-238	-1	---	---	
Pu-239	-1	1.85E-04	1.85E+05	30,402
Pu-240	-1	2.48E-05	2.48E+04	28,956
Pu-242	-1	4.24E-04	4.24E+05	31,295
Ra-226	-1	6.15E-09	6.15E+00	21,734
Th-230	8,000	6.95E+02	6.95E+11	31,082
Th-232	-1	4.94E-03	4.94E+06	31,380
U-232	-1	---	---	
U-233	7,100	5.15E-03	5.15E+06	18,852
U-234	5,000	4.40E+02	4.40E+11	18,877
U-235	8,300	1.42E-04	1.42E+05	18,903
U-236	5,700	5.27E+00	5.27E+09	19,082
U-238	6,700	2.51E-02	2.51E+07	18,903

NOTES: -1 indicates that compound did not exceed standard within the 12,000 years modeled
--- indicates that concentrations do not peak at the water table within 120,000 yrs

Table 6. Peak Concentrations (pCi/L) and Time to Exceed GWPL at the Water Table, 0.364 cm/yr Side Slope Vertical PATHRAE Model Results for Uranium and Progeny

NUCLIDE	TIME TO EXCEED (Year)	PEAK CONCENTRATION (Ci/m^3)	PEAK CONCENTRATION (pCi/L)	PEAK YEAR
Am-243	800	3.44E-03	3.44E+06	2,364
Cm-244	-1	---	---	> 120,000
K-40	100	1.53E+01	1.53E+10	469
Pu-238	-1	---	---	---
Pu-239	10,000	2.38E-04	2.38E+05	22,159
Pu-240	10,300	5.75E-05	5.75E+04	21,231
Pu-242	9,900	4.34E-04	4.34E+05	22,624
Ra-226	11,000	9.47E-08	9.47E+01	17,068
Th-230	5,700	7.59E+02	7.59E+11	22,500
Th-232	9,000	4.98E-03	4.98E+06	22,654
U-232	-1	---	---	---
U-233	5,100	5.31E-03	5.31E+06	13,630
U-234	3,600	4.50E+02	4.50E+11	13,630
U-235	6,000	1.43E-04	1.43E+05	13,649
U-236	4,100	5.30E+00	5.30E+09	13,779
U-238	4,800	2.53E-02	2.53E+07	13,649

NOTES: -1 indicates that compound did not exceed standard within the 12,000 years modeled
--- indicates that concentrations do not peak at the water table within 120,000 yrs

Horizontal Model Results

The horizontal modeling results (Table 9, Table 10) indicate that none of the uranium species modeled would reach the compliance well within 10,000 years.

Concentrations of K-40, which was run as a surrogate, are similar to the results from previous modeling for the early output times (100 through 1,000 years) which confirms that the longer term model results are comparable to the previously approved modeling results. However, the results are not identical due to differences in timestep discretization. The previous model required very short timesteps during the early years, while the 10,000 year model uses a 100-year timestep. Because uranium does not arrive at the water table before 1,000 years, the coarser timestep used in the current modeling is appropriate for modeling uranium species.

Summary

The fate and transport of uranium species disposed in the Class A cell was evaluated using the PATHRAE model. The model was run for over 10,000 years, for both the top slope and side slope areas of the cell. The modeling indicates that although uranium species would exceed GWPLs at the water table in 5,000 – 8,300 years for the top slope and 3,600 – 6,000 years for the side slope, uranium would not arrive at the compliance well within 10,000 years. Uranium concentrations in groundwater at the compliance well would remain well below GWPLs for at least 10,000 years.

References

Merrell, G.B., Rogers, V.C., and Chau, T.K., 1995. The PATHRAE-RAD Performance Assessment Code for the Land Disposal of Radioactive Wastes, Rogers & Associates Engineering Corporation, RAE-9500/2-1. March 1995.

Whetstone Associates, Inc, 2000. Envirocare of Utah Revised Western LARW Cell Infiltration and Transport Modeling, consultants report dated July 19, 2000. Document Number 4104M.000719.

Whetstone Associates, Inc, 2007. EnergySolutions – Class A South Cell Infiltration and Transport Modeling, consultants report dated Dec 7, 2007. Document Number 4101L.071207.

Table 7. Radionuclide Concentrations (pCi/L) at the Water Table, 0.265 cm/yr Top Slope Vertical PATHRAE Model Results for Uranium Isotopes

Table 8. Radionuclide Concentrations (pCi/L) at the Water Table, 0.364 cm/yr Side Slope Vertical PATHRAE Model Results for Uranium Isotopes

Table 9. Radionuclide Concentrations (pCi/L) at the Compliance Well, 0.265 cm/yr Top Slope Horizontal PATHRAE Model Results for Uranium Isotopes

Table 10. Radionuclide Concentrations (pCi/L) at the Compliance Well, 0.364 cm/yr Side Slope Horizontal PATHRAE Model Results for Uranium Isotopes

TABLE 7. RADIONUCLIDE CONCENTRATIONS (pCi/L) AT THE WATER TABLE--VERTICAL PATHRAE MODEL RESULTS FOR THE 0.265 cm/yr TOP SLOPE

NUCLIDE:	YEAR TO EXCEED:	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100
Am-243	1200	0	0	0	0	0	0	3.8E-09	2.6E-06	3.8E-04	1.9E-02	4.5E-01	5.8E+00	4.8E+01	2.8E+02	1.2E+03	4.4E+03	1.3E+04	3.2E+04	7.0E+04	1.4E+05	2.4E+05
Cm-244	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
K-40	200	0	1.2E+02	6.9E+06	7.3E+08	6.3E+09	1.4E+10	1.4E+10	7.9E+09	3.2E+09	9.8E+08	2.5E+08	5.8E+07	1.2E+07	2.3E+06	4.3E+05	7.4E+04	1.2E+04	2.0E+03	3.2E+02	5.0E+01	7.6E+00
Pu-238	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pu-239	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pu-240	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pu-242	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ra-226	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Th-230	8000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Th-232	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
U-232	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
U-233	7100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
U-234	5000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
U-235	8300	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
U-236	5700	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
U-238	6700	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

NOTE: Year to exceed GWPL reported to next lowest model output year. -1 indicates nuclide does not exceed GWPL in years modeled

Year to exceed GWPL reported to next lowest model output ye

TABLE 7. RADIONUCLIDE CONCENTRATIONS (pCi/L) AT THE WATER TABLE--VERTICAL PATHRAE MODEL RESULTS FOR THE 0.265 cm/yr TOP SLOPE

NUCLIDE:	2200	2300	2400	2500	2600	2700	2800	2900	3000	3100	3200	3300	3400	3500	3600	3700	3800	3900	4000	4100	4200	4300
Am-243	4.0E+05	6.2E+05	8.9E+05	1.2E+06	1.6E+06	1.9E+06	2.3E+06	2.6E+06	2.9E+06	3.0E+06	3.1E+06	3.1E+06	3.1E+06	2.9E+06	2.7E+06	2.5E+06	2.2E+06	2.0E+06	1.7E+06	1.5E+06	1.2E+06	1.0E+06
Cm-244	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
K-40	1.1E+00	1.7E-01	2.5E-02	3.6E-03	5.2E-04	7.4E-05	1.1E-05	1.5E-06	2.1E-07	3.0E-08	4.1E-09	5.7E-10	8.0E-11	1.1E-11	0	0	0	0	0	0	0	0
Pu-238	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pu-239	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pu-240	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pu-242	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ra-226	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Th-230	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Th-232	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
U-232	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
U-233	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.4E-11	7.0E-11	3.1E-10	1.3E-09	5.0E-09	1.8E-08	6.1E-08	1.9E-07
U-234	0	0	0	0	0	0	0	0	0	8.4E-11	7.3E-10	5.5E-09	3.7E-08	2.2E-07	1.2E-06	5.8E-06	2.6E-05	1.1E-04	4.2E-04	1.5E-03	5.1E-03	1.6E-02
U-235	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3.4E-11	1.3E-10	4.7E-10	1.6E-09	5.0E-09
U-236	0	0	0	0	0	0	0	0	0	0	0	6.1E-11	4.1E-10	2.4E-09	1.3E-08	6.5E-08	2.9E-07	1.2E-06	4.7E-06	1.7E-05	5.7E-05	1.8E-04
U-238	0	0	0	0	0	0	0	0	0	0	0	0	0	1.2E-11	6.5E-11	3.2E-10	1.4E-09	5.9E-09	2.3E-08	8.2E-08	2.8E-07	8.9E-07

NOTE: :ar. -1 indicates nuclide does not exceed GWPL in years modeled

TABLE 7. RADIONUCLIDE CONCENTRATIONS (pCi/L) AT THE WATER TABLE--VERTICAL PATHRAE MODEL RESULTS FOR THE 0.265 cm/yr TOP SLOPE

NUCLIDE:	4400	4500	4600	4700	4800	4900	5000	5100	5200	5300	5400	5500	5600	5700	5800	5900	6000	6100	6200
Am-243	8.6E+05	7.0E+05	5.6E+05	4.5E+05	3.6E+05	2.8E+05	2.2E+05	1.7E+05	1.3E+05	9.9E+04	7.5E+04	5.7E+04	4.3E+04	3.2E+04	2.4E+04	1.7E+04	1.3E+04	9.4E+03	6.9E+03
Cm-244	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
K-40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pu-238	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pu-239	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pu-240	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pu-242	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ra-226	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Th-230	0	0	0	0	0	0	2.1E-11	8.7E-11	3.3E-10	1.2E-09	4.1E-09	1.4E-08	4.3E-08	1.3E-07	3.8E-07	1.1E-06	2.9E-06	7.5E-06	1.9E-05
Th-232	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.6E-11	4.2E-11	1.1E-10
U-232	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
U-233	5.8E-07	1.7E-06	4.6E-06	1.2E-05	3.0E-05	7.1E-05	1.6E-04	3.7E-04	7.9E-04	1.7E-03	3.4E-03	6.6E-03	1.3E-02	2.4E-02	4.4E-02	7.8E-02	1.4E-01	2.4E-01	4.0E-01
U-234	4.9E-02	1.4E-01	3.8E-01	9.9E-01	2.5E+00	5.9E+00	1.4E+01	3.1E+01	6.6E+01	1.4E+02	2.8E+02	5.5E+02	1.1E+03	2.0E+03	3.7E+03	6.5E+03	1.1E+04	2.0E+04	3.3E+04
U-235	1.5E-08	4.3E-08	1.2E-07	3.1E-07	7.7E-07	1.8E-06	4.2E-06	9.5E-06	2.0E-05	4.3E-05	8.7E-05	1.7E-04	3.3E-04	6.2E-04	1.1E-03	2.0E-03	3.6E-03	6.1E-03	1.0E-02
U-236	5.5E-04	1.6E-03	4.2E-03	1.1E-02	2.8E-02	6.6E-02	1.5E-01	3.4E-01	7.4E-01	1.5E+00	3.1E+00	6.2E+00	1.2E+01	2.2E+01	4.1E+01	7.3E+01	1.3E+02	2.2E+02	3.7E+02
U-238	2.7E-06	7.6E-06	2.1E-05	5.4E-05	1.4E-04	3.2E-04	7.5E-04	1.7E-03	3.6E-03	7.6E-03	1.5E-02	3.0E-02	5.8E-02	1.1E-01	2.0E-01	3.6E-01	6.3E-01	1.1E+00	1.8E+00

NOTE:

TABLE 7. RADIONUCLIDE CONCENTRATIONS (pCi/L) AT THE WATER TABLE--VERTICAL PATHRAE MODEL RESULTS FOR THE 0.265 cm/yr TOP SLOPE

NUCLIDE:	6300	6400	6500	6600	6700	6800	6900	7000	7100	7200	7300	7400	7500	7600	7700	7800	7900	8000	8100
Am-243	5.0E+03	3.6E+03	2.6E+03	1.9E+03	1.4E+03	9.8E+02	7.0E+02	5.0E+02	3.6E+02	2.5E+02	1.8E+02	1.3E+02	9.0E+01	6.3E+01	4.4E+01	3.1E+01	2.2E+01	1.5E+01	1.1E+01
Cm-244	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
K-40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pu-238	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pu-239	2.0E-11	4.7E-11	1.1E-10	2.5E-10	5.4E-10	1.2E-09	2.4E-09	5.0E-09	1.0E-08	2.0E-08	3.8E-08	7.1E-08	1.3E-07	2.4E-07	4.3E-07	7.7E-07	1.3E-06	2.3E-06	3.9E-06
Pu-240	1.5E-11	3.5E-11	8.1E-11	1.8E-10	3.9E-10	8.3E-10	1.7E-09	3.5E-09	7.0E-09	1.4E-08	2.6E-08	4.9E-08	9.0E-08	1.6E-07	2.9E-07	5.1E-07	8.8E-07	1.5E-06	2.5E-06
Pu-242	2.4E-11	5.6E-11	1.3E-10	2.9E-10	6.5E-10	1.4E-09	2.9E-09	6.0E-09	1.2E-08	2.4E-08	4.6E-08	8.7E-08	1.6E-07	3.0E-07	5.3E-07	9.5E-07	1.6E-06	2.8E-06	4.8E-06
Ra-226	0	0	0	1.7E-11	3.6E-11	7.4E-11	1.5E-10	2.9E-10	5.6E-10	1.1E-09	2.0E-09	3.6E-09	6.4E-09	1.1E-08	1.9E-08	3.3E-08	5.5E-08	9.0E-08	1.5E-07
Th-230	4.6E-05	1.1E-04	2.6E-04	5.8E-04	1.3E-03	2.7E-03	5.7E-03	1.2E-02	2.4E-02	4.6E-02	9.0E-02	1.7E-01	3.2E-01	5.8E-01	1.0E+00	1.8E+00	3.2E+00	5.5E+00	9.3E+00
Th-232	2.6E-10	6.2E-10	1.4E-09	3.3E-09	7.2E-09	1.6E-08	3.3E-08	6.7E-08	1.3E-07	2.7E-07	5.1E-07	9.7E-07	1.8E-06	3.3E-06	6.0E-06	1.1E-05	1.8E-05	3.2E-05	5.4E-05
U-232	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
U-233	6.6E-01	1.1E+00	1.7E+00	2.7E+00	4.1E+00	6.3E+00	9.5E+00	1.4E+01	2.1E+01	3.0E+01	4.3E+01	6.1E+01	8.5E+01	1.2E+02	1.6E+02	2.2E+02	3.0E+02	3.9E+02	5.2E+02
U-234	5.5E+04	8.9E+04	1.4E+05	2.2E+05	3.5E+05	5.3E+05	8.0E+05	1.2E+06	1.7E+06	2.5E+06	3.6E+06	5.1E+06	7.1E+06	9.9E+06	1.4E+07	1.8E+07	2.5E+07	3.3E+07	4.4E+07
U-235	1.7E-02	2.8E-02	4.4E-02	7.0E-02	1.1E-01	1.6E-01	2.5E-01	3.7E-01	5.4E-01	7.8E-01	1.1E+00	1.6E+00	2.2E+00	3.1E+00	4.2E+00	5.8E+00	7.7E+00	1.0E+01	1.4E+01
U-236	6.2E+02	1.0E+03	1.6E+03	2.5E+03	3.9E+03	6.0E+03	9.0E+03	1.3E+04	2.0E+04	2.8E+04	4.1E+04	5.7E+04	8.0E+04	1.1E+05	1.5E+05	2.1E+05	2.8E+05	3.7E+05	4.9E+05
U-238	3.0E+00	4.9E+00	7.8E+00	1.2E+01	1.9E+01	2.9E+01	4.4E+01	6.5E+01	9.6E+01	1.4E+02	2.0E+02	2.8E+02	3.9E+02	5.5E+02	7.5E+02	1.0E+03	1.4E+03	1.8E+03	2.4E+03

NOTE:

TABLE 7. RADIONUCLIDE CONCENTRATIONS (pCi/L) AT THE WATER TABLE--VERTICAL PATHRAE MODEL RESULTS FOR THE 0.265 cm/yr TOP SLOPE

NUCLIDE:	8200	8300	8400	8500	8600	8700	8800	8900	9000	9100	9200	9300	9400	9500	9600	9700	9800	9900	10000
Am-243	7.5E+00	5.2E+00	3.6E+00	2.5E+00	1.7E+00	1.2E+00	8.4E-01	5.8E-01	4.0E-01	2.8E-01	1.9E-01	1.3E-01	9.0E-02	6.2E-02	4.3E-02	2.9E-02	2.0E-02	1.4E-02	9.4E-03
Cm-244	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
K-40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pu-238	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pu-239	6.4E-06	1.1E-05	1.7E-05	2.8E-05	4.4E-05	6.8E-05	1.1E-04	1.6E-04	2.5E-04	3.7E-04	5.5E-04	8.1E-04	1.2E-03	1.7E-03	2.5E-03	3.5E-03	5.0E-03	6.9E-03	9.7E-03
Pu-240	4.2E-06	6.8E-06	1.1E-05	1.7E-05	2.7E-05	4.3E-05	6.6E-05	1.0E-04	1.5E-04	2.2E-04	3.3E-04	4.8E-04	7.0E-04	1.0E-03	1.4E-03	2.0E-03	2.8E-03	3.9E-03	5.4E-03
Pu-242	8.0E-06	1.3E-05	2.2E-05	3.5E-05	5.5E-05	8.7E-05	1.3E-04	2.1E-04	3.1E-04	4.7E-04	7.1E-04	1.0E-03	1.5E-03	2.2E-03	3.2E-03	4.6E-03	6.5E-03	9.1E-03	1.3E-02
Ra-226	2.3E-07	3.7E-07	5.8E-07	8.9E-07	1.3E-06	2.0E-06	3.0E-06	4.4E-06	6.5E-06	9.3E-06	1.3E-05	1.9E-05	2.7E-05	3.7E-05	5.1E-05	6.9E-05	9.4E-05	1.3E-04	1.7E-04
Th-230	1.6E+01	2.6E+01	4.2E+01	6.7E+01	1.1E+02	1.7E+02	2.6E+02	4.0E+02	6.1E+02	9.1E+02	1.4E+03	2.0E+03	2.9E+03	4.3E+03	6.1E+03	8.7E+03	1.2E+04	1.7E+04	2.4E+04
Th-232	9.0E-05	1.5E-04	2.4E-04	3.9E-04	6.2E-04	9.7E-04	1.5E-03	2.3E-03	3.5E-03	5.3E-03	7.9E-03	1.2E-02	1.7E-02	2.5E-02	3.6E-02	5.1E-02	7.2E-02	1.0E-01	1.4E-01
U-232	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
U-233	6.8E+02	8.9E+02	1.1E+03	1.5E+03	1.9E+03	2.4E+03	3.0E+03	3.7E+03	4.6E+03	5.7E+03	7.0E+03	8.5E+03	1.0E+04	1.2E+04	1.5E+04	1.8E+04	2.1E+04	2.5E+04	2.9E+04
U-234	5.7E+07	7.5E+07	9.7E+07	1.2E+08	1.6E+08	2.0E+08	2.5E+08	3.1E+08	3.9E+08	4.8E+08	5.9E+08	7.1E+08	8.7E+08	1.0E+09	1.3E+09	1.5E+09	1.8E+09	2.1E+09	2.5E+09
U-235	1.8E+01	2.3E+01	3.0E+01	3.9E+01	4.9E+01	6.2E+01	7.8E+01	9.8E+01	1.2E+02	1.5E+02	1.8E+02	2.2E+02	2.7E+02	3.3E+02	3.9E+02	4.7E+02	5.6E+02	6.6E+02	7.8E+02
U-236	6.5E+05	8.4E+05	1.1E+06	1.4E+06	1.8E+06	2.3E+06	2.8E+06	3.5E+06	4.4E+06	5.4E+06	6.6E+06	8.1E+06	9.8E+06	1.2E+07	1.4E+07	1.7E+07	2.0E+07	2.4E+07	2.8E+07
U-238	3.2E+03	4.1E+03	5.3E+03	6.9E+03	8.7E+03	1.1E+04	1.4E+04	1.7E+04	2.1E+04	2.6E+04	3.2E+04	4.0E+04	4.8E+04	5.8E+04	7.0E+04	8.3E+04	9.9E+04	1.2E+05	1.4E+05

NOTE:

TABLE 8. RADIONUCLIDE CONCENTRATIONS (pCi/L) AT THE WATER TABLE–VERTICAL PATHRAE MODEL RESULTS FOR THE 0.364 cm/yr SIDE SLOPE

NUCLIDE:	YEAR TO EXCEED:	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200
Am-243	800	0	0	0	0	2.1E-09	1.4E-05	6.4E-03	5.7E-01	1.7E+01	2.3E+02	1.8E+03	9.0E+03	3.3E+04	9.6E+04	2.3E+05	4.5E+05	8.0E+05	1.3E+06	1.8E+06	2.3E+06	2.8E+06	3.2E+06
Cm-244	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
K-40	100	1.1E-05	1.1E+06	1.1E+09	1.1E+10	1.4E+10	6.5E+09	1.5E+09	2.5E+08	3.2E+07	3.5E+06	3.3E+05	2.9E+04	2.4E+03	1.9E+02	1.5E+01	1.1E+00	7.7E-02	5.4E-03	3.8E-04	2.6E-05	1.8E-06	1.2E-07
Pu-238	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pu-239	10,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pu-240	10,300	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pu-242	9,900	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ra-226	11,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Th-230	5,700	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Th-232	9,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
U-232	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
U-233	5,100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
U-234	3,600	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2.6E-11
U-235	6,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
U-236	4,100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
U-238	4,800	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

NOTE: Year to exceed GWPL reported to next lowest model output y Year to exceed GWPL reported to next lowest model output year. -1 indicates nuclide does not exceed GWPL in years modeled

TABLE 8. RADIONUCLIDE CONCENTRATIONS (pCi/L) AT THE WATER TABLE–VERTICAL PATHRAE MODEL RESULTS FOR THE 0.364 cm/yr SIDE SLOPE

NUCLIDE:	2300	2400	2500	2600	2700	2800	2900	3000	3100	3200	3300	3400
Am-243	3.4E+06	3.4E+06	3.3E+06	3.0E+06	2.7E+06	2.3E+06	1.9E+06	1.5E+06	1.2E+06	9.2E+05	6.9E+05	5.1E+05
Cm-244	0	0	0	0	0	0	0	0	0	0	0	0
K-40	7.8E-09	5.2E-10	3.4E-11	0	0	0	0	0	0	0	0	0
Pu-238	0	0	0	0	0	0	0	0	0	0	0	0
Pu-239	0	0	0	0	0	0	0	0	0	0	0	0
Pu-240	0	0	0	0	0	0	0	0	0	0	0	0
Pu-242	0	0	0	0	0	0	0	0	0	0	0	0
Ra-226	0	0	0	0	0	0	0	0	0	0	0	0
Th-230	0	0	0	0	0	0	0	0	0	0	0	0
Th-232	0	0	0	0	0	0	0	0	0	0	0	0
U-232	0	0	0	0	0	0	0	0	0	0	0	0
U-233	0	0	0	1.5E-11	1.3E-10	9.9E-10	6.4E-09	3.7E-08	1.9E-07	8.5E-07	3.5E-06	1.3E-05
U-234	5.6E-10	9.1E-09	1.2E-07	1.2E-06	1.1E-05	8.2E-05	5.4E-04	3.1E-03	1.5E-02	7.1E-02	2.9E-01	1.1E+00
U-235	0	0	0	0	0	2.5E-11	1.6E-10	9.4E-10	4.8E-09	2.2E-08	9.0E-08	3.4E-07
U-236	0	1.0E-10	1.3E-09	1.4E-08	1.2E-07	9.2E-07	6.0E-06	3.4E-05	1.7E-04	7.9E-04	3.3E-03	1.2E-02
U-238	0	0	0	6.8E-11	6.0E-10	4.5E-09	2.9E-08	1.7E-07	8.4E-07	3.8E-06	1.6E-05	6.0E-05

NUCLIDE:	3500	3600	3700	3800	3900	4000	4100	4200	4300	4400	4500	4600
Am-243	3.7E+05	2.6E+05	1.9E+05	1.3E+05	8.8E+04	6.0E+04	4.0E+04	2.7E+04	1.8E+04	1.2E+04	7.6E+03	4.9E+03
Cm-244	0	0	0	0	0	0	0	0	0	0	0	0
K-40	0	0	0	0	0	0	0	0	0	0	0	0
Pu-238	0	0	0	0	0	0	0	0	0	0	0	0
Pu-239	0	0	0	0	0	0	0	0	0	0	1.2E-11	4.0E-11
Pu-240	0	0	0	0	0	0	0	0	0	0	1.0E-11	3.4E-11
Pu-242	0	0	0	0	0	0	0	0	0	0	1.3E-11	4.5E-11
Ra-226	0	0	0	0	0	0	0	0	0	0	0	0
Th-230	0	1.9E-11	1.3E-10	7.9E-10	4.4E-09	2.3E-08	1.1E-07	4.7E-07	1.9E-06	7.4E-06	2.7E-05	9.0E-05
Th-232	0	0	0	0	0	0	0	0	1.1E-11	4.1E-11	1.5E-10	5.0E-10
U-232	0	0	0	0	0	0	0	0	0	0	0	0
U-233	4.6E-05	1.5E-04	4.5E-04	1.3E-03	3.5E-03	8.8E-03	2.1E-02	5.0E-02	1.1E-01	2.3E-01	4.8E-01	9.5E-01
U-234	3.9E+00	1.3E+01	3.8E+01	1.1E+02	2.9E+02	7.4E+02	1.8E+03	4.1E+03	9.2E+03	2.0E+04	4.0E+04	7.9E+04
U-235	1.2E-06	3.9E-06	1.2E-05	3.3E-05	9.0E-05	2.3E-04	5.5E-04	1.3E-03	2.8E-03	6.0E-03	1.2E-02	2.5E-02
U-236	4.3E-02	1.4E-01	4.2E-01	1.2E+00	3.2E+00	8.2E+00	2.0E+01	4.6E+01	1.0E+02	2.2E+02	4.5E+02	8.9E+02
U-238	2.1E-04	6.8E-04	2.1E-03	5.9E-03	1.6E-02	4.0E-02	9.8E-02	2.3E-01	5.0E-01	1.1E+00	2.2E+00	4.3E+00

TABLE 8. RADIONUCLIDE CONCENTRATIONS (pCi/L) AT THE WATER TABLE--VERTICAL PATHRAE MODEL RESULTS FOR THE 0.364 cm/yr SIDE SLOPE

NUCLIDE:	4700	4800	4900	5000	5100	5200	5300	5400	5500	5600	5700	5800	5900	6000	6100	6200	6300	6400	6500	6600	6700	6800	6900	7000
Am-243	3.1E+03	2.0E+03	1.3E+03	8.0E+02	5.0E+02	3.2E+02	2.0E+02	1.2E+02	7.5E+01	4.6E+01	2.8E+01	1.7E+01	1.1E+01	6.5E+00	3.9E+00	2.4E+00	1.4E+00	8.7E-01	5.2E-01	3.1E-01	1.9E-01	1.1E-01	6.7E-02	4.0E-02
Cm-244	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
K-40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pu-238	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pu-239	1.3E-10	3.9E-10	1.1E-09	3.2E-09	8.5E-09	2.2E-08	5.3E-08	1.3E-07	2.9E-07	6.5E-07	1.4E-06	3.0E-06	6.1E-06	1.2E-05	2.4E-05	4.5E-05	8.4E-05	1.5E-04	2.7E-04	4.8E-04	8.3E-04	1.4E-03	2.3E-03	3.8E-03
Pu-240	1.1E-10	3.3E-10	9.5E-10	2.6E-09	6.9E-09	1.8E-08	4.3E-08	1.0E-07	2.3E-07	5.2E-07	1.1E-06	2.3E-06	4.7E-06	9.3E-06	1.8E-05	3.4E-05	6.3E-05	1.1E-04	2.0E-04	3.5E-04	6.0E-04	1.0E-03	1.7E-03	2.7E-03
Pu-242	1.5E-10	4.5E-10	1.3E-09	3.6E-09	9.7E-09	2.5E-08	6.2E-08	1.5E-07	3.4E-07	7.6E-07	1.7E-06	3.5E-06	7.2E-06	1.4E-05	2.8E-05	5.3E-05	1.0E-04	1.8E-04	3.3E-04	5.7E-04	9.9E-04	1.7E-03	2.8E-03	4.6E-03
Ra-226	1.9E-11	5.6E-11	1.6E-10	4.2E-10	1.1E-09	2.6E-09	6.3E-09	1.4E-08	3.2E-08	6.8E-08	1.4E-07	2.9E-07	5.6E-07	1.1E-06	2.0E-06	3.7E-06	6.6E-06	1.2E-05	2.0E-05	3.3E-05	5.5E-05	8.9E-05	1.4E-04	2.2E-04
Th-230	2.9E-04	8.9E-04	2.6E-03	7.2E-03	1.9E-02	4.9E-02	1.2E-01	2.9E-01	6.7E-01	1.5E+00	3.3E+00	6.9E+00	1.4E+01	2.8E+01	5.5E+01	1.1E+02	2.0E+02	3.6E+02	6.4E+02	1.1E+03	1.9E+03	3.3E+03	5.5E+03	9.0E+03
Th-232	1.6E-09	5.0E-09	1.4E-08	4.0E-08	1.1E-07	2.8E-07	6.8E-07	1.6E-06	3.8E-06	8.4E-06	1.8E-05	3.9E-05	8.0E-05	1.6E-04	3.1E-04	5.9E-04	1.1E-03	2.0E-03	3.6E-03	6.4E-03	1.1E-02	1.9E-02	3.1E-02	5.1E-02
U-232	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
U-233	1.8E+00	3.4E+00	6.1E+00	1.1E+01	1.8E+01	3.1E+01	5.1E+01	8.1E+01	1.3E+02	2.0E+02	3.0E+02	4.4E+02	6.5E+02	9.3E+02	1.3E+03	1.9E+03	2.6E+03	3.5E+03	4.7E+03	6.3E+03	8.3E+03	1.1E+04	1.4E+04	1.8E+04
U-234	1.5E+05	2.8E+05	5.1E+05	9.0E+05	1.5E+06	2.6E+06	4.2E+06	6.8E+06	1.1E+07	1.6E+07	2.5E+07	3.7E+07	5.4E+07	7.8E+07	1.1E+08	1.6E+08	2.2E+08	2.9E+08	4.0E+08	5.3E+08	7.0E+08	9.1E+08	1.2E+09	1.5E+09
U-235	4.7E-02	8.8E-02	1.6E-01	2.8E-01	4.8E-01	8.0E-01	1.3E+00	2.1E+00	3.3E+00	5.1E+00	7.7E+00	1.1E+01	1.7E+01	2.4E+01	3.4E+01	4.8E+01	6.7E+01	9.1E+01	1.2E+02	1.6E+02	2.2E+02	2.8E+02	3.7E+02	4.7E+02
U-236	1.7E+03	3.2E+03	5.7E+03	1.0E+04	1.7E+04	2.9E+04	4.7E+04	7.6E+04	1.2E+05	1.8E+05	2.8E+05	4.1E+05	6.1E+05	8.8E+05	1.2E+06	1.7E+06	2.4E+06	3.3E+06	4.4E+06	5.9E+06	7.8E+06	1.0E+07	1.3E+07	1.7E+07
U-238	8.3E+00	1.5E+01	2.8E+01	4.9E+01	8.5E+01	1.4E+02	2.3E+02	3.7E+02	5.8E+02	9.0E+02	1.4E+03	2.0E+03	3.0E+03	4.3E+03	6.1E+03	8.5E+03	1.2E+04	1.6E+04	2.2E+04	2.9E+04	3.8E+04	5.0E+04	6.5E+04	8.3E+04

TABLE 8. RADIONUCLIDE CONCENTRATIONS (pCi/L) AT THE WATER TABLE–VERTICAL PATHRAE MODEL RESULTS FOR THE 0.364 cm/yr SIDE SLOPE

NUCLIDE:	7100	7200	7300	7400	7500	7600	7700	7800	7900	8000	8100	8200	8300	8400	8500	8600	8700	8800	8900	9000	9100	9200	9300	9400
Am-243	2.4E-02	1.4E-02	8.4E-03	5.0E-03	2.9E-03	1.7E-03	1.0E-03	6.1E-04	3.6E-04	2.1E-04	1.2E-04	7.3E-05	4.3E-05	2.5E-05	1.5E-05	8.6E-06	5.0E-06	2.9E-06	1.7E-06	1.0E-06	5.9E-07	3.4E-07	2.0E-07	1.2E-07
Cm-244	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
K-40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pu-238	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pu-239	6.1E-03	9.7E-03	1.5E-02	2.4E-02	3.6E-02	5.4E-02	8.1E-02	1.2E-01	1.7E-01	2.5E-01	3.5E-01	5.0E-01	7.0E-01	9.6E-01	1.3E+00	1.8E+00	2.4E+00	3.3E+00	4.3E+00	5.7E+00	7.5E+00	9.7E+00	1.3E+01	1.6E+01
Pu-240	4.3E-03	6.8E-03	1.1E-02	1.6E-02	2.5E-02	3.7E-02	5.4E-02	7.9E-02	1.1E-01	1.6E-01	2.3E-01	3.2E-01	4.5E-01	6.1E-01	8.4E-01	1.1E+00	1.5E+00	2.0E+00	2.6E+00	3.5E+00	4.5E+00	5.8E+00	7.4E+00	9.5E+00
Pu-242	7.4E-03	1.2E-02	1.9E-02	2.9E-02	4.4E-02	6.6E-02	9.9E-02	1.5E-01	2.1E-01	3.1E-01	4.4E-01	6.2E-01	8.7E-01	1.2E+00	1.7E+00	2.3E+00	3.1E+00	4.1E+00	5.5E+00	7.3E+00	9.5E+00	1.2E+01	1.6E+01	2.1E+01
Ra-226	3.5E-04	5.3E-04	8.0E-04	1.2E-03	1.7E-03	2.5E-03	3.6E-03	5.1E-03	7.1E-03	9.8E-03	1.3E-02	1.8E-02	2.4E-02	3.2E-02	4.3E-02	5.6E-02	7.2E-02	9.3E-02	1.2E-01	1.5E-01	1.9E-01	2.3E-01	2.9E-01	3.6E-01
Th-230	1.5E+04	2.3E+04	3.6E+04	5.6E+04	8.6E+04	1.3E+05	1.9E+05	2.8E+05	4.1E+05	6.0E+05	8.5E+05	1.2E+06	1.7E+06	2.3E+06	3.2E+06	4.4E+06	5.9E+06	8.0E+06	1.1E+07	1.4E+07	1.8E+07	2.4E+07	3.1E+07	4.0E+07
Th-232	8.3E-02	1.3E-01	2.1E-01	3.2E-01	4.9E-01	7.4E-01	1.1E+00	1.6E+00	2.4E+00	3.4E+00	4.9E+00	6.9E+00	9.7E+00	1.4E+01	1.9E+01	2.5E+01	3.4E+01	4.6E+01	6.1E+01	8.1E+01	1.1E+02	1.4E+02	1.8E+02	2.3E+02
U-232	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
U-233	2.3E+04	2.9E+04	3.6E+04	4.4E+04	5.4E+04	6.6E+04	8.0E+04	9.6E+04	1.1E+05	1.4E+05	1.6E+05	1.9E+05	2.2E+05	2.5E+05	2.9E+05	3.4E+05	3.8E+05	4.4E+05	4.9E+05	5.6E+05	6.2E+05	7.0E+05	7.8E+05	8.6E+05
U-234	1.9E+09	2.4E+09	3.0E+09	3.7E+09	4.6E+09	5.6E+09	6.7E+09	8.1E+09	9.6E+09	1.1E+10	1.3E+10	1.6E+10	1.8E+10	2.1E+10	2.5E+10	2.8E+10	3.2E+10	3.7E+10	4.2E+10	4.7E+10	5.3E+10	5.9E+10	6.5E+10	7.2E+10
U-235	6.0E+02	7.5E+02	9.3E+02	1.2E+03	1.4E+03	1.7E+03	2.1E+03	2.5E+03	3.0E+03	3.6E+03	4.2E+03	4.9E+03	5.8E+03	6.7E+03	7.7E+03	8.8E+03	1.0E+04	1.1E+04	1.3E+04	1.5E+04	1.6E+04	1.8E+04	2.0E+04	2.3E+04
U-236	2.2E+07	2.7E+07	3.4E+07	4.2E+07	5.1E+07	6.3E+07	7.6E+07	9.1E+07	1.1E+08	1.3E+08	1.5E+08	1.8E+08	2.1E+08	2.4E+08	2.8E+08	3.2E+08	3.7E+08	4.2E+08	4.7E+08	5.3E+08	5.9E+08	6.6E+08	7.4E+08	8.2E+08
U-238	1.1E+05	1.3E+05	1.7E+05	2.0E+05	2.5E+05	3.1E+05	3.7E+05	4.5E+05	5.3E+05	6.3E+05	7.5E+05	8.7E+05	1.0E+06	1.2E+06	1.4E+06	1.6E+06	1.8E+06	2.0E+06	2.3E+06	2.6E+06	2.9E+06	3.3E+06	3.6E+06	4.0E+06

TABLE 8. RADIONUCLIDE CONCENTRATIONS (pCi/L) AT THE WATER TABLE--VERTICAL PATHRAE MODEL RESULTS FOR THE 0.364 cm/yr SIDE SLOPE

NUCLIDE:	9500	9600	9700	9800	9900	10000	10100	10200	10300	10400	10500	10600	10700	10800	10900	11000	11100	11200	11300	11400	11500	11600
Am-243	6.7E-08	3.9E-08	2.3E-08	1.3E-08	7.7E-09	4.5E-09	2.6E-09	1.5E-09	8.7E-10	5.1E-10	2.9E-10	1.7E-10	9.8E-11	5.7E-11	3.3E-11	1.9E-11	1.1E-11	0	0	0	0	0
Cm-244	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
K-40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pu-238	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pu-239	2.0E+01	2.6E+01	3.3E+01	4.1E+01	5.1E+01	6.3E+01	7.8E+01	9.5E+01	1.2E+02	1.4E+02	1.7E+02	2.0E+02	2.4E+02	2.9E+02	3.5E+02	4.1E+02	4.8E+02	5.7E+02	6.6E+02	7.7E+02	9.0E+02	1.0E+03
Pu-240	1.2E+01	1.5E+01	1.9E+01	2.3E+01	2.9E+01	3.5E+01	4.3E+01	5.3E+01	6.4E+01	7.7E+01	9.2E+01	1.1E+02	1.3E+02	1.5E+02	1.8E+02	2.1E+02	2.5E+02	2.9E+02	3.4E+02	3.9E+02	4.5E+02	5.2E+02
Pu-242	2.6E+01	3.4E+01	4.2E+01	5.3E+01	6.6E+01	8.2E+01	1.0E+02	1.3E+02	1.5E+02	1.9E+02	2.3E+02	2.7E+02	3.3E+02	3.9E+02	4.6E+02	5.5E+02	6.5E+02	7.7E+02	9.0E+02	1.0E+03	1.2E+03	1.4E+03
Ra-226	4.4E-01	5.3E-01	6.5E-01	7.8E-01	9.3E-01	1.1E+00	1.3E+00	1.5E+00	1.8E+00	2.1E+00	2.4E+00	2.8E+00	3.2E+00	3.7E+00	4.2E+00	4.8E+00	5.4E+00	6.1E+00	6.9E+00	7.7E+00	8.6E+00	9.5E+00
Th-230	5.1E+07	6.4E+07	8.1E+07	1.0E+08	1.3E+08	1.6E+08	1.9E+08	2.4E+08	2.9E+08	3.6E+08	4.3E+08	5.2E+08	6.2E+08	7.4E+08	8.8E+08	1.0E+09	1.2E+09	1.5E+09	1.7E+09	2.0E+09	2.3E+09	2.7E+09
Th-232	3.0E+02	3.8E+02	4.7E+02	6.0E+02	7.4E+02	9.2E+02	1.1E+03	1.4E+03	1.7E+03	2.1E+03	2.5E+03	3.1E+03	3.7E+03	4.4E+03	5.2E+03	6.2E+03	7.3E+03	8.6E+03	1.0E+04	1.2E+04	1.4E+04	1.6E+04
U-232	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
U-233	9.5E+05	1.0E+06	1.1E+06	1.3E+06	1.4E+06	1.5E+06	1.6E+06	1.7E+06	1.9E+06	2.0E+06	2.1E+06	2.3E+06	2.4E+06	2.6E+06	2.7E+06	2.8E+06	3.0E+06	3.1E+06	3.3E+06	3.4E+06	3.6E+06	3.7E+06
U-234	8.0E+10	8.8E+10	9.6E+10	1.1E+11	1.1E+11	1.2E+11	1.3E+11	1.5E+11	1.6E+11	1.7E+11	1.8E+11	1.9E+11	2.0E+11	2.2E+11	2.3E+11	2.4E+11	2.5E+11	2.7E+11	2.8E+11	2.9E+11	3.0E+11	3.1E+11
U-235	2.5E+04	2.8E+04	3.0E+04	3.3E+04	3.6E+04	3.9E+04	4.2E+04	4.6E+04	4.9E+04	5.3E+04	5.6E+04	6.0E+04	6.4E+04	6.8E+04	7.2E+04	7.6E+04	8.0E+04	8.4E+04	8.8E+04	9.1E+04	9.5E+04	9.9E+04
U-236	9.1E+08	1.0E+09	1.1E+09	1.2E+09	1.3E+09	1.4E+09	1.5E+09	1.7E+09	1.8E+09	1.9E+09	2.0E+09	2.2E+09	2.3E+09	2.5E+09	2.6E+09	2.7E+09	2.9E+09	3.0E+09	3.2E+09	3.3E+09	3.5E+09	3.6E+09
U-238	4.4E+06	4.9E+06	5.4E+06	5.9E+06	6.4E+06	6.9E+06	7.5E+06	8.1E+06	8.7E+06	9.3E+06	1.0E+07	1.1E+07	1.1E+07	1.2E+07	1.3E+07	1.3E+07	1.4E+07	1.5E+07	1.5E+07	1.6E+07	1.7E+07	1.8E+07

TABLE 9. RADIONUCLIDE CONCENTRATIONS (pCi/L) AT THE COMPLIANCE WELL HORIZONTAL PATHRAE MODEL RESULTS FOR THE 0.265 cm/yr TOP SLOPE

	EXCEEDS	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400
Am-243	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
K-40	800	0	0	0	0	0	0	0	0	1.8E+06	1.4E+06	3.6E+05	7.4E+04	1.7E+08	1.6E+08	4.1E+07	8.5E+06	1.4E+09	1.6E+09	4.2E+08	8.7E+07	3.6E+09	4.9E+09	1.3E+09	2.7E+08
Pu-239	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pu-240	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pu-242	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ra-226	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Th-230	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Th-232	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
U-233	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
U-234	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
U-235	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
U-236	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
U-238	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

NOTE: Year to exceed GWPL reported to next lowest model output year. -1 indicates nuclide does not exceed GWPL within the 11,900 years modeled

TABLE 9. RADIONUCLIDE CONCENTRATIONS (pCi/L) AT THE COMPLIANCE WELL HORIZONTAL PATHRAE MODEL RESULTS FOR THE 0.265 cm/yr TOP SLOPE

	2500	2600	2700	2800	2900	3000	3100	3200	3300	3400	3500	3600	3700	3800	3900	4000	4100	4200	4300	4400	4500	4600	4700	4800
Am-243	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
K-40	4.2E+09	7.1E+09	1.9E+09	4.0E+08	2.7E+09	5.8E+09	1.6E+09	3.4E+08	1.1E+09	3.1E+09	8.7E+08	1.8E+08	3.1E+08	1.2E+09	3.5E+08	7.5E+07	6.9E+07	3.7E+08	1.1E+08	2.4E+07	1.3E+07	9.5E+07	3.0E+07	6.3E+06
Pu-239	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pu-240	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pu-242	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ra-226	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Th-230	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Th-232	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
U-233	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
U-234	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
U-235	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
U-236	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
U-238	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

TABLE 9. RADIONUCLIDE CONCENTRATIONS (pCi/L) AT THE COMPLIANCE WELL HORIZONTAL PATHRAE MODEL RESULTS FOR THE 0.265 cm/yr TOP SLOPE

	4900	5000	5100	5200	5300	5400	5500	5600	5700	5800	5900	6000	6100	6200	6300	6400	6500	6600	6700	6800	6900	7000	7100	7200
Am-243	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
K-40	2.3E+06	2.2E+07	7.2E+06	1.6E+06	4.0E+05	4.7E+06	1.6E+06	3.4E+05	7.4E+04	9.1E+05	3.2E+05	7.0E+04	1.4E+04	1.7E+05	6.3E+04	1.4E+04	2.8E+03	3.0E+04	1.1E+04	2.5E+03	5.1E+02	4.8E+03	2.0E+03	4.4E+02
Pu-239	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pu-240	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pu-242	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ra-226	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Th-230	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Th-232	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
U-233	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
U-234	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
U-235	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
U-236	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
U-238	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

TABLE 9. RADIONUCLIDE CONCENTRATIONS (pCi/L) AT THE COMPLIANCE WELL HORIZONTAL PATHRAE MODEL RESULTS FOR THE 0.265 cm/yr TOP SLOPE

	7300	7400	7500	7600	7700	7800	7900	8000	8100	8200	8300	8400	8500	8600	8700	8800	8900	9000	9100	9200	9300	9400	9500	9600
Am-243	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
K-40	9.0E+01	7.9E+02	3.4E+02	8.0E+01	1.6E+01	1.2E+02	5.9E+01	1.4E+01	2.7E+00	2.0E+01	9.7E+00	2.3E+00	4.5E-01	2.8E+00	1.5E+00	3.6E-01	7.5E-02	3.9E-01	2.4E-01	5.8E-02	1.2E-02	5.6E-02	3.8E-02	9.5E-03
Pu-239	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pu-240	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pu-242	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ra-226	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Th-230	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Th-232	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
U-233	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
U-234	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
U-235	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
U-236	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
U-238	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

TABLE 9. RADIONUCLIDE CONCENTRATIONS (pCi/L) AT THE COMPLIANCE WELL HORIZONTAL PATHRAE MODEL RESULTS FOR THE 0.265 cm/yr TOP SLOPE

	9700	9800	9900	10000	10100	10200	10300	10400	10500	10600	10700	10800	10900	11000	11100	11200	11300	11400	11500	11600	11700	11800	11900	12000
Am-243	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
K-40	1.9E-03	7.8E-03	6.0E-03	1.5E-03	3.0E-04	1.0E-03	9.1E-04	2.3E-04	4.7E-05	1.3E-04	1.4E-04	3.5E-05	7.4E-06	1.7E-05	2.1E-05	5.5E-06	1.1E-06	2.1E-06	3.2E-06	8.6E-07	1.8E-07	2.5E-07	4.6E-07	1.2E-07
Pu-239	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pu-240	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pu-242	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ra-226	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Th-230	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Th-232	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
U-233	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
U-234	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
U-235	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
U-236	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
U-238	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

TABLE 10. RADIONUCLIDE CONCENTRATIONS (pCi/L) AT THE WATER TABLE--VERTICAL PATHRAE MODEL RESULTS FOR THE 0.364 cm/yr SIDE SLOPE

	EXCEEDS	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400
Am-243	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
K-40	400	0	0	0	0	1.9E+05	2.1E+03	2.2E+01	2.5E-01	1.7E+08	1.9E+06	2.0E+04	8.7E+02	1.7E+09	1.9E+07	2.0E+05	4.4E+05	3.2E+09	3.6E+07	3.7E+05	1.0E+07	2.4E+09	2.6E+07	2.8E+05	3.3E+07
Pu-239	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pu-240	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pu-242	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ra-226	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Th-230	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Th-232	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
U-233	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
U-234	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
U-235	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
U-236	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
U-238	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

NOTE: Year to exceed GWPL reported to next lowest model output year. -1 indicates nuclide does not exceed GWPL within the 12,000 years modeled

TABLE 10. RADIONUCLIDE CONCENTRATIONS (pCi/L) AT THE WATER TABLE--VERTICAL PATHRAE MODEL RESULTS FOR THE 0.364 cm/yr SIDE SLOPE

	2500	2600	2700	2800	2900	3000	3100	3200	3300	3400	3500	3600	3700	3800	3900	4000	4100	4200	4300	4400	4500	4600	4700	4800
Am-243	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
K-40	8.5E+08	9.3E+06	9.8E+04	3.1E+07	1.7E+08	1.8E+06	1.9E+04	1.4E+07	2.5E+07	2.7E+05	2.8E+03	3.7E+06	2.8E+06	3.0E+04	3.2E+02	6.9E+05	2.8E+05	3.0E+03	3.2E+01	9.9E+04	2.3E+04	2.5E+02	2.7E+00	1.2E+04
Pu-239	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pu-240	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pu-242	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ra-226	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Th-230	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Th-232	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
U-233	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
U-234	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
U-235	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
U-236	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
U-238	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

TABLE 10. RADIONUCLIDE CONCENTRATIONS (pCi/L) AT THE WATER TABLE--VERTICAL PATHRAE MODEL RESULTS FOR THE 0.364 cm/yr SIDE SLOPE

	4900	5000	5100	5200	5300	5400	5500	5600	5700	5800	5900	6000	6100	6200	6300	6400	6500	6600	6700	6800	6900	7000	7100	7200
Am-243	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
K-40	1.9E+03	2.0E+01	2.1E-01	1.3E+03	1.4E+02	1.5E+00	1.6E-02	1.2E+02	1.0E+01	1.1E-01	1.1E-03	1.1E+01	7.1E-01	7.5E-03	8.0E-05	9.0E-01	4.7E-02	5.0E-04	5.3E-06	6.8E-02	3.0E-03	3.2E-05	3.4E-07	5.0E-03
Pu-239	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pu-240	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pu-242	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ra-226	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Th-230	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Th-232	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
U-233	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
U-234	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
U-235	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
U-236	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
U-238	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

TABLE 10. RADIONUCLIDE CONCENTRATIONS (pCi/L) AT THE WATER TABLE--VERTICAL PATHRAE MODEL RESULTS FOR THE 0.364 cm/yr SIDE SLOPE

	7300	7400	7500	7600	7700	7800	7900	8000	8100	8200	8300	8400	8500	8600	8700	8800	8900	9000	9100	9200	9300	9400	9500	9600
Am-243	0	0	0	0	0	0	0	0	0	0	0	1.0E-11	2.5E-10	1.4E-10	4.5E-11	1.3E-11	0	0	0	0	0	0	0	0
K-40	1.9E-04	2.0E-06	2.1E-08	3.7E-04	1.2E-05	1.3E-07	1.4E-09	2.6E-05	7.5E-07	7.9E-09	8.4E-11	1.8E-06	4.7E-08	4.9E-10	0	1.2E-07	2.8E-09	3.0E-11	0	7.5E-09	1.7E-10	0	0	4.9E-10
Pu-239	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pu-240	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pu-242	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ra-226	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Th-230	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Th-232	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
U-233	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
U-234	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
U-235	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
U-236	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
U-238	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

TABLE 10. RADIONUCLIDE CONCENTRATIONS (pCi/L) AT THE WATER TABLE--VERTICAL PATHRAE MODEL RESULTS FOR THE 0.364 cm/yr SIDE SLOPE

	9700	9800	9900	10000	10100	10200	10300	10400	10500	10600	10700	10800	10900	11000	11100	11200	11300	11400	11500	11600	11700	11800	11900	12000
Am-243	0	0	0	0	0	0	0	0	2.2E-07	1.3E-06	6.4E-07	2.1E-07	6.0E-08	1.7E-08	4.5E-09	1.2E-09	3.3E-10	9.1E-11	2.5E-11	0	0	0	0	0
K-40	1.0E-11	0	0	2.9E-11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pu-239	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pu-240	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pu-242	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ra-226	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Th-230	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Th-232	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
U-233	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
U-234	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
U-235	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
U-236	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
U-238	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

DOCKETED 01/18/05

SERVED 01/18/05

COMMISSIONERS:

Nils J. Diaz, Chairman
Edward McGaffigan, Jr.
Jeffrey S. Merrifield

In the Matter of LOUISIANA ENERGY SERVICES, L.P. (National Enrichment Facility)	Docket No. 70-3103-ML

CLI-05-05

MEMORANDUM AND ORDER

I. Introduction

In CLI-04-25,[1] the Commission accepted for review the issue whether depleted uranium from a uranium enrichment facility appropriately may be categorized as a "low-level radioactive waste," assuming the intent to treat the material as a "waste" requiring disposal instead of utilizing the material as a "resource." We directed the parties to submit briefs on the issue. For the reasons given below, we conclude that depleted uranium is properly considered a low-level radioactive waste.

II. Background

At issue is a contention on waste disposal submitted by intervenors Nuclear Information and Resource Service (NIRS) and Public Citizen (PC).[2] The contention claims that the

---

[1] 60 NRC 223 (2004).

[2] As originally submitted by the intervenors, the contention was titled "waste storage and disposal" and given the number "2.1." As admitted by the Board, the contention is titled "NIRS/PC EC-3/TC-1 – Depleted Uranium Hexafluoride Storage and Disposal."

applicant, Louisiana Energy Services, L.P. (LES), does not have a "plausible strategy" for disposal of the depleted uranium hexafluoride (DUF6) waste that the LES facility will produce.[3] Most of the intervenors' contention challenged LES's first proposed strategy -- indeed its "preferred plausible strategy"[4] -- to dispose of the depleted uranium through *private* sector conversion and disposal of the tails.[5] However, one basis for the intervenors' contention challenged a second option proposed by LES for disposition of the tails: transfer of the tails to the Department of Energy (DOE), pursuant to Section 3113 of the USEC Privatization Act.[6]

Section 3113(a) of the USEC Privatization Act requires DOE, if requested, "to accept for disposal low-level radioactive waste, including depleted uranium if it were ultimately determined to be low-level radioactive waste," generated by "any person licensed by the Nuclear Regulatory Commission to operate a uranium enrichment facility."[7] Consequently, the hearing notice issued for this proceeding specified that "an approach by LES to transfer to DOE for disposal by DOE of LES['s] depleted tails pursuant to Section 3113 of the USEC Privatization Act" would "constitute[] a 'plausible strategy'" for disposal of the depleted tails if the tails could be considered low-level radioactive waste under 10 C.F.R. Part 61.[8] The hearing notice also stated

---

[3] *See* Petition to Intervene by NIRS/PC (April 6, 2004)("Intervenors' Petition/Contention") at 25-31.

[4] *See* National Enrichment Facility Environmental Report, Rev. 2 (July 2004)("Environmental Report") at 4.13-8.

[5] The Board admitted the intervenors' "private sector" claim, and the Commission affirmed that aspect of the Board's "plausible strategy" decision. *See* CLI-04-25, 60 NRC at 226.

[6] *See* Intervenors' Petition/Contention at 27-31; Environmental Report at 4.13-8 to 4.13-9.

[7] 42 U.S.C. 2297h-11 (2000). The Act also provides that the generator of the waste must reimburse DOE for cost of the disposal.

[8] *See Louisiana Energy Services, L..P.* (National Enrichment Facility), CLI-04-3, 59 NRC 10, 22 (2004), *reprinted in* 69 Fed. Reg. 5873, 5877 (Feb. 6, 2004).

that if LES did not demonstrate a use as a resource for the uranium in the depleted tails, the tails "may be considered waste,"[9] and if "such waste meets the definition of 'waste' in 10 C.F.R. § 61.2, the depleted tails are to be considered low-level radioactive waste within the meaning of 10 C.F.R. Part 61."

In challenging LES's proposed strategy (termed "Option 2") to dispose of the depleted uranium tails by transfer to DOE, the intervenors stressed that this option would be "plausible" only if the "NRC makes a formal determination that [depleted uranium tails] are low-level radioactive waste."[10] Their contention goes on to argue that depleted uranium is not low-level radioactive waste, and that therefore the proposed strategy to have DOE accept, convert, and dispose of the depleted uranium tails is not a "plausible" strategy.[11]

The current issue before us is a narrow one. We consider only whether depleted uranium is properly considered low-level radioactive waste, and thus whether transfer of the LES tails to DOE pursuant to Section 3112 of the USEC Privatization Act constitutes a "plausible strategy" for disposal of the tails. We need not address any of the other waste disposal options, including particular disposal methods (*e.g.*, engineered trenches, concrete vaults, underground mine) that LES has proposed.

To understand all the issues discussed in this order requires some knowledge of 10 C.F.R. Part 61, which sets out the performance objectives for disposal of low-level radioactive waste, and includes a classification scheme -- and related technical disposal requirements -- for near-surface disposal of low-level radioactive waste. We begin, therefore, with a brief background description of Part 61. Next, we address the relevant statutory definitions of low-

---

[9] LES states that it will "make a determination as to whether the depleted uranium is a resource or a waste and will notify the NRC." *See* Environmental Report at 4.13-7.

[10] Intervenors' Petition/Contention at 28.

[11] *See id.* at 27-31.

level radioactive waste. We then turn to why the intervenors' contention contains a misunderstanding of Part 61 and of what constitutes low-level radioactive waste. We conclude with our reasons why depleted uranium should be properly characterized as a low-level radioactive waste.

III. Analysis

A. Background On Part 61

Part 61 contains the NRC's licensing requirements for land disposal of low-level radioactive waste. The regulations include general performance objectives applicable to any method of land disposal of low-level radioactive waste.[12] Land disposal – as opposed to sea or extraterrestial disposal – includes both disposal near the earth's surface and deeper disposal. "Near-surface" methods of disposal involve disposal at a depth of approximately 30 meters (although burial deeper than 30 meters may also be acceptable).[13] More protective methods of land disposal, often called "intermediate" land disposal,[14] may involve deeper burial than near-surface disposal, a mined cavity, or special engineered barriers or disposal techniques.[15] The definition of "land disposal" facilities excludes only a geologic repository,[16] for such facilities are regulated under Part 60 or 63.

While Part 61 contains general performance objectives -- specifying limits on radiation

---

[12] 10 C.F.R. § 61.7(a).

[13] *Id.*

[14] *See, e.g.,* Final Rule, "Disposal of Radioactive Wastes," 54 Fed. Reg. 22,578, 22,580-22,581 (May 25, 1989).

[15] *See, e.g.,* Draft Environmental Impact Statement on Part 61, "Licensing Requirements for Land Disposal of Radioactive Waste," NUREG-0782, Vol. 2 at 1-2, 2-4, 2-5 (Sept. 1981).

[16] *See* 10 C.F.R. § 61.2.

dose levels -- applicable to *any* form of land disposal of low-level radioactive waste, it also contains specific technical requirements for near-surface disposal of radioactive waste.[17] Part 61 establishes a classification scheme for those types of low-level radioactive wastes considered "generally acceptable for near-surface disposal."[18] Such wastes are divided into three classes: A, B, and C.

The suitability of wastes for near-surface disposal and their appropriate classification (*e.g.*, Class A, B, or C) is determined by the amounts of long-lived and short-lived radionuclides contained in the waste, and whether radiation dose levels will drop to acceptable levels over specified periods of time.[19] Safety objectives for near-surface disposal include assuring stability of the waste and of the disposal site after closure -- in other words, assuring that the waste form maintains its structural integrity. Specific goals include protecting against inadvertent intruders and minimizing water's access to waste (to limit the potential for radionuclides migrating).[20] Compared to Class A waste, Class B waste requires "more rigorous requirements on waste form to ensure stability after disposal."[21] Class C waste "not only must meet more rigorous requirements on waste form to ensure stability but also requires additional measures at the disposal facility" to protect against inadvertent intrusion.[22]

Those low level radioactive wastes with radionuclide concentration limits even greater than the limits specified for Class C – commonly termed GTCC [Greater Than Class C] waste -

---

[17] *See* 10 C.F.R. §§ 61.7; 61.50.

[18] *See* Final Rule, "Licensing Requirements for Land Disposal of Radioactive Waste," 47 Fed. Reg. 57,446, 57,452 (Dec. 27, 1982)(Final Rule, "Licensing Requirements").

[19] *See* 10 C.F.R. §§ 61.55(a)(3); 61.55(a)(4).

[20] *See* 10 C.F.R. §§ 61.7(b)(1); 61.7(b)(2).

[21] 10 C.F.R. § 61.55(a)(2)(ii).

[22] 10 C.F.R. § 61.55(a)(2)(iii).

are "generally unacceptable for near-surface disposal," although on a case-by-case basis and with proposed "special processing or design" such waste may be approved as suitable for near-surface disposal.[23] Moreover, even if a particular form of GTCC waste does not meet the Part 61 requirements for near-surface disposal, it may still be acceptable for disposal by more protective land disposal methods, if the Part 61 performance objectives for land disposal can be met.[24]

We turn now to the intervenors' contention, specifically as it challenges LES's proposed strategy for DOE to dispose of depleted uranium.

B. The USEC Privatization Act and NIRS/PC Contention on DOE Strategy

The USEC Privatization Act requires DOE to accept for disposal depleted uranium from any NRC uranium enrichment licensee, if depleted uranium is "ultimately determined to be low-level radioactive waste."[25] The statute does not specify any further conditions, such as whether the depleted uranium waste also meets NRC requirements for near-surface disposal or any other method of disposal, or whether it falls within a particular class of low-level radioactive waste (*e.g.*, A, B, etc.). Under the statute, therefore, if LES's depleted uranium is low-level waste, regardless of radionuclide concentration, DOE must accept it for disposal.

The hearing notice in this proceeding specified one way of showing that the depleted uranium tails are low-level waste: if the tails meet the definition of "waste" in 10 C.F.R. § 61.2. That definition reads as follows: "*Waste* means those low-level radioactive wastes containing source, special nuclear, or byproduct material that are acceptable for disposal in a land disposal

---

[23] *Id.*

[24] *See, e.g.*, 10 C.F.R. §§ 61.55(a)(2)(iv); 61.58.

[25] 42 U.S.C. § 2297h.

facility."

Recently, the Commission received a brief from USEC, Inc., which is not a party to this proceeding, but like LES, also has pending before the NRC an application to construct and operate a uranium enrichment facility, and therefore has an interest in whether the transfer of depleted uranium tails to DOE is a plausible waste disposal strategy.[26] USEC submits that depleted uranium tails "do *not* need to meet the 10 C.F.R. 61.2 definition of "Waste" to be considered LLW."[27] We agree.

The term "waste" in the Part 61 definition is very clearly, as USEC states, "a subset of the larger category of LLW," and refers specifically to "*those*" low-level wastes that are acceptable for land disposal under Part 61.[28] This is evident from the "waste" definition itself, and from the broader definition of *low-level radioactive waste* that immediately follows it in § 61.2:

> [L]ow-level waste has the same meaning as in the Low-Level Waste Policy Act, that is, radioactive waste not classified as high-level radioactive waste, transuranic waste, spent nuclear fuel, or byproduct material as defined in section 11e.(2) of the Atomic Energy Act (uranium or thorium tailings and waste).

Most low-level radioactive wastes likely would be acceptable for some form of land disposal, and thus would fall within the § 61.2 "waste" definition,[29] given the wide array of

---

[26] The Commission chose to treat the USEC brief as an *amicus* filing in this proceeding, and allowed the parties to respond to the brief. *See* Order (12/01/04)(unpublished).

[27] USEC, Inc. Brief on the Proper Classification of Depleted Uranium Tails (Oct. 18, 2004)("USEC Brief") at 6 (emphasis in original).

[28] *Id.*

[29] *See, e.g.,* Proposed Rule, "Licensing Requirements for Land Disposal of Radioactive Waste," 46 Fed. Reg. 38,081, 38,082 (July 24, 1981)(emphasis added)("Part 61 is intended to deal with the disposal of *most* wastes included in this [Low-Level Radioactive Waste Policy Act] definition)." Whether a low-level radioactive waste is "acceptable for land disposal" depends upon whether (1) the waste meets the Part 61 criteria for near-surface disposal, or (2) the NRC,

potential land disposal methods – near-surface and intermediate – that may be governed under Part 61.[30] (Only a geologic repository – which instead is regulated under Part 60 or 63 – is not encompassed by the Part 61 definition of "land disposal" facilities.)[31] Nonetheless, USEC is correct that the § 61.2 "waste" definition does not "represent a comprehensive definition of LLW [low-level waste]," and thus that, conceivably, some materials "may not meet the [Part 61] definition of '[w]aste' ... but nevertheless may properly be classified as LLW [low-level waste]."[32]

The "plausible strategy" contention before us concerns LES's proposed strategy to dispose of depleted uranium by transfer to DOE, pursuant to the USEC Privatization Act. That Act does not mention Part 61 and refers generally to "low-level radioactive waste," not to an NRC-established subset of that waste. We therefore agree with USEC that in determining whether the proposed DOE option is a "plausible strategy," we need not resolve the question whether the LES depleted uranium tails also would meet the "waste" definition in § 61.2. As USEC states, "inclusion of the reference to the [Part 61] definition of "Waste"' in the hearing notice added an unnecessary requirement for showing that material is low-level radioactive waste.[33] Our inquiry must begin with the USEC Privatization Act and how it expressly defines

---

after evaluating the "specific characteristics of the waste, disposal site, and method of disposal," finds reasonable assurance that radiation exposures will not exceed the limits established in the Part 61 performance objectives for land disposal. *See* 10 C.F.R. §§ 61.58; 61.55(a)(2)(iv); 61.40 ; 61.55 (requirements for near-surface disposal).

[30] *See, e.g.*, 10 C.F.R. §§ 61.7(a); Final Rule, "Disposal of Radioactive Wastes," 54 Fed. Reg. at 22,581.

[31] *See* 10 C.F.R. § 61.2; Final Rule, "Disposal of Radioactive Wastes," 54 Fed. Reg. at 22,580. The NRC has regulations for "specific types of disposal facilities .... Part 60 applies to any geologic repository for HLW [high-level waste], regardless of what other types of radioactive wastes may be disposed of there," while "Part 61 pertains to land disposal facilities other than repositories." Final Rule, "Disposal of Radioactive Wastes," 54 Fed. Reg. at 22,579.

[32] USEC Brief at 6.

[33] *Id.*

low-level waste.

Section 3102 of the USEC Privatization Act specifies that "'low-level radioactive waste' has the meaning" set forth in section 2(9) of the Low-level Radioactive Waste Policy Act.[34] In turn, section 2(9) of the Act[35] defines low-level radioactive waste as radioactive material that:

> (A) is not high-level radioactive waste, spent nuclear fuel, or byproduct material (as defined in section 11e.(2) of the Atomic Energy Act of 1954 (42 U.S.C. 2014(e)(2)))[36] and
>
> (B) the Nuclear Regulatory Commission, consistent with existing law and in accordance with paragraph (A), classifies as low-level radioactive waste.

The intervenors' contention does not contend that LES's depleted uranium tails will contain high-level radioactive waste, spent nuclear fuel, or 11e.(2) byproduct material. In other words, their contention nowhere suggests that depleted uranium falls into any other general category of waste other than low-level radioactive waste. Instead, the contention reflects a misunderstanding of the structure and content of Part 61 and its relation to the Low-Level Radioactive Waste Policy Act, which determines ultimately what kinds of wastes may fall under the "umbrella" category of low-level radioactive waste.

Specifically, in challenging the DOE disposal strategy option, the intervenors argue that "[t]he classification of low-level waste can apply only to waste that would clearly be appropriate for shallow land disposal and 100 year institutional control," and that depleted uranium "meets neither requirement."[37] The contention further argues that "[t]he long half-life of all three

---

[34] 42 U.S.C. § 2297h.

[35] 42 U.S.C. § 2021b(9).

[36] The 10 C.F.R. § 61.2 definition of low-level radioactive waste also excludes transuranic waste, as does the low-level radioactive waste definition in the Nuclear Waste Policy Act of 1982 (*see* 42 U.S.C. § 10102). Depleted uranium tails are not transuranic waste.

[37] *See* Intervenors' Petition/Contention at 28.

uranium isotopes ..., the fact that they are all alpha emitters, and the specific activity of DU [depleted uranium] ... all point to the classification of DU as GTCC [greater-than-Class-C] waste."[38] The intervenors conclude that depleted uranium as proposed for disposal by LES is unsuitable for near-surface disposal and will require disposal in a deep geologic repository. None of these arguments, however, even if correct, would preclude categorizing depleted uranium as a low-level radioactive waste.

To begin with, the intervenors' suggestion that only wastes suitable for disposal by near surface methods can be categorized as low-level radioactive wastes is patently incorrect. Part 61 identifies three classes of waste typically suitable for near-surface disposal – Classes A, B, and C – but in no way suggests that these are the only wastes considered low-level radioactive waste, or even that Part 61 applies only to such wastes. On the contrary, Part 61 explicitly governs "*any* method of land disposal" of low-level radioactive waste, including methods more stringent than near-surface.[39] Low-level radioactive wastes are not limited to those suitable for near-surface disposal.

Indeed, when Part 61 was issued, its Environmental Impact Statement explicitly acknowledged that the NRC might receive license applications involving disposal of low-level radioactive waste requiring either an enhanced near-surface disposal method or "intermediate" land disposal methods. It was -- and remains -- the NRC's intent to "retain the flexibility to be able to address these license applications in the existing framework of the [Part 61] rule."[40] Thus, Part 61 did not originally "establish an absolute concentration limit for land disposal of

---

[38] *Id.* at 29.

[39] 10 C.F.R. § 61.7(a)(emphasis added).

[40] FEIS for Part 61, Vol. 2, at B-92.

transuranic or other radionuclides."[41] The Part 61 performance objectives would govern all applications involving land disposal of low-level radioactive waste, including waste that might require more isolation than near-surface methods.

In the end, the "bottom line for disposal" of low-level radioactive wastes are the *performance objectives* of 10 C.F.R. Subpart C,[42] which set forth the ultimate standards and radiation limits for (1) protection of the general population from releases of radioactivity; (2) protection of individuals from inadvertent intrusion; (3) protection of individuals during operations; (4) and stability of the disposal site after closure.[43] Thus, while there may not yet be detailed technical criteria established for all of the kinds of land disposal that might be proposed under Part 61, criteria can be developed "on a case-by-case basis," as needed.[44] After all, any technical requirements are "intended to help ensure that the performance objectives established in Subpart C are met," but they are "not the end in themselves, ... [only] a means of achieving the end,"[45] which are the performance standards. Specific disposal requirements for more stringent land disposal methods, therefore, "were left to be addressed in action on a specific application, subsequent guidance, and rulemaking effort, if rulemaking is

---

[41] *Id.*

[42] Final Environmental Impact Statement (FEIS) On 10 C.F.R. Part 61 "Licensing Requirements for Land Disposal of Radioactive Waste," NUREG-0945, Vol. 2 (Nov. 1982)("FEIS for Part 61") at B-107.

[43] 10 C.F.R. §§ 61.41, 61.42, 61.43, 61.44.

[44] *See, e.g.* Final Rule, "Licensing Requirements for Land Disposal of Radioactive Wastes," 58 Fed. Reg. 33,886, 33,887 (June 22, 1993)(clarifying that Part 61 performance objectives can apply to the licensing of above-ground disposal facilities for low-level radioactive waste, although Part 61 does not contain technical criteria specific to above-ground disposal).

[45] FEIS for Part 61, Vol. 2 at B-91.

warranted."[46]

In any event, low-level radioactive waste can encompass both those wastes suitable for near-surface disposal and those that may require greater isolation. That a particular waste might not meet the requirements for near-surface disposal does not mean it is not low-level waste. Recognizing this defeats the intervenors' contention attacking the DOE disposal option. At its heart that contention rests on the intervenors' claim that depleted uranium "fits into the waste category of GTCC [greater-than-Class-C] waste" because of its specific radioactivity and because it has long-lived radiation-emitting isotopes.[47] But GTCC waste is itself a form of *low-level radioactive waste*. It is a "low-level radioactive waste that exceeds the concentration limits of radionuclides established for Class C waste in § 61.55" of Part 61.[48] Thus, even if we assume that the intervenors are correct, and that the depleted uranium from the LES facility conceivably might ultimately be classified as GTCC waste, such waste is a form of low-level radioactive waste.[49]

Since its inception, Part 61 has treated GTCC waste as low-level radioactive waste. Part 61 established radionuclide concentration limits for the first three classes of low-level

---

[46] Branch Technical Position Statement On Licensing of Alternative Methods of Disposal of Low-Level Radioactive Waste, 51 Fed. Reg. 7806, 7807 (Mar. 6, 1986); *see also* Final Rule, Licensing Requirements, 47 Fed. Reg. at 57,451; Final Rule, "Disposal of Radioactive Wastes," 54 Fed. Reg. at 22,581, 22,579. Because no intermediate land disposal facilities ever were constructed, the NRC never had the need to develop and issue regulations outlining specific technical requirements for land disposal methods other than near surface disposal.

[47] *See* Intervenors' Petition/Contention at 29-30.

[48] *See* 10 C.F.R. §72.3.

[49] *See generally* Final Rules, Disposal of Radioactive Wastes, 54 Fed. Reg. 22,578 (discussing "greater-than-Class-C (GTCC) low level radioactive waste); *see also, e.g.*, Interim Storage for Greater Than Class C Waste, 66 Fed. Reg. 51,823 (Oct. 11, 2001)(while GTCC waste is generally unsuitable for near-surface disposal "it is considered as LLW [low-level waste]."

radioactive wastes (A, B, and C), but never considered that those wastes that do not fall within the other defined waste categories (*e.g.*, high-level waste, spent nuclear fuel) but simply exceed the Class C limits in § 61.55 are anything other than a low-level radioactive waste, albeit one not typically suitable for near-surface disposal.[50] Among the 3 classes of low-level radioactive wastes that are routinely acceptable for near-surface disposal, Class C waste "denotes the highest radionuclide concentrations of the three [classes];" but Class C waste "does not denote a maximum concentration limit for low-level wastes."[51] Because "there is no regulatory limit on the concentrations of LLW [low-level waste] ... some LLW (exceeding Class C concentrations) may [even] have concentrations approaching those of HLW [high-level waste]."[52]

Indeed, in 1989 the NRC considered revising the definition of *high-level* radioactive waste to include Greater-Than-Class-C wastes because intermediate land disposal facilities had not yet become available. But the agency explicitly chose to maintain GTCC wastes within the category of low-level wastes, concluding that to assure the safe disposal of GTCC waste it would be unnecessary and counter-productive to alter waste category definitions.[53] Instead of broadening the high-level waste definition, the NRC amended Part 61 to highlight the need for prior NRC approval of land disposal methods for GTCC, and to state that without such approval the GTCC waste would require disposal in a geologic repository. Even so, the agency stressed that while GTCC waste is "not generally acceptable for near-surface disposal," and thus may require disposal methods "more stringent" than near-surface disposal, a geologic repository is

---

[50] *See generally*, Draft Environmental Impact Statement on 10 C.F.R. Part 61 'Licensing Requirements for Land Disposal of Radioactive Waste,' NUREG-0782, Vol. 2 (Sept. 1981).

[51] Advance Notice of Proposed Rulemaking, "Definition of High-Level Radioactive Waste," 52 Fed. Reg. 5992, 5994 (Feb. 27, 1987).

[52] *Id.*

[53] *See generally*, Final Rule, Disposal of Radioactive Wastes, 54 Fed. Reg. 22,578.

only *one* of several potential "more stringent" disposal methods for GTCC waste.[54] Various alternative or "intermediate" land disposal methods for GTCC wastes could be approved by the Commission,[55] such as disposal at an intermediate depth, or disposal with special engineered barriers. In short, as we discussed above, "[a] wide variety of disposal methods, including all of those currently proposed as 'intermediate' disposal methods could be licensed under Part 61,"[56] taking into consideration the Part 61 performance objectives and applicable radiation standards.

Under Part 61, GTCC low-level waste may be acceptable for disposal in a near-surface disposal facility with special design provisions, or acceptable for land disposal in an intermediate land disposal facility.[57] But even if it were sent to a geologic repository governed under Part 60 -- a choice that conceivably could be made for cost reasons -- it would still be "GTCC [greater-than-Class-C] LLW [low-level waste]." [58]

In sum, the intervenors' challenge to the DOE disposal option as a "plausible strategy" for disposal of the LES depleted uranium tailings rests on inaccurate premises -- that only waste suitable for near-surface disposal can be low-level radioactive waste and that GTCC waste is not a low-level waste. Because these assumptions are incorrect on their face, the portion of the intervenors' contention challenging the DOE disposal option does not raise a "genuine dispute ... on a material issue" for litigation as our contention rules require.[59] While the contention

---

[54] *See id.,* 54 Fed. Reg. at 22,580.

[55] *Id.*

[56] *Id.,* 54 Fed. Reg. at 22,581; *see also id.*, 54 Fed. Reg. at 22,578.

[57] *See* 10 C.F.R. §§ 61.7(b)(5); 61.58, 61.55(a)(2)(iv).

[58] *See* Final Rule, Disposal of Radioactive Wastes, 54 Fed. Reg. at 22,578, 22,579-81.

[59] *See* 10 C.F.R. § 2.309(f)(1).

raises factual arguments over whether the LES waste may properly be disposed of in a near-surface waste disposal facility (a matter we need not resolve today), such allegations are simply not material to the DOE "plausible strategy" issue before us. Even if proved, they would not show that depleted uranium should be categorized as anything other than a low-level radioactive waste. It is depleted uranium's status as low-level radioactive waste, not its suitability (or non-suitability) for near-surface disposal, that triggers DOE's statutory duty to accept the waste for disposal under the USEC Privatization Act.

C. Depleted Uranium is a Low-Level Radioactive Waste

In assessing whether the proposed DOE disposal option is a "plausible strategy," the *only* question to be answered is whether depleted uranium is a low-level radioactive waste, not whether it meets one of the particular low-level waste classifications, or whether a near-surface disposal facility will be adequate. Consistent with the Low-Level Radioactive Waste Policy Act, the Commission finds that depleted uranium, assuming it is not treated as a resource, is appropriately categorized as a low-level radioactive waste. Depleted uranium is not high-level waste, spent nuclear fuel, 11e.(2) byproduct material, or transuranic waste as those waste categories are currently defined under relevant statutes and regulations.[60] Further, no other statute, regulation, or consideration either precludes or would render inappropriate identifying depleted uranium as a low-level radioactive waste.

Low-level waste traditionally has been defined by what it is not. Thus, both the "Low-Level Radioactive Waste Policy Act, and the Commission's regulations in 10 C.F.R. Part 61 currently classify wastes as 'low-level' if they are not otherwise classified as high-level wastes or

---

[60] *See, e.g.*, NWPA, 42 U.S.C. §§ 10101(12); 10101(23); AEA, 42 U.S.C. § 2014e(2);10 C.F.R. § 60.2.

certain other types of materials (*e.g.*, uranium mill tailings)"[61] and the Commission further finds the categorization appropriate. Depleted uranium clearly is not spent fuel, transuranic waste, or 11e.(2) byproduct material. Nor does it meet the high-level waste definition, which includes specific kinds of wastes such as irradiated fuel and the liquid and solid wastes resulting from the processing of irradiated fuel. Indeed, as we recounted above, the NRC years ago considered but explicitly rejected the idea of broadening the high-level waste definition to encompass those low-level wastes with the highest radionuclide concentrations -- the GTTC wastes.[62] Regardless of which form the uranium may take at the time of disposal (*e.g.* UF6 or U3O8) or its radionuclide concentration, depleted uranium belongs most appropriately under the general low-level radioactive waste category. In the event depleted uranium at some particular radionuclide concentration level and volume were to require disposal by methods more stringent than near-surface disposal, it would still be low-level waste.

Although the Commission itself may not have explicitly declared previously, as a matter of law, that depleted uranium is a form of low-level radioactive waste, it has long been understood within the NRC to fall within the low-level radioactive waste umbrella.[63] A more

---

[61] 52 Fed. Reg. at 5997; *see also* 10 C.F.R. § 61.2 (low-level waste definition, following "waste" definition).

[62] *See generally*, Final Rule, Disposal of Radioactive Wastes, 54 Fed. Reg. 22,578.

[63] For example, in the proposed Part 61 rule, depleted uranium was one of the radionuclides included in the low-level waste classification charts found in 10 C.F.R. § 61.55, with assigned upper bound concentration limits for near-surface disposal. *See* Proposed Rule, 46 Fed. Reg. at 38,097. Prior to issuance of the final rule, however, the staff removed uranium from the charts because at the time the types of uranium-bearing material typically disposed of by NRC licensees did not pose a sufficient safety hazard to warrant inclusion in the charts. *See* FEIS (Part 61), Vol. 1 at 5-37 to 5-38. But at no point did the staff suggest that depleted uranium waste – at any radionuclide concentration – would be anything other than a low-level radioactive waste.

Before the Commission, the intervenors cite a 1991 SECY paper titled the "Disposition of Depleted Uranium From Enrichment Plants," highlighting the "unique licensing issue" presented by disposal of depleted uranium from a uranium enrichment plant. *See* SECY-91-019 (Jan. 25, difficult question – and one we need not answer today -- concerns whether the LES material, in the volumes and concentration proposed, will meet the Part 61 requirements for near-surface disposal. The Commission agrees with the intervenors that a definitive conclusion on this and other disposal method questions cannot be reached at this time, and may require further environmental or safety analysis. Our decision should not be read to intimate any Commission view on this issue, which relates both to the plausibility of LES's proposed private disposal options, and to financial assurance -- issues which remain before the Board.[64]

IV. Conclusion

We conclude today that depleted uranium properly is considered a form of low-level radioactive waste. Accordingly, pursuant to Section 3113 of the USEC Privatization Act, disposal of the LES depleted uranium tails at a DOE facility represents a "plausible strategy" for disposition of the tails. We therefore reverse the admission to this proceeding of the portion of the intervenors' plausible strategy contention NIRS/PC EC-3/TC-1 that challenges the DOE disposal option (termed Basis "D" in the intervenors' contention and renamed by the Board

---

1991). The paper nonetheless concludes that if depleted uranium from uranium enrichment facilities is treated as a waste instead of a resource, "it is a unique form of *low-level waste* that would require disposal." *Id.* at 4 (emphasis added).

[64] *See* Contention NIRS/PC EC-5/TC-2 AGNM TC-i (Decommissioning Costs); NIRS/PC EC-6/TC-3 (Costs of Management and Disposal of Depleted UF6). It appears that when the intervenors discuss the question whether material may be disposed of as "low-level waste," they may mean whether near-surface disposal is acceptable. But as we have explained at length in today's decision, that is not a question we need answer in considering the plausible strategy contention.

Another point warrants mention. In accepting review of whether depleted uranium is a low-level radioactive waste, the Commission in CLI-04-25 directed the parties to address 10 C.F.R. § 61.55(a)(6), a rule that we believed might bear on our analysis. The parties addressed the rule in their briefs. However, because our decision rests on the relevant statutes – the USEC Privatization Act and the Low-Level Radioactive Waste Policy Act – we need not reach the issues concerning § 61.55(a)(6) that have been presented in the briefs.

Basis "C").

IT IS SO ORDERED.

For the Commission

/RA/

Annette L. Vietti-Cook
Secretary of the Commission

Dated at Rockville, Maryland
this 18th day of January 2005.

Radiation Control Board Minutes
January 12, 2010

Speaker	
	Aye
Chairman	Any opposed?
	I just abstain, I wasn't here.
Chairman	Okay. Note that for the record. Thank you Pauline??
Chairman	Uh, so the motion carries. The minutes are adopted. We're going to change our agenda around a little bit. We'll go ahead I think with agenda item 5 to begin with. If the division staff member is here. John are you here? Are you ready to present? Okay. So we'll go ahead with item 5A first which will be presented by John Holquist from the division.
John	Thank you members of the Board, Chairman. Give you an update on the license condition 35 public comment period. We received about 20 comments from 8 commenters or individuals. I kind of grouped them together just for means of summarizing this for us. There was one comment made based on the characteristics of DU that there is not a problem with the disposal at the ___ facility. There were two comments regarding the burial depth of 10 feet that was in the license condition. There was a comment regarding the extension of the public comment period and a public hearing. There was a comment regarding the license condition 35A and there was a lot of editorial language in it and it wasn't relevant to the compliance, to the facility out at 5?? and they provided some revisions to that condition. There was a comment regarding the stability of the disposal site after ___ closure and site closure itself. There was a comment about institutional requirements. There was a comment about the period of performance. There was two comments regarding remediation measures. I think condition E or F, E, talked about removal of that material at some later date if performance assessment was not adequate. We had two comments regarding the surety which I believe was condition F, 35F. We had another comment regarding the proposed language and they provided new language for condition 35 and then there was just one general comment regarding misinformation on radiation subjects in general. Not sure really applied to the condition itself but just the health, physics and radiation safety that the public deals with. So that kind of summarizes how many comments we [pause in tape] what we have to go through. The public comment period request in the public hearing was denied by the division director because there was opportunity for the rulemaking process to add additional comments and there was going to be a public hearing during that phase which we are currently underway so we're working on getting responses to those

Speaker	
	comments and we will continue working on them, so if there's any comments or questions?
Chairman	Dr. Trip?
Dr. Trip?	Do we have any, is the Board going to be privy to what those comments were?
Chairman	Yes _____
Male	Thank you. That was my question for the Board. This is an unusual approach to writing a license condition so my question for the Board is, we will take a first draft of our responses to the comments. John and his people and Laura Lockhart is assisting us in writing those responses. Does the Board want to look at the draft of our responses and weigh in on the response?
?	Yes or at least from my standpoint anyway.
Dr. Trip?	The only question I have is if the condition is appealed we would then be asked to enter an adjudicative process where we would then be expected to well adjudicate the matter and so my question to Ms. Lockhart then would be, would that in any way, if we requested those comments and commented on that, how would that affect that process?
Laura	I'm Laura Lockhart with the Attorney General's office and in this situation because this is a license condition to be approved by the Executive Secretary it makes more sense for it to go that direction without more consideration at that stage.
Chairman	Okay. Does that answer your question Dr. Trip?
Dr. Trip	Well it answers my, it answers my question. I just thought it would be interesting to know what people had to say.
Laura	There would be no problem with sharing the comments.
Dr. Trip	Oh well fine, that's all I would be interested in. I don't think we necessarily have to a long drawn out session discussing each of those 30 points or whatever. I'd just be interested to know what people think. After all, we do represent the public and we need to be cognizant of what they have to say.
Male	Yeah there's no problem with providing you with the comments. My question had to do with the responses that we have to make to those comments. Did the Board want to be involved in crafting the responses

Speaker

	to the comments.
Dr. Trip	I misunderstood because I thought you were saying that you were asking us if we wanted to look at the questions, then your responses after the fact, so to speak.
Male	No, I wouldn't have any problem with it.
Male	Would all the Board members like to be emailed with the comments that were received?
	Please.
	Okay ____ take care of that John.
Chairman	Okay. Thank you. Ed Johnson.
Ed	Question for John. Do you have a projected date now at which this amendment, a best guess, as to when this amendment could be issued and become enforced?
John	I was expecting a question like that, ___ how soon ___ get through these comments. The way things are coming in the door here I don't know, but I wouldn't want to put a hard date on it. I think we can get through most of them in 2-3 weeks barring anything. I don't see anything keeping us from that and then we can get the draft on his desk but of course when you start talking reviews and getting it back, it might be ____ there, maybe a little longer.
Ed Johnson	So maybe 60 days, 2 months from now?
John	I would think so.
Ed Johnson	These amendments might be enforced or issued?
John	Issued by the Executive Secretary? I don't see why not.
Ed Johnson	And as soon as the amendment is issued it becomes a part of the license and it is then enforceable. Is that correct?
John	Correct.
Ed Johnson	Thank you.
Chairman	Other questions? Comments? Pat?

Speaker	
Pat	When is specific, question, we talked about this a little bit [pause in sound] amendment having to do with more specific information on things like the exhumation, digging things up. I mean is that, is the Board's role, does it still have a role in talking about that trying to be a little bit more specific because right now it just talks about getting rid of it. I mean __ come back, ___ discuss that at some point. I just think nothing is spelled out about how it happens, who does it and pays for it, things like that. Or is that something our Executive Secretary can add to that?
Chairman	Are you asking a question?
Pat	Uh hmm.
Chairman	To D___?
Pat	How do we, how do we talk to them, we brought that up before, right now it doesn't really spell out exactly, Mr. Miner just said, well we'll dig it up if it's a problem. I guess I wanted some more specific information about who does it, who pays for it, where it's going if possible, things like that, does that make sense?
Chairman	Yeah.
Male	Once the license amendment has been adopted into the License, then it's Energy Solution's responsibility to provide us the information that you have requested of them through that license condition. Now, and they will provide it to us. The question then becomes, what role does the Board want to have in reviewing that information.
Pat	Right.
Male	Okay so that's your question, not mine.
Pat	And at that point we'll ______ can ________ what they're plan is?
Male	_____ plan.
Chairman	Sorry to stop this discussion. Can everybody hear in the back?
	inaudible
Chairman	So maybe kind of give us a signal if you can start to hear us back there. Okay, so does that answer your question Pat?
Pat	Yeah ____ had that question, wanted to throw that at the Board to see if there's any interest in making sure ___ specific enough.

Speaker

Chairman	Is there any other comments? Dr. Trip?
Dr. Trip	I'm not sure I heard all he had to say. Could you just give me a 25 word summary of what it was you were saying?
Pat	Well and I talked to the Executive Secretary about this, he had the same concerns, about how, specifics of how something gets dug up. I mean who pays for it, how is it done, things like that, I wanted a few more specifics - their proposal when it comes into us about how that actually happens, if it is deemed necessary. That's all I was asking.
Dr. Trip?	And so your response to that Dean? was?
Dean?	Once Energy Solutions has provided the information that is required by the license condition, normally we take that information and we review it, we challenge it, we digest it. But in this case this is slightly different than the routine that we normally have. The Board, if they want to, has the opportunity to review the information too and have input into decisions about that information.
Dr. Trip?	Okay, that's what I thought you said or that's what I wanted to hear. Thanks.
Chairman	Are there any other questions for John? Thank you for your time. Okay, we'll move on to item 5B and we've asked Amanda Smith to give us an update and a briefing on the Governor's agreement with the DOE concerning the current shipment of DU waste.
Amanda	Thanks. I had hoped to have a letter or something to share with you today. There is, maybe some of you have seen it. There's a Department of Energy letter that is addressed to Governor Herbert regarding the agreement. And currently what I can update the Board on is that there are parts of this, a good part of it, that I think the Governor's office agrees to as to the agreement that they had but there are some nuances that are still being negotiated that are not specifically addressed in the DOE letter. So that is continuing on currently and I'm not at liberty to share the specifics on what those nuances are but I believe that the Governor's office is still discussing this with DOE in terms of a second and third shipment and what specifics the division should be working on Energy Solutions with so as soon as we have something we will email it out to the rest of the Board from that end. Specific [pause in sound]
Chairman	We've heard since the press release that there was a 2 month time limit

Speaker

on the agreement. Can you address that issue?

Amanda I can. There's been a little bit of confusion about what the 2-month time period was going to and what the Governor had asked the division to do and had agreed with DOE about is that within a 2-month time period the division, working with Energy Solutions, would look at for this first trainload that has arrived, what specifically are there safety standards that should be in place that aren't currently in place under the license, specifically concerning depth cover height and radon detection so Dave and his staff have proceeded on that and are working with Energy Solutions and there are some other issues that are still in negotiation with DOE. Just today, I should share with the Board that the Governor did ask the department and the division to go out and do independent testing on the drums that have been received from Savannah River. Energy Solutions has already done some testing on some of the drums in those. My understanding is that they have not gotten back the results yet but we will be sending staff out to do independent tests and we'll also bring that information to the Board. But the Governor felt that enough question had been raised that as the regulator we should do independent testing.

Chairman Yes, Ed Johnson?

Ed Johnson And the tests that you'll be performing, Amanda, or Dane?, will be what? Container integrity? Container contents?

Amanda The tests will be done on container content.

Chairman Yes, Dr. Trip?

Dr. Trip Dane, in that regard, relative to the contents, what, will you simply do a gamma ray spectrum of what's there or what's – there's been some word?, some claims made that there are things in there that ought not to be, etc., etc. and obviously gamma ray spectroscopy might be a way of determining what is there.

Dane We determine what the sample gets analyzed for based on a couple of things: (1) how it was manifested and any other information that we have about these materials that would lead us to tell a laboratory, look for something else. So certainly, yeah, gamma spectroscopy is one of the things we would expect the laboratory to do. I'm not prepared to say what else we need to ask a lab to do on our behalf.

Dr. Trip So you're saying another lab independent of, in other words you don't have that facility here locally?

Speaker	
Dane	No, we will have to find ______
Dr. Trip	Find a contractor
Dane	We will find a contract lab, an independent third party contract lab, to analyze the samples we send them.
Dr. Trip	So you'll do maybe gamma spectroscopy. Would you be doing any, would this company, or would you be asking in the contract to do some alpha spectroscopy as well since there are a lot of alpha emitters in that, in the ________?
Dane	You're way ahead of us on that Dave. We've just now started to talk about actually 2:00 when I came back from a meeting, we just started to talk about this sampling that we're going to do so we haven't made any decisions about what we're going to do and how we're going to contract for it. The Governor's guidance was that the sampling should be statistically meaningful.
Ed Johnson?	With an adequate number of samples and adequate tests?
Dane	That's what statistically meaningful means, yes.
Chairman	Yes Pat?
Pat	I had one request and Ed brought it up when he was talking about integrity out there I would guess that when our contractor goes out and takes a look at this if there are any obvious issues having to do with integrity of the containers that those would be brought to our attention, do you think?
Amanda	I just want to clarify Pat that we won't have the contractor go out and do the testing. It will actually be Division staff who will go do the testing and take a look at the containers but the samples will be sent out to another entity for analysis.
Pat	And the answer to the integrity issue?
Dane	My staff has been out there since this shipment has arrived and especially the first few days to observe the offloading of these palletized drums. We have photographs if you'd like to see them and I showed them to [pause in sound] for the meeting. You know, we're not there to see every drum and its disposition after it's been offloaded but based on the photographs there's been no reason to believe there is integrity issues with these drums.

Speaker	
Pat	Okay.
Dane	At this time.
Pat	Okay, the reason I asked, actually, I've got a document from the ____ Facility Safety Board talking about Savannah River and they talk about breaches of the metal drums and contamination. So I would think obviously is their packaging out there, they're recontainerizing or decontaminating and they're not – shouldn't be an issue for us right?
Dane	The repackaging should be done at Savannah River, not by Energy Solutions unless something has happened in transit. The Department of Energy should not be loading a drum that doesn't meet DOT specifications for handling radioactive material.
Pat	Okay and they're just seeing that onsite ___ Savannah River ___ material ____ drums ____ looking at.
Pat	So maybe I can just ask Amanda one last question. So what should we expect just to kind of wrap up the discussion on this agreement with the Governor and the DOE. What should we expect in the near future concerning this agreement, things that are pertinent to the Board and some of the actions on our agenda? Is there anything that we should be aware of or waiting for the rest of the details to be worked out?
Amanda	As it pertains to the agenda I don't believe so. Some of the details and, I hate to get out in front of their discussions, are more to do with the second and third trains allowing us to complete our license amendment prior to disposal even if this is agreed, things around that that were not clear in the original discussion. The Governor was sort of, I've actually done a timeline, the Governor sent his letter on December 15th asking DOE not to send the trains, or to halt the trains, the trains were already on their way, I think everybody has a copy of that letter. He had a phone conversation with members of DOE on the 17th, short discussion that neither Dane or I were on the phone for so after the agreement there were understandably a few issues having to do with the specifics, particularly the second and third trainloads, but were not understood by either party clearly and those are the things that they'll definitely impact I think how the Board looks at the issue and how we potentially look at our rulemaking but ___ good to wait until those discussions are finalized.
Pat?	Do we have, the question of the day, do we have a timeframe when we can expect an agreement?

Speaker

Amanda	I'm sure it will be fairly soon, I would guess, but I don't have a timeframe.
Pat?	Okay thanks.
Chairman	Are there any other questions or comments on this item for Amanda from the Board? Okay. Mr. Thomas, do you want to take some time now?
Mr. Thomas	Sure.
Chairman	Okay. Come to the table. Recognize yourself, excuse me, introduce yourself.
Mr. Thomas	Thank you very much. I am recognizing myself as Christopher Thomas, Policy Director for Yale Utah. I just want to make a brief public comment. We're pleased to hear that the Governor is putting importance upon more sampling. We were concerned because as we looked through some of the manifesting information on these shipments there's a range of densities described and a range of radionuclide concentrations described. And what we realized is that at the high end of the radionuclide concentration for Technesium99 and at the high density, that would, a drum fitting that description would be over the Class A limit for Technesium99. And just to back up for a bit, we weren't sure this whole time whether these shipments from Savannah River site were from enrichment, uranium enrichment, in other words creating nuclear fuel, or whether they were from some other process and it was really hard to be able to get that information so we were only able to really look at that after we were able to look at the manifesting information. Just a brief digression. Actually it's not a digression, this is really important. The uranium coming from Savannah River site is coming from spent fuel, spent reactor cores and they put these reactor cores in these reactors was to create plutonium so that spent fuel comes out and part of it's plutonium, part of it's fission products and part of it's uranium and then they separate that out using chemical reprocessing but it's not perfect so there's some of these fission products that end up contaminating the uranium and of course we have limits in our state framework on some of these other constituents even though we don't on uranium as we've discussed over many many months so we are pleased to hear that that is happening and some of these reactor wastes, just to briefly talk about them. Technesium99 is one we mentioned, there's also some plutonium and low amounts but plutonium and also cesium, strontium and some other things so we're happy to hear about that. Just a couple of brief comments. I think it's really important that when the sampling takes place it's done in a particular way. As we've seen from the Department of Energy standpoint, I mean, it was grossly inadequate, 33 samples over

Speaker

33,000 drums. That's 1/10th of 1 percent and it just seems crazy they would rely upon that to determine what is in all of these drums so, and what I've heard about some of Energy Solution sampling, and I don't know when they employ this, some times and not at other times, but they'll actually take aliquots from different drums, mix those together and then characterize that mixed sample and I would hope that the sampling that's done by the State not be done that way because obviously what could happen is, low radioactivity parts of the shipment can mask the high radioactivity parts of the shipment, right? So if you take a very low activity drum, mix it with a very high activity drum, it comes out somewhere in the middle and you don't ever capture the fact that you had a high radioactivity drum that shouldn't have, that exceeds our state ordinance for that radionuclide. So I think that's a really important part of the way these drums are sampled in the future. And the second part is, I really don't think, I mean it's unfair that the State of Utah is having to pay to do these additional samples, right? I mean this is waste that we specifically asked the Department of Energy not to ship here in the first place, they did it anyway, and now we're having to pay to do this additional sampling. So these additional train shipments, my feeling is very strongly that the Department of Energy should have to do the robust sampling required, statistically significant, demonstrating that those drums aren't going to violate our state standards or they shouldn't be able to send them here. And I think, you know, this is a race against time and unfortunately we've got this one shipment here. I still hope that it goes back but I am disappointed that it seems as though this agreement is not protecting us from the waste that was able to come through and I hope these additional shipments do not enter the state period. So those are my comments.

Chairman — Thank you Mr. Thomas. There is a question I have that ___ my memory. Is there typically the DOE will do a specific drum characterization. Has that been done for this waste, do we know, did they do itemized drum characterization of any of this waste?

Amanda — Dane, do you know that?

Chairman — Dane?

Amanda — Can I answer that?

Chairman — Yeah.

Amanda — I think it would be helpful for Dane to explain why, the reasoning and the process of how they determine how many drums to test and I think it would also, I would like to hear from Energy Solutions about the testing

Speaker

	that they have done. I know that they are doing testing and if it is correct what Christopher Thomas just said about the way that they test, just to get -
Dane?	Is there a representative from Energy Solutions that could address?
Amanda	But if you could talk about the sampling from DOE first.
Chairman	So let's make sure we all know what we're talking about. Dane will give us --
Amanda	Why 33 drums.
Chairman	How is statistically significant determined or the sampling rate determined and then also comments from Energy Solutions concerning what sampling is being done and then answer to my question is, has DOE done individual drum assay for the waste that's been shipped here, is that information available? Dane?
Dane	Well I can't address specifically why the Department of Energy sample took 33 samples. But I can tell you that the standard methods behind bulk sampling are based on a knowledge of the homogeneity or the heterogeneity place. So if there's a high confidence that this is homogeneous it may be that a minimum number of samples is representative. If there is a high likelihood that not all the samples are alike, then a greater number of samples is required and we applied that standard, we had a discussion earlier today whether when we negotiated the waste characterization plan with Energy Solutions, we discussed whether it was an EPA document that provided us the guidance or American Society of Testing Materials that provided guidance on bulk sampling. But as a result of knowing that there were going to be large volumes of material involved Energy Solutions for 15 years, maybe longer, there has been a waste characterization plan that we expect and we expect Energy Solutions to follow the waste characterization plan for new waste streams and existing waste streams and then we in turn inspect Energy Solutions' compliance with that waste characterization plan. So I think at this point Dan, I think you were going to, Dan Trummer??, you were going to speak to the waste characterization that you've done?
Dan	First of all, is this on? Can you hear me? I'd like to reiterate what was just mentioned earlier. A lot of the characterization that we do is based off of the process knowledge of the material and where this had been processed, it's a very homogeneous material so the number of samples was determined by the Department of Energy at Savannah River on a sampling plan that was approved and had gone through their QA process and they had determined that 33 was the appropriate number based off of

Speaker

characterization, the process knowledge of the material. That's the first point. The second point is, is what characterization have we done is we have collected 11 samples that have been submitted for analytical work and then we've also collected from the Savannah River material that had been shipped before and we haven't dug that up but we can provide that also if you would like that information. We're highly receptive to, if the DEQ? wants to come out and take samples, they always have that option, that opportunity and so that's not an issue for us and they're more than welcome to come out. You asked a very specific question that I do not know the answer to right now but I will find out. I imagine that this material was assayed as it came out of the processing facility and put into the drums. I do not know that for a fact though and I will find that information out for you. We, in my experience, and the fact that we are building a facility like this for the Department of Energy, I can only imagine that was done because you have to know what your end products are going to be, you have to have controls in place, that's why we have a good understanding of the homogeneity of the material. What was the other point?

The manifest vs. _____

Dan — Oh yeah. I'm not exactly sure where Mr. Thomas got his information, what he's going off of, but we need to be very clear that there's three pieces of information. There's the profile, the waste profile, that's generated before material is sent to our facility and that waste profile information is provided and that gives a tool so when the material is shipped to us we recognize it when it shows up. What we do, as does the Department of Energy, classification based off the manifest. Those are the actual drums that are being sent and that's where we do our classification because that's where we've been told to do our classification ___ the profile. Sorry I missed the middle one. The middle one is the notice to ship, ____ the term, notice to ship. So we get the profile, based off the profile we can agree that it will meet the limits and there's more than just Class A limits, there's also chemical analysis that's done, other chemical analysis. We give the notice to transport. The manifests show up, we compare the manifests to our license and ensure that the material meets all of our license conditions. But I will check on if the material was assayed as it came out of the processing facility. Okay? Thank you.

Chairman — Are there other questions on this issue? Yeah? [pause in sound]

Ed Johnson?? — On the manifest that they sent, DOE sent to you, did they indicate to you that there were these other contaminants, i.e., the plutonium, the

Speaker

	technesium99 and the other uranium isotopes and other fission products?
Dan	Yes sir. They are on the manifests.
Ed?	Okay you're aware of that?
Dan	Yes. And they were also on the profile.
Ed?	Okay so my biggest question then, that I do not understand, how can this be considered depleted uranium? The NRC definition of depleted uranium says it's uranium whose concentration of U235 is less than .71% and how can these other isotopes and contaminants that come from spent fuel mixed in with this material have it still be classified as depleted uranium?
Dan	Is that me that's doing that? (high squealing noise in the sound system). Sorry.
Ed?	And I realize this is not your definition. It's a definition question that I'm asking.
Dan	From the profile that I looked at and the manifest, it's manifested as, I know this is going to shock some people in the room, but it's 100% DU so then somebody is going to say, well what about these other things? Well there are really really small concentrations so it is manifested as 100% DU that's why we've taken this as depleted uranium. Did that help? So from what we understand, it's less than, I think, it's point 2 (.2), U235?
?	It's ______
Ed?	.2 percent U235 and does that have a percentage for the other contaminants?
Dan	They're in the picocuries per gram range. Less than 100th of a percent. They would not be quantifiable in any meaningful way as a percentage so it wouldn't be manifested as a percentage. They would just be manifested as being present and then you would confirm those levels based on activity alpha beta gamma spectroscopy lab work, sample analysis. So the reason they call it depleted uranium is because in fact it is a significantly low .7 percent naturally?? occurring isotopic composition U235. So that's where that comes from.
Chairman	Dr. Trip?

Speaker

Dr. Trip I do it find it kind of interesting though that, you know, when I think of depleted uranium I think of ____ they were going to ship "the results from various", from the plants like in Paducah and so on, where in essence they were simply separating out the U235 from the U238. It's kind of interesting that instead of this, at least as I thought it would be, suddenly we have reactor fuel that has been processed and shipped here. ___ Energy Solutions when obviously when you entered into some sort of a contractual agreement with DOE, was any of that made clear to you or did they just sort of broad stroke or broad brush the whole thing and say, well you're getting stuff from these gaseous diffusion plants and things of that nature rather than specifically from a reactor reprocessing?

Dan? If I could start by answering your question, Dr. Trip, by backing up a little bit. The focus on the pedigree of the waste doesn't necessarily have anything to do with the safety of the disposal of the waste. Uranium waste from spent fuel reprocessing is defined as low level radioactive waste and it's recognized it has the other constituents in it and they have to be within the appropriate limits of the tables in Part 6155. So there is a check on that but it is by definition low level radioactive waste, always has been. It's one of the waste streams that comes out of a reprocessing, whether it's reprocessing to recapture plutonium for weapons or to reprocess spent fuel [pause in sound] it's called a mixed oxide fuel which is part plutonium and part uranium so that is a traditional low level waste stream. Neither DOE nor any other generator would classify its waste or manifest its waste based on its pedigree or where it came from so it's not unusual, they don't, nor does anybody else, tell us or any other processor or disposal entity where it came from, that's not on the manifest. It's not important to the health and safety. What's on the manifest is what's in the waste. That's what we need to know in order to know if it meets the classification criteria, it meets the waste acceptance criteria. So that's the important aspect of this. To focus on where it came from actually historically many years ago got a lot more attention and there are some oddities in definitions of, in particular, high level waste because at that point in time the science was not sufficiently robust to do much more than characterize it by where it came from but that's something that the industry and the NRC have migrated away from significantly over the years.

Dr. Trip Thank you.

Chairman Yes, Colleen Johnson?

Colleen Are these other elements also in the vitro tailings?? that are out there?

Speaker	
Dan	I would not imagine that tech99 is in the vitro tailings, but I'm going to answer a question you didn't ask though. They are in our license though.
Colleen	I understand that I just --
Dan	But they're not in vitro.
Chairman	Pat __?
Pat	I have a kind of basic question. We're making rules and license ____ talking about depleted uranium and you say this is manifested as 100% uranium but a lot of other people call it reprocessed uranium, are we making a rule for something the wrong thing basically?
?	I believe you have the definition of depleted uranium based off your rule in the proposed rule. Is that not correct Dane?
Dane	Yeah, you're defining depleted uranium in your rulemaking.
Pat	I know I was just wondering, because I mean, right now actually ______ Citizens Advisory Board of Savannah River is meeting right now and one of their agenda is talking about reprocessed uranium which is what they call the material that they sent to us.
?	___ definition _____
Pat	I'm just curious. _________
	Not that I'm real fond of the depleted uranium proposed rule but to help answer the question, you focused on essentially a concentration off depleted uranium so to the extent you want to capture a problem that's associated with the progeny of uranium over time, then yes, you've captured that. You have absolutely captured that. If you wanted to say something about what else it could or couldn't contain then I'm not sure how you would even do that or why because it's all captured someplace else. It's all, because it's the uranium that we've been talking about which has been the focus of this attention over the last several months, it's the focus of the rulemaking to require a site specific performance assessment from the NRC. None of the isotopes other than that in this waste or any other waste has been identified as an issue that regards additional regulatory attention. As a matter of fact we have lots of other ways and we talked about this here before that on the manifest calls out depleted uranium that we account for in our, the aggregates, the numbers that you've heard thrown around, the 46,000 tons that we've already disposed of which is a manifest number. Most people ___ yeah there probably is some depleted uranium in there but not necessarily a

Speaker	
	significant quantity but because they can't rule it out they put it on the manifest. So yeah, this manifest, the stated amounts of which we've disposed are certainly an overestimate and a conservative number because of that.
Chairman	Ed Johnson?
Ed	According to an NRC document that I believe Laura provide to us a month or so back. It says here that depleted uranium is defined as source material, intensity?? of ___.2 so, and source material it means ore or material whose uranium concentration is above such and such?? a percent and it does not get into the isotopic breakdown at all.
Pat?	But the isotopic breakdown is important to site performance.
Ed	Well that's true.
Pat? or Dane?	So we can debate whether this depleted uranium, the pedigree, the genealogy, I know that it concerns people. As Energy Solutions goes about having their consultant do the performance assessment and when we review the performance assessment, we are consultants, we're interested in the behavior of specific isotopes of radioactivity in the environment in various pathways and so that's really what is important to know about any of the waste, not just the materials from Savannah River, but any of the waste that Energy Solutions ____ and I want to remind you that when I made a presentation to the Board I tried to emphasize that with you that you need to be focused on the isotopic concentration or the quantity by isotope and that is what will determine whether a performance assessment demonstrates that it's safe for a period of time or not, under what given pathway or scenario you're looking at.
Chairman	Yes ___
	If I understand what you said Dane then in the performance assessment basically we're talking about a model or modeling, correct?
Dane	Yes it is modeling, ____ modeling.
	So the model then not only takes care of the U238 in terms of its span of life and sequencing of different isotopes but does it also take into consideration then the fusion or the fission, rather, products as well as things like plutonium and so on, is that something that is included in the modeling?
Dane	I'm going to let Dan Trummer? answer that question because they are the ones that are preparing, having prepared the performance assessment

Speaker

	that's required to be submitted to us.
Dan	Yes. [laughter]
	Gee that was short.
Chairman	Okay we need to wrap up this part of the discussion. Is there any other pertinent, thank you. We'll move on then to, oh sorry. Okay Dr. Nelson, okay, thank you.
Dr. Nelson	If I'm not mistaken, the waste profile record lists a mean depleted uranium activity of about 311 picocuries per gram. We need to recognize if that is just ____ that activity is accounted for just by isotopes of uranium, as long as we are one year post processing that there is an equal activity of thorium234 and protactinium234.
	Excuse me Steve I think you meant 311,000.
Dr. Nelson	What did I say?
	311 picocuries per gram
Dr. Nelson	311,000 picocuries. Do if that waste is one year post processing the total activity is closer to a million picocuries per gram, total activity.
	Total activity. ________
Chairman	So we will then move on to agenda item 2A. In your Board packet you received a copy of the letter sent to me from Energy Solutions requesting an extension in the public comment period for the proposed rule. I chose not to, I chose to bring it to the Board as an action item. If you'll recall last month we had a somewhat lengthy discussion discussing how long we would have the public comment period. If you recall we talked about having 30 days or 60 days and then somebody said 45 days and we ended up with 30 days and then as it turned out because of the deadlines for filing for the public notice, the actual public comment period didn't begin until the 1st of January and so there was a 2 or 3 week window there where there was no formal action taken so basically the public comment period ends on the end of this month, is that right? Is there a specific date?
	inaudible
Chairman	February 2nd. A public hearing on the proposed rule has been set for 26th. I had all these numbers, I forgot them all. For January 26th. So I'd like the Board to consider then is Energy Solutions' request to extend

Speaker

	the public comment period. The letter requests essentially an additional 30 days and so I would like to open that up for discussion and then I'll entertain a motion from the Board to either leave the public comment period the way it is or to propose some extended period. So is there discussion about that item? Generally how does the Board feel about the public comment period an additional 30 days in light of everything else that's going on. Maybe we could start off by asking Dane. Have you received any comments so far on the rule?
Dane	No we have not.
Chairman	Okay. Sir?
	Guess we could assume two things is, nobody's interested or they're still taking time to formulate their response. Yeah Dane
Dane	I was going to say Peter, I think I mentioned at the last Board meeting, we normally see a lot of them come in near the end of the public comment period so this isn't unusual.
Chairman	Okay. ___ you had a comment?
	I was going to say I'm sure we'll public comment before the deadline of February 2. I'm personally fine with the comment period. I think this is a time sensitive issue as we've seen over the last _____ doorstep, I think we need to knock?? this out.
Chairman	Okay. Perhaps we could stimulate some conversation. Dr. Nelson, you wrote on here that you would like to comment on 2A. Would you like to comment on this item?
Dr. Nelson	What I don't know better is when to shut up. Um I would like to encourage some further consideration of the public comment period. I just want to show just a ________ figures. This is Tacoma, Washington. Here's Mt. Ranier, ____ zones for volcanic mud flows are laid out with return probabilities. This sort of hazard analysis [pause in sound] based on careful detail ___ mapping? and investigation __________. ___________ Salt Lake County. Here's __________ map. It's based in large part upon the ___ history of _____ of the Wasatch Falls? and related Falls?? The ______ motions that are generated. This type of information is used in building codes to specify building requirements for schools and hospitals and whatnot. But we ______ past geological record to understand the probability in the future of happening?? Here's a map of the four major still?? stands of Lake Bonneville?? Energy Solutions site is out here, south of I-80. Here we are close to downtown. This is the historical lake levels in light blue. The largest prehistorical

Speaker

level of the lake _____ reaches about 1700. This lake expands and contracts. You have to base your hazard analysis, the performance assessment, of this site based upon past history of this lake. There's the Lake Bonneville shoreline cut in bedrock. I believe that's the north end of the Stansberry? Range. Here's the north end of the Silver Island Range, here's, I believe, this is the ___ level, intermediate, one of the intermediate level shorelines. The red bar is 100 feet. The lake is capable of producing ____ platform in excess of 100 feet or so in bedrock. I hope that you will give very serious consideration to letting the public have ample opportunity to comment what's in your rule because this is going to affect whether or not this site can isolate waste. I'd like to wrap up by reading something that was said by Mr. ___ Christianson on the _____ Shell (Shelf?) He said, those _____ are ___ materials that would otherwise be harmful [pause in sound] elsewhere and are being isolated and shielding?? human beings forever with a dense cap that can't be eroded by animals or rainfall or even if Lake Bonneville ______ have the lake lap up against it. The perfect place to put these materials. You folks have a responsibility and if you don't think that 10,000 years from now a million tons of depleted uranium in Lake Bonneville, the Great Salt Lake system, is important, then don't worry about. But if you think it's important, if you think protecting the future of the environment is important I think you need to give ample opportunity for members of the public to comment and I think you very seriously need to consider what is in your rule.

Chairman Dr. Nelson, are you arguing to support Energy Solutions' petition to extend the public comment period?

Dr. Nelson Sure. They want to – I know there are reasons, I know there are reasons if you're opposed to it that have it ______ shorter, but I think the public ought to have ample opportunity to comment and here are some reasons why. To ignore the science, the experiments that Mother Nature has run for us and say well we can't predict the future is illogical and it's bad science. I mean we give the public plenty of opportunity and you folks need to consider what's in your rule.

?? So you think that thirty days is not enough for the public to --

Dr. Nelson It's gonna be enough for me. Look at _________. I can't speak further.

Chairman Will you attend the public hearings?

Dr. Nelson Will I?

Chairman Yeah.

Speaker	
Dr. Nelson	Yeah, sure.
Chairman	Okay. Thank you. Okay, with that, I'd like a motion from the board, eventually here, is there any desires – Pat – you kind of mentioned that you're happy with the public comment period expiring on the 2nd of February.
Pat	Well, I mean, this subject came up about a year ago and I know we've spent basically an entire year, a lot of the summer during _____ days from the _________ to Energy Solutions to Dr. Nelson and having this discussion, I think it's time to move on. I think the public's ready and willing to comment on this and if doing the public hearing before February 2nd Mr. Nelson has his materials together, I imagine he does and other members of the public were worried about this. I think its, you know, now or never.
Chairman	And didn't we think that the public commentary would start sooner, too, so we've had – and _____ time already given.
Pat	Yeah. Yeah, that's true.
??	Peter?
Peter	Yes, Ed Johnson?
Ed Johnson	Ah, I had – I don't think that I have heard in 25 words or less the main reasons that Energy Solutions would like to extend the comment period. Is that possible?
Peter	We can ask them to. It was in your handout. I would remind – a plug for the board members to read all of their materials. (Laughter) Is there a representative from Energy Solutions who would like to address the question?
??	I read it, but I need 25 words.
??	He doesn't know anything.
Tom Ogeda	My name is Tom Ogeda, I'm with Energy Solutions and in 25 words or less, or at least close. The main reason is that, it was suggested at the last meeting that this is something that everybody's already thought about, they have all of their comments ready and all they have to do is pack them up and send them in and we don't think that's true. We have a lengthy statement of basis which the state has prepared to justify why I think this will make sense, which we believe is ripe with legal misinterpretation and technical inaccuracy, to be perfectly blunt. And we

Speaker

	think to dispel those or comment on those, or refute those one by one is a completely different exercise than, you know, for example, putting a cover letter on the presentation I gave you in July. We think it could be robust and thorough and correct and defensible takes time and that's why we asked for more.
??	Okay.
Tom Ogeda	Thank you.
??	I remember _______ was also asking for a public hearing which will involve once again for another day, at least one day.
Tom Ogeda	We believe that would be prudent, yes.
??	Yes. January 26.
Tom Ogeda	Yes, Dr. Drew?
Dr. Drew	I'm just curious, given the circumstances I wonder if extending it – if their – if Energy Solutions' proposal to extend the public comment period is more a publicity thing than science?
??	Peter, I need to clarify something for the Board. The January 26 meeting, it's an opportunity for the public to provide [tape cuts out] orally rather than in writing. It is not a meeting where there's going to be dialogue expect to acknowledge somebody would like to speak on behalf of this issue, the comments will be recorded by a court reporter and the transcript will be made available and those comments are treated the same as comments that have been received in writing. So let's make this clear, this isn't going to be a period for debating the merits of what's being discussed. It's an opportunity for oral comments for those people who don't take the time to write them to us. Write and send them to us.
Chairman	Okay, seemingly we have Pat express 2 opposing opinions, neither of which have been worded in a motion. Yes, Pat?
Pat	Well I'd make a motion to reject the request for extended time and to keep our original time table to the 30 day comment period.
Chairman	Okay, which would expire February 2nd.
Pat	Correct.
Chairman	Okay, we have a motion on the table. Is there a second to the motion?

Speaker

??	I second that.
Dr. Thompson	Aye.
Chairman	Seconded by Dr. Thompson. Further discussion on the issue? Okay, then the Chair will call the question. All those in favor of rejecting the petition of Energy Solutions and sticking with the public – current public comment period to expire February 2nd indicate by Aye..
[Many]	Aye.
Chairman	Any opposed?
Colleen Johnson	Me.
Chairman	Opposed by Colleen Johnson. I believe the rest of the votes were anon-unanimous, is that correct? Okay. The Chair abstains. Then the motion carries the request for an extension has been denied. Okay, with that taken care of, we'll move into our next item. Again, I've changed the order a little bit. We'll have a presentation from Energy Solutions on the issue of waste blending. Who'll be presenting? Yes?
??	________
Chairman	Oh, I'm sorry.
Amanda	Sorry, Peter, I asked if maybe Dane would do maybe a short presentation on – from the state on --
Chairman	Okay, yeah, Dane – I forgot. I didn't write it down. Dane would you take some time please?
Dane	I guess I would! Many of you know that later this week the nuclear regulatory commission is hosting a stakeholders meeting on waste lending. What started this process was the recognition on the part of the commissioners that because there is limited capacity, limited access to disposal capacity for Class B and C waste in this country because of changes in the operations of the commercial waste disposal facilities primarily in South Carolina that there may be more people interested in taking B and C waste and blending them in such a way that it changes the classification to Class A, thus making Energy Solutions available as one of the disposal options for Class A material.

Speaker

	The Nuclear Regulatory Commission has asked the State of Utah for comments and over the last several weeks we have been preparing our comments and at this point I would like Amanda to say where we are on that.
Amanda	Dane has prepared, his division has prepared comments and I believe he has copies here to pass out to the Board and additionally we've started these comments with the Governor's Office and have received their position on waste blending which are in concurrence with the comments of the division, which you'll soon get a copy of, which is basically an opposition to waste blending.
??	An opposition to --
Amanda	An opposition to waste blending as the intent to alter waste classification. So I think Dane's done a fairly good job of outlining our comments here and.
Dane	Okay. I know you've had a long time to review those, but we'll anticipate our next item to take some time so if you have some comments, we'll entertain some few minutes here or we can handle that on a case-by-case basis if the Board [tape cuts out] comments on these that they'd like to address. Do you have a question? Yes, Pat?
Pat	Real quick while we're reading through this, I appreciate your putting this together, I know in 2 days there is a meeting at the NRC. Is the State of Utah or someone representing us going to be there to talk to them?
??	Yeah, a couple of months ago through the Low Level Waste Forum we arranged for the members, in this case it's so far comments have in from Texas, Utah, Pennsylvania – and our joint comments are going to be presented at this stakeholders meeting by a colleague of ours from the State of South Carolina – a regulator from the State of South Carolina. So he's representing all of the states in this instance – all of the states that choose to send in comments.
??	Specifically somebody from the DRC? Or the State of Utah?
??	No, no one from the DRC – the State of Utah.
??	Okay, thanks.
??	Ed Johnson?
Ed Johnson	Well for someone who is involved in the radiation control process back in the 70's when the low level radioactive waste compact was passed and

Speaker

which every state in the Union said they would join a particular regional compact and each regional compact would have a site of their own. Furthermore, every state who joined the compact had to be willing to say yes at some point in time if this particular host state becomes full and we cannot – and they can no longer accept any more waste, yes, this – our state would be willing to throw our hat in the ring and be a host to a low level waste site. The fact that there's only been 3 commercial waste sites in operation since that time, you know – or 4, I guess – I don't think puts the onus on the State of Utah to have to accept everybody's waste. And the NRC making the claim that it is a very – it's absolute necessity that they did go into a blending program because of this lack of other sites, I don't think is Utah's problem. [Clapping]

Chairman — Any other comments on this document that Dane's staff has prepared for the stakeholder's meeting? Yes, Dr. Trip?

Dr. Trip — So basically, Dane, in the course ____ that you've received from the NRC, then would – how would you classify it? Are they essentially trying to blend waste to make them Class A based on simply a level of activity rather than in terms of what – what the content of the wastes are?

Dane — Dr. Trip, the Nuclear Regulatory Commission hasn't said anything along those lines. What they're doing at this point is they're trying to get – the commissioners asked the staff a number of questions about waste blending policy issues, technical issues and they're asking for opinions that will help direct where they take this matter. For instance, one of our comments was, listen, if waste blending is an important issue, currently their Nuclear Regulatory Commission rules neither prohibit nor endorse it as an approach. So if this important enough to do this, we believe it's important enough that whatever the rule might be, that whatever they decide needs to be put into rule, because as a sediment comment, most of the generators that access Energy Solutions – virtually all of the generators that access Energy Solutions are outside of Utah. And so who is mostly impacted by this aren't Utah licensees although we do talk about Utah licensees as well, and we pointed out that Utah licensees – their wastes go to Washington. So whatever regulations the NRC, if they do regulations impose, affect Utah [tape skips] because they access Washington, whereas other states that might access Energy Solutions will be impacted by the same rules if they go that direction. So they haven't made any technical – haven't disclosed any feelings about a technical approach. They're just gathering comments.

Dr. Trip — You know, it almost sounds like back in March of last year when they decided to classify depleted uranium quote – whatever that now means – reprocessed or whatever – as Class A, it almost seems like they were

Speaker

	trying to get their foot in the door to now say well what about if we – what about blended? If we can blend stuff together to get the activities down then wouldn't that be sufficient then to classify it as a – I'm not saying that that's what their motive is, but in a way it's sort of smells that way. I might add it seems that if the NRC had done its homework, did its – carried out its responsibilities, we wouldn't have had this one year's worth of the bait[?] relative to what to do with depleted uranium. All we had to do was come up and make some logical determinations rather than trying to lump it all into one classification. That's my annotorial comment.
Dane	Okay, thank you. I think if you have, oh, sorry Pat.
Pat	I wanted to real quick, request – I know that the NRC's gathering information now and they actually have a voting paper in front of the commissioners on April 2nd and the meeting is happening on Thursday – I would be grateful of the Executive Secretary when he gets the information as to what happens and it's just so we keep in the loop that you'd send that along to us.
Exec. Secy	Pat, if you're interested, I can give you the phone number where you can listen into the proceeding on Thursday, if you want to spend 6 hours on the phone. Hahahha.
Pat	Well, actually, I'm going to do that.
Exec. Secy	Are you? Okay.
Pat	But I just think just as briefing it then you could ____ points on what happened.
Exec. Secy	There will be a transcript and we can --
Pat	Okay.
Exec. Secy	-- and we can digest that, and --
Pat	Maybe instead of sending us the transcript you can --
Exec. Secy	I know. I understood that, I'm just saying we'll be able to do that.
Pat	Thank you.
??	Will it be 19 hundred pages?
Chairman	I just want to say if you have any other comments on this document to

Speaker	
	give those to Dane after the meeting or in some other way. Let's go ahead and move to the Energy Solutions' presentation. How, I guess we were unprepared for the size of the information packet you gave. How much time did you anticipate taking?
??	About 20 minutes.
Chairman	20 minutes. Okay.
??	____________
Chairman	Yeah, could you try to shave it off a little bit?
?/	____________
Chairman	As much as possible.
??	____________ [+ space of time with misc. background voices]
Tom Midgette	Thank you, Mr. Chairman and members of the Board, my name is Tom Midgette and I'd like to talk to you a little bit about the blending of low level radioactive waste today. This is essentially a condensation of a presentation I gave at the invitation of the NRC on December 15th where they asked us to come in and talk about these issues. So I'm just going to introduce the topic, talk a little bit about the concept, talk about the current regulatory status, what the NRC is doing, what we have planned to do, and I'll be glad to answer any of your questions. I'd like to start by focusing on what's important. And I think what's important here is protecting public health and safety, protecting the workers, protecting the environment. That's what 10 CFR Part 61 is designed to do. Specifically, the performance objectives in subpart C, that's 10 CFR 141 through 44. And those are what we talk about when we talk about protecting health and safety. They also are what – are the important component of waste classification. We've talked a lot – you've heard a lot about waste classification. Dr. Trip, you asked some really important questions a while ago which go to the heart of the matter and I'm going to come back to them in the presentation because I think they really are key here. But if you look at blending in the proper context which is in the context of public health and safety, I think it's a pretty clear and straightforward issue. Blending in general is just one way to manage low level waste. It's not any sort of end-all, be-all, it's not intended to be – it's just one component of that. Okay, the flip side to what's important is what is not important and frankly the NRC has been dealing with some suggestions,

Speaker

which to be blunt were brought to them by two of our competitors, Studzvich and WCF, who have raised issue and made very specific allegations in their letters to the NRC – which the NRC has already rebutted, and I'll read you a couple of quotes from there and I'll talk about that when I talk about guidance. But even the proposed rule that came to the NRC here was introduced by Randy Vooruchy – a Studzvich employee. So we're getting a lot of attention on the matter from two companies that if we do, if Energy Solutions does what it proposes, they won't be able to compete with. The NRC has recognized that, so I think it's only fair to be very clear about the difference between commerce and protecting health and safety.

When we talk about blending we're simply talking about taking a variety of low level waste, all waste, no clean material, processing it in a variety of ways and then disposing of what's Class A – Class A disposal. There still may be post-processing of Class B or C waste, obviously that wouldn't go to Class A.

Now the first key thing I want to go to goes to your question, Dr. Trip, about whether we're talking about concentrations or whether we're talking about some other thing that makes something Class B. In a nutshell, there is no such thing. It is only concentration, not the constituents. There is not some special constituent that can be in or cause waste to be classified as Class B or C that can not also be in Class A. It is only how much of those constituents. So you can go up that scale – more of it makes the higher classification, you can go down that scale – less of it makes a lower classification. So that's the first point to be real clear on. There are NO uniquely Class B or Class C constituents. If you look at this graphic, you see a couple of glasses of tinted water if you will – assume the one on the left is tinted with a few drops of food coloring and the one on the right is tinted with 5 times as many. It is exactly the same food coloring in both glasses. Nothing different, but how much. If you look at this just at face value as a picture, if you saw this in a magazine, if you're familiar with what printers do, they talk about screening to make something a lighter share or a darker shade? The one on the left might be screened at 10%, the one on the right's probably screened at 30%, the same ink, the exact same product would be on the page, the exact same product is on that screen. It's only how much. So the idea that you have drawn some unique hazard into [tape goes out] state of realm in some surreptitious way is completely false. And often in the context of this debate, intentionally misleading.

Why do you blend? Well, as I said before, that's part of the strategy. You can get significant dose reduction overall taking into all accounts all aspects of the process at the power plant, at the processor, at the disposal

Speaker

site, you can get significant operational efficiency at a power plant, you get more disposal options, these have cost _______ which are very important to the generators. Clearly, this is intended and arises because of the lack of disposal for PC waste. And also the result of much lower interim storage, not just at power plants, but for that matter the waste that's being stored today in Texas, or is being shipped to Texas, is being stored because it can't be disposed of, it can only be stored there as of today. I've mentioned this a couple of times. There are a lot of different things that go into taking account of the ways that generated not just a power plant, although that's what we're talking about today, whether it's a pharmaceutical or hospital, this is just one piece of that.

I'd like to put the problem into a little bit of context wherein this is also very important. We're talking about resins, we're talking about physical mixing, we're not talking about some sort of numerical averaging over something, where clearly it's hotter in one place than another place, although that is specifically allowed, that's not what we're talking about with resins. We're talking about something that can be physically, homogeneously mixed. And these resins are generated from the cleanup of water in your clear power plants, that's where they come from. About 65,000 cubic feet across the entire nuclear power industry, Class A – that number varies, you'll hear 75, you'll hear 60, but that's an ____ number, it's as good as any. Class B, C resins being generated – about 18,000 cubic feet a year, also there's some fluctuation in that number, these are rounded off. Historically at Clive we've disposed of about 18,000 so 100 cubic feet per year, all Class A. In the future, and that starts with 2009, that number goes up a lot. That's about 46,000 – we expect it to stay somewhere around that number and that has largely to do with the closing of Barnwell. This waste is coming here not – not – this has nothing to do with BC being blended and coming here, that's just Class A waste that used to go to Barnwell's now coming to Clive.

This next bullet is about one of the subtleties with blending. That bullet additional 8,000 cubic feet per year is essentially a part of the BC resin which is blendable. There are certain restrictions on what we're able to blend and make Class A and only half – probably somewhere from half to two-thirds can be managed. If you took that and combined it with all of the Class A resin that's been generated across the industry on an annual basis you'd have about 73,000 cubic feet. So compare that additional number, that additional amount that could conceivably go to Clive, 8,000 cubic feet with 3.4 million cubic feet, which is the – an annual disposal level. So there's – there's your context. 8,000 out of 3 1/2 million. So this is what I would say to those that suggested there's a capacity problem with this approach. There is NOT a capacity problem

Speaker

with this approach.

The next question which is, of course, very important to everybody's activity – what about the activity? Are you going to have some significant impact on the activity loading at a Class A site? Well if you look at Clive and you look at the amount of activity that has been disposed at the end of the year 2008, all of the waste disposed, which is about – at that time – 6.1 million cubic yards – the activity in the site is about 1.9% of what it could be – about 1.9% of the Class A limit is what's in the site as of the end of the year 2008.

Now this next slide is a hypothetical. This is a mathematical calculation and I'll tell you what the assumptions are. The same at the top – 100% is the Class A limit. The blue line is flat because I'm not really projecting to put any significant additional volume in there. As a matter of fact, I'm not putting any additional volume in there. I'm assuming that volume stays the same and all I do is take all of the activity from all of the PC resins that could be generated and assume it goes into Clive, just the activity not the volume, so there's no – there's no increase of the denominator, there's no increased volume. I just take all of the activity from all of that waste for 10 years [tape skips] increases from 1.9% of the limit to 2.4% of the limit. Now I've already said we could maybe take half of that waste maximum, and also we'd of course be taking something on the order of – we don't know exactly – 2, 3, 4 million cubic feet a year, some years it's been higher like 5 or 6, so it'd probably be divided by 50 million cubic feet and _________ no addition. So you can see from an activity perspective there's not a significant change.

I'd like to turn now to the regulations because it's important to know, and this goes to another comment that was made, Dr. Trip, this is very different from depleted uranium. This is very much contemplated by the regulations, very much regulated, very specifically regulated and very much controlled by existing guidance and has been for a long time. There is no analogy between some notion that this popped up, nobody thought of it and it hasn't been looked at. The regulations specifically contemplated exactly how to manage this issue. In particular, 6142, that's the part of the performance objections, and so Part C that addresses the inadvertent intruder, that's the guiding ultimate regulation which is interpreted in guidances of 500 MR per year number. And in 6155(a)(8) it specifically states that you could average the concentration over the volume or weight of the waste. And that's not just physically homogeneously mixed waste. That is other averaging where clearly it does differ in part of the waste than in other parts of the waste. Although here again it's not what we're talking about doing here.

Speaker

Appendix G is really key here because what we're talking about is not taking B and C waste, we're talking about taking waste from processors that don't classify it because they can't classify it. Because you can't classify waste appropriately that you're going to process you don't know what the processing is going to do to the classification. You can characterize it, you can scribe the amount, the type of the activity that's in there, but you don't classify it. It's strictly regulated as such. You do not have to classify it. You only have to classify it for disposal. That links back to 6142. The only reason the classification system exists is to classify for disposal. It's the only reason it exists. That's why they're explicitly exempt in – from shipping to processor classified waste. Then of course the processor does have to classify. The guidance is very clear, as I've said before this has been consciously addressed. This is clearly allowed. They made a statement that it's neither endorsed nor prohibited by the guidance. But there's a third key aspect to that. It's not endorsed, it's not prohibited, but it is allowed. This first document up here that I mentioned under the existing guidance, the branch technical position on concentrations averaging and encapsulation. If you ever have trouble falling asleep at night I encourage you to have a copy of this by the bedside. It's a very difficult read. It's been around for a long time, as you can see, 1995. The only reason this document exists is to provide guidance on, among other things, blending. Anything relating to the averaging of concentrations. Here again ___________ - that's the only reason the guidance exists. If blending weren't allowed, this guidance would not exist. So this is not new, it's not unclear. These other letters clarify it. The third one on there you'll see it was written to Energy Solutions when we specifically asked the NRC because of this confusion it was being promulgated in the marketplace to respond to a question. And in that letter, last August, they specifically said yes under the proper circumstances it's okay. I mentioned the WCS in physic letters. I just – to give you a couple of comments from the NRC response that when they suggested that the NRC was changing it's position, and this has been one of the allegations that I would call one of the obfuscations that's been brought up – this is new and can change. The NRC said, this is a quote, NRC has not changed its positions on blending of low level waste. This is not new, it's not a change. When they suggested that it should – it was under their guidance not permitted, NRC's response to that was this statement is not a correct interpretation of the staff's position. These documents all are – not – they are – of course [tape skips] atoms which is kind of tough to navigate sometimes, but they now have a blending page on the NRC that are a little easier to find. I'd also be glad to make them available if necessary. But it just talks very briefly about what the BTP talks about in terms of homogenous waste. It talks about ______ concentrations and what was mentioned earlier about DU – different context, but this notion of homogeneity or uniformity which is important

Speaker

in the context of the intruder scenarios because the intruder assumes that some unknown person at some unknown time in the future is either as a resident or trans – or coordinated across the site encounters some waste. So this homogeneity is important. The BTP specifically calls out spent ____ exchange resins which here again is what we're talking about here. And it clearly and specifically states mixing of similar homogenous waste sites is permissible. Let me give some guidance on how you do that – I'll skip that in the interest of time and we can come back to it if you want.

The recent letters already mentioned in some, I've read a couple of quotes, you've heard the first one about not prohibited or explicitly addressed, they shouldn't be mixed solely to lower waste classification but that it may be appropriate and the acceptability of any specific proposal would have to be evaluated by a regulatory authority. It goes here again to the heart of the matter of classification. Waste classification is related to the safety of disposal. That's the only time it matters. Until you package it for disposal, classification simply has no meaning. And they also point out which is generally clear but also forgotten, it's guidance. It's only one way to show that you comply, other approaches could be found acceptable, but frankly we're not proposing anything that's not explicitly acceptable under their guidance.

We talked a lot about classification. I've talked about processing. Just to be a little clear about what I mean and why it's important to only classify post-processing. Some of the things that are listed up there, the D watering, the compaction and consolidation thermal processing, those are some of the things that we and other waste processors in the industry do when we get radioactive waste. Generally the intent is to reduce the volume. Reduce volume or mass. Why? You reduce costs. You have a smaller package to dispose of, it costs you less to dispose. That's why we process, that's why everybody processes. That's why generators love processors. The same thing, though, you keep into mind I've said before is if you change the volume, if you change the mass, you're going to change the concentration. You're not going to change the constituents that are in that waste, you're just going to change how much per unit volume or how much per unit mass.

So the last bullet is important because you bring into account the burial container. You also have to account for the container when you classify. I think this next slide gives a real clear illustration. These are all drums of waste that have been compacted at our Bear Creek Facility in Oak Ridge, Tennessee. If you take the two and the fork around, the one on the right obviously has not been compacted as far as the one on the left. And the reason is because you have to be mindful of the concentration so,

Speaker

yeah, we have to know what's in there when it comes in the door. We have to characterize what that waste would be classified in its current form. We have to be mindful if we take it all the way down to the 2 inch maximum that we can compact a drum, is it all of a sudden Class B waste or Class C waste because by reducing the volume we increase the concentration. And so you can see, we can't compact them all the same amount. Nor can we classify them until after we process them. Yes, the full drum – the full 55 gallon drum that you can picture standing full – does it – has it been characterized such that it could be classified? Yes. Why do you not classify? Because the classification may change after you run it through the compactor. Same material as in the drum. Exact same stuff, it's just 6" high instead of 2" high. Changes the waste classification.

There's also been a lot of attention of particularly – it's been suggested by the people that are opposed to this that there aren't really any efficiencies. And WCIS, I can quote – base that on their intuition. Well, we can base it on actual in-plant experience of Energy Solutions operates waste processing – liquid waste processing equipment that we design and installed and operate with our own employees at 29 nuclear power plants. We process water at about a third of the nuclear power plants in the industry. We provide water processing services to about another third. We handle the resins from every single nuclear power plant in this country. We know how they're processed, we know how they're packaged, we know how they have to be measured, how they have to be dewatered, how they have to be prepared for shipping, how they have to be shipped because we do all of the shipping, too.

So we have specific experience that we can point to, that we know will have increased dose if you have indefinite storage because we have routine surveillance of these packages. Furthermore, expended storage requires additional inspection prior to shipment. Not just exterior – is this drum still intact – but opening containers, opening liners because over time as these wastes sit they generate liquid and they generate gas, which would make them in conflict with the waste acceptance criteria at Clive. I mean they have to be dewatered, but certainly they have to be re-verified, so they have to be opened up. These are dose-intensive evolutions, about a third of the nuclear power plants in this country have remote handling equipment so they can do this remotely. When they do that, they generate a few mill or rem to the people that do it. They other two-thirds generate something more like, and we have specific dose information from half a dozen nuclear power plants this week, somewhere between 180 to 250 milligrams. It's a very specific, real savings. Of course it wouldn't be a real savings if when they shipped it to us we just incurred that same dose. But because our facility is

Speaker

designed to manage that dose, it is in fact a real savings.

You've heard about the Chairman's direction, this is just from the memo, from Termin Yasko to the staff, to review these issues. Gave him six months to put the – the techie paper together. It's due in April and they have been given guidance as to whether they need to make any revisions to their current regulation or guidance.

The NRC published its federal register 13 questions – you may have seen it. I pulled one of them out, I addressed all 13 in the presentation to the NRC, but I think there's one that's particularly germane, which is this notion of whether or not there are policy issues that are raised by the blending of waste to lower the classification. And I would suggest that they're not. And I would say it's misperceptions and misrepresentations that have led to the suggestions that there are. First of all, it provides a real solution to the B, C disposal problem. Not all of it. A lot of it's activated metals. We're not talking about that. There's a lot of B, C waste that would simply not be suitable for this. We're not talking about all of it, we're talking about resins that can be physically mixed. It does provide a dose savings. It does provide improved plant efficiencies. The Utility representatives, there are going to be two of them sitting on that panel as well as an _______ representative Thursday. I'm sure they'd be glad to talk about this. It's consistent with the waste classification system, but it's also been suggested that, here again, by one of our competitors that it's not consistent with the volume production policy statement that goes back to 1981. I had about 20 slides on that on my presentation to the NRC. I've left that out for today, but suffice it to say that policy statement is aimed at generators. We've seen reduction by about 3 orders of magnitude in the volume that's generated of these materials over the past 20 years. You could look at Barnwell from when this policy statement came out to the year 2000. They went from an average of about 2.4 million cubic feet of resin waste a year to about 2,000 cubic feet of resin waste per year. Same activity. Same activity, a thousandth less volume of waste going into that site. So what I say is that the volume reduction policy worked, the industry achieved remarkable economies of scale. We let the volume reduce, we operate – in fact the two largest volume reduction processing facilities in this country – we do more volume reduction than everybody. But not everything can be volume-reduced. It's that simple. It doesn't present any disposal capacity problems, it's simply a blip on the radar, and frankly another advantage is it doesn't result in anything being diverted to an industrial landfill.

And I'd finally like to address another one of the more contentious points that this is somehow a notion of dilution, which it is not because the NRC

Speaker

has specifically said in its most recent guidance dilution is blending from mixing waste with clean material. Blending is mixing with waste – with waste. Everything that we would blend or mix is low level radioactive waste that's going to licensed disposal. Therefore there's no increase in volume, not introducing any clean material into the equation. So disposing other – we've already talked about how it essentially has no result for its decrease in health and safety. In fact, it could be argued that it provides a better protection for the [tape skips] or intruder by that greater averaging over volume. Here again, the same volume. No increase. And it ensures that all of this waste, even the very low contaminated stuff that some generators would like to blend and send to outside radioactive waste disposal – to general disposal sites – that that doesn't happen. All of this waste remains in licensed disposal space.

I have a couple slides of Energy Solutions, I can go through them very quickly. This is our facility in Tennessee where we would simply take the wastes and blend them. We don't plan to commingle resins at this point for multiple generators. We don't plan on changing attribution. There's some subtleties that we get into there which may not be relevant here, but they are something that our competitors do in their processes – this is just a grab bag that walks through at a little bit more, but it clearly results in the reduction in off-site storage, clearly saves time, clearly saves dose and personnel exposure, and also it could be argue that it change – that it reduces the volume generated because today what some nuclear power plants do in response to a lack of B, C disposal is they just yank their resins out before they get that much activity on them. That clearly results in an increase in Class A waste coming to Clive. We _____ it's already resulted in a greater increase than that 8,000 cubic feet that I talked about. So that's, I think, another point that should not go unmentioned. And finally just for the generators it gives them a stable, predictable disposal pathway that they can count on.

In summary, I think probably hit on all of these points each more than once so with that I'd be glad to take any questions that you might have.

Chairman: Yeah, let's open it up for a few minutes of direction questions concerning the presentation. And I think our next agenda item problem will also address some of these questions so we can revisit them. So if you have specific questions relating to the presentation, let's take a few minutes and address them now. Pat, you want to start?

Pat: So are you requesting a license amendment to receive this material or do you believe we don't need one to do that?

Tom: We don't think we need one. As a matter of fact, if you needed a license

Speaker

Midgette	amendment to take blended waste you'd already have to have it because people are doing it on Clive and power plants already and another point that I think is important from a DRC perspective is I don't know what you would do or how you would even know, I mean the manifest doesn't say what the waste used to be – if it's not manifested as Class A waste, we can't take it.
Pat	My second question, I mean there's no regulation in place to agree with this, but the NRC does have guidance that says that you shouldn't down-blend solely to change the classifications that come out. So that – I mean that's the guidance and of course they're going through this big process to try and figure that out as well in the next three or four months. But so, at this point you're saying you could go ahead and do this at any point you want to do it?
Tom Midgette	Yes. In the State of Tennessee, an agreement state, license their resin solutions facility on a test basis. It's not a commercial operation, but on a test basis. And frankly I think – I don't think it's correct to say that they're trying to figure it out. The letters that I referred to up there are only a couple of months old. I mean they very clearly reaffirm that it's guidance, they're going to respond to the directions from the Chairman, but there's certainly no ambiguity in their guidance today.
Pat	And then how do you address the intruder scenario when you start bringing this material in? Is it going to change?
Tom Midgette	It doesn't change because the material that we'd be bringing in doesn't change from what we're bringing in today.
Pat	It's not a higher concentration?
Tom Midgette	No. I mean – no, it's not. There's nothing intrinsically higher about a blended waste. I meant the guidance is for – not the guidance – the limit is in a regulation, it's not a guidance, it's a reg. You know, each of those isotopes listed in Table 2 and 6155, that's the maximum.
Pat	Well, we see what the State of Utah has – has a position paper talking about that right here, but I mean it reminds me of lawmaking when making sausage, when it comes right down to it. So, wait for somebody else to chime in on this.
Tom Midgette	Well, if I could --
Chairman	I didn't understand your comment about sausage. (laughter)

Speaker	
Pat	Well they say that's – that's what they say when you're making laws that's one thing you don't want to watch because it's like making sausage. You really don't want to know what into it. So that's a little bit like what this is about, I mean they're going to put it in a --
Tom Midgette	If you're talking about uncertainty about what went into it, I think the important thing to recognize is that there's no change. I mean the DRC position talks about that this would have the result of the classification before receipt at the disposal site, most meaningfully accomplished away from the disposal site. That's – every manifest we get at Clive was prepared away from Clive. There's no such thing as us getting waste and not knowing what it is and manifesting it at Clive. So that's no different.
Pat	I understand that. So would [tape skips] You respond to the – you shouldn't down-blend solely to change the waste classifications, you say no we have other reasons?
Tom Midgette	Yes. That's correct
Pat	Okay. Thank you.
Chairman	Are there other direct questions concerning – yes, Dr. Trip.
Dr. Trip	So basically then the compaction of the so-called resin of materials that you're working with, this is still – this is all them in Oak Ridge, or in Tennessee?
Tom Midgette	It would all be done in Oak Ridge, yes. By – for what we would do.
Dr. Trip	Sure. Where do you stand time-wise in terms of your resin processing?
Tom Midgette	We have completed the test on clean resins. We've designed a mixing facility. We're actually proposing to construct the resin solutions facility at a building that was actually abandoned by a waste processor that abandoned the radioactively contaminated facility because they went out of business and we --
??	Sounds like Rocky Flats.
Tom Midgette	-- and we agreed to take it from the State of Tennessee and clean it up and as long as we were given the property to you so we spent about $5 million restoring and decontaminating the site. It's immediately adjacent to our Bear Creek Facility where we do incineration and compaction and so that's where it would be, in that building. And we're

Speaker

	about second quarter of next year away from being complete, but we're prepared to do tests already.
Dr. Trip	So then the testing then that will be done in terms of your processing or reprocessing or whatever you want to call it, then would be under the scrutiny then of the NRC, basically?
Tom Midgette	It would be licensed by an agreement state, so it would be under their scrutiny. I mean that was one of the questions that was asked by the NRC, is there additional oversight that would be required and you know we would say it's no you have agreement state regulators at the disposal site, at the processing site. You have NRC at the generator site, so you have oversight. You have QA programs. I think that would be covered.
Dr. Trip	Interesting.
Chairman	Ed Johnson?
Ed Johnson	Yes, so you were not, or excuse me – I guess I don't understand really then why we're debating this issue because are you trying to get your license amended so that you can do blending onsite here in Utah?
Tom Midgette	No. We're not asking for anything in Utah. We're simply addressing the issue because it's been raised before the NRC, it's been raised before this board, questions have been asked, you know, we were hopeful to get in here and try to get some background on it before it pertained, you know, essentially a public debate, I think we probably got you in the middle of it.
Ed Johnson	Yeah! But that's so – so why are we involved because really we don't even know, to look at a manifest. We do not know whether it is blended or unblended waste that comes in. Is that correct.
Chairman	I'd just draw your attention to our next agenda item.
Ed Johnson	Okay.
Tom Midgette	But the answer to your question is yes, we don't know. There's no – there's no manifest that says what it used to be.
Ed Johnson	Okay.
Chairman	Pat Comb?
Pat Comb	I guess I've asked this question on another subject, but your timeline for bringing material like this in, I mean do you have any pending upcoming

Speaker

	contracts --
Tom Midgette	We're pitting on – now I'm going to try and answer so that we both understand the answer more clearly this time than last time, but we would clearly love for Utilities to send us their B, C waste to blend and process. We don't have contracts now to do that. We are actively pursuing that work, but we don't have any. And although we do have interested parties, but we don't have anything right now. The earliest physically – not – it's not – it would not be a contractual constraint in this case because physically we couldn't do this for at least a couple more quarters, I think.
Pat Comb	Couple more quarters?
Tom Midgette	Yeah.
Tom Comb	Ah, ok, so --
Tom Midgette	I mean I think the NRC's going to be over and done with before.
Pat Comb	In April, right?
Tom Midgette	Yeah.
Pat Comb	And then – so you might be signing a contract, well, you know, tomorrow morning – we don't know. So --
Tom Midgette	You know if I could sign one tomorrow morning, I certainly would, but I don't – I can't physically do that – I don't have – I'm not set up – Energy Solutions is not uprunning, licensed, ready to roll. So I can't do that, that's why it's a physical constraint. Because the Utilities are interested in this solution, the Utilities are interested in lots of solutions. I think what you're going to hear them say on Thursday is they're not promoting this, they're not opposing this, they're not promoting what our competitors want to do or opposing that. They want to have flexibility and options.
Pat Comb	Okay. I guess I'm just wondering how timely it was and how deliberative we can be and all that kind of thing because NRC guidance is just that – we can basically do what we need to do for the people of the State of Utah in regards to this and so I'm kinda trying to figure out what – how much time we have before our train shows up. So two quarters.

Speaker	
Tom Midgette	Yeah, at the earliest and I – that would be – that's an optimistic schedule.
Pat Comb	Okay. Thanks.
Chairman	Okay, are there any specific questions about the presentation? If there are none, then we are going to move to our next agenda item and ask the Energy Solutions representatives to remain close, if there are further questions from the board. It looks like we will go into overtime. And the next agenda item there is the – we will turn the time over for – to Christian Gardner to present that. Christian?
Christian Gardner	Thank you, Chairman. And I'd also like to thank Energy Solutions for their presentation. I think it is very helpful. I am proposing a rule that I'll pass out here to prohibit the blending of B and C waste. The reason why I'm interested in this and it goes back to the point Tom just made was – I do believe this should be a public discussion, that we should have a public debate on this. As a matter of good public policy I think it's something that we need to – to really look at, especially as it interrelates with depleted uranium and as we look at bringing waste streams into the Energy Solutions site that I don't know if we ever fully contemplated years ago. When Energy Solutions proposed before the – well when they had the discussion with the NRC in the December 15th meeting, Question 10 by the NRC – and I just got on their website and pulled up Energy Solutions' response was – the energy question is given that the agreement states are not required to adopt NRC's guidance on blending, how are different states addressing this issue? And then what are the advantages and disadvantages of these approaches? And Energy Solutions point on Slide 52 is no state in which Energy Solutions operates regulates or objects to blending. And it seemed that that may be true for you, Tom, I don't think we have an official position objecting or regulating blending. I propose this rule as a way for us to start the process of really discussing what we think. I appreciate Amanda giving us the letter from the Governor and it's, you know, six good points that I think we need to take into consideration as we go forward down this. Some of the things – some of the questions I have that, you know, I think we need to address, you know, regard the performance assessment that was originally done for this site. Did they contemplate these types of waste streams? Did it, you know, what about its – the radioactive level of this coupled with depleted uranium. Is this site – I mean have all of those things been contemplated? We looked at the long-term impacts. You know the other thing we looked at I think on the slides, if we're taking – if there's 18,000 cubic feet of B and C resin and they're going to take roughly 8,000 cubic feet of it, that's roughly going against my

Speaker

business school professor's advice and never do math in public, roughly 44% of all the B and C waste out there, you know, that will be coming to Utah – is that something that's – that if we accept it that we can ensure that the health and safety of the public, you know, is our No. 1 priority. I don't know if we've thought about that or if we've really, really talked about it.

I mean there's several other questions. You know, what are rules governing blending already here in the state? You know, I mean, that branch technical document probably covers some of that but it's – it's probably vague why the NRC's going through this. What are the sources of this waste? You know, what type? And where is it coming from? You know, just a bunch of these that I think we as a board need to get in front of an issue before you know as Pat said the trains are here. I mean let's – let's talk about this. And I'd like to get feedback from the board. I have a lot more questions and I'm sure many of you do, but let's --

Chairman

I would like to, you know, kind of [tape skips] board members of some things that we've learned the hard way in our discussion of the depleted uranium waste. No. 1, and I think I heard it mentioned is that, you know, there is guidance put forth by the NRC and it is not – it does not carry the weight of regulation. However, if we chose to ignore that guidance we have to have significant technical reasons in which to do that. As was pointed out, I think there is a significant body of guidance of dealing with dilution and everything else that has been redefined in – in all of these things that we've talked about today. And I think – a simple, you know, glance at the NRC's website will pull up several SECE(?) documents, new reg documents, opinions, innuendo, everything else that you want, concerning – concerning that. One of the concerns that I would have is how would this rule – how would we overcome that technical challenge ________? I don't know that this board has the expertise inherent in it to do such a thing, nor am I confident that the resources are immediately available to do such a thing. Nor am I convinced that there's a practical reason that we would have to. Honestly, I've put a lot of thought into this and since Christian proposed this idea and I want to remind everybody all the painful discussions that we had on depleted uranium waste. And how we went through all these machinations. We went back and forth, we had all the different presenters come to us, the NRC, Energy Solutions, HEEL, members of the public and so on and then at the end of the day we kind of came to the realization that maybe we were missing the forest for the trees. We were getting caught up in a whole bunch of details that maybe we didn't really need to in order to accomplish the same thing. And I can't help but wonder if we're not going down the same course with this.

Speaker

Let me ask the question, just kind of rhetorically and I'll continue my soapbox speech. But, consider that, you know, we've got the DU rule out for public comment. Consider hypothetically we've put out a depleted or, excuse me, a diluted rule – diluted waste rule.

?? Blended.

Chairman Blended. Whatever we want to call it. Six months later, what's next? What's after that? And so I wonder if instead of focusing on specific waste types we need to be focusing on rules that would address the health and safety of this waste and the appropriateness of all wastes in general at the site. And I don't wonder if that is more the way that we should go. In other words, if such a rule were in place with such a wording that, and some suggested wording that I've kind of thought of if it is not specifically defined by regulation and if it's not specifically addressed through standing, established guidance by the NRC, then the State of Utah require that the waste – that waste stream undergo a site-specific performance assessment prior to acceptance. So let's back up and say well how would such a rule affect this blended waste? If it is in fact, and if you read through several of those letters that have been quoted, Larry Kemper from the NRC who came and spoke to our board on the DU waste a couple of months ago, is quoted in a couple of those letters stating that, for instance, without being specific, this type of waste was never addressed in the branch technical position document. So where does that leave the State of Utah? If we based our waste acceptance criteria to a certain degree on the branch technical position document and we've all of a sudden discovered there's a waste stream that doesn't meet that or if there's question concerning the way that a waste was blended, whether or not is it appropriate and the branch technical document or new reg – I found one – new reg. 1757 which specially addressed some of these blending issues and a couple of the other SECE(?) documents – if it is not specifically characterized in one of these guidance or rules that the NRC has put out, what then is the fallback for the State of Utah? Short of [tape skips] us launching our own nuclear regulatory commission with a complete technical scientific staff, I think we – to a certain degree we have to rely upon that scientific evidence. But what I would suggest that instead of combating and tackling each specific waste type that we addressed it from a – what I feel is probably more appropriate for the board. I do not want to see any regulation, whether it's radiation regulation or anything else – be so prescriptive that it becomes so bureaucratic and such a large unweildable beast that nothing can get done. That's not, I think, what our form of government is about. But rather if we can put in some safeguards in place such that there is something that would be a catch-all so to speak, so if it is not specifically classified here or there that we do come back and we say what is the

Speaker

	purpose here? Ultimately we want to protect the health and safety of the citizens of Utah. So why not write a rule that addresses those things rather than swatting at every fly or every flavor of waste that comes at us.
	And so I don't disagree that probably here we need to have some type of rule. I'm not 100% certain that, and I agree with Christian on this, I'm not 100% certain that there is a rule in place. However, just with our experience with the depleted uranium waste and probably the bigger picture here, I just wonder if that – we're trying to be too specific in addressing each type of waste that will come before us. Is that kind of clear?`
??	That makes sense and I think, you know, we share those thoughts, we don't want to go through this every board meeting with a new waste stream and a new rule making process, six months of hearing on it. But I guess we're just in a sense, we have the blended issue before us as well. You know, I don't know if you take two separate tracks or one, but I do believe we just need to have the public discussion on it.
Chairman	Yeah, and I agree. And I think, I think what I was saying is that – the wording I would proposed --
??	______ it could be much broader. This would fall under that umbrella. Sure. Not a problem.
Chairman	Yeah. Yes. Ed Johnson.
Ed Johnson	Yes, Mr. Chairman, does this and I'll ask Laura as well, does this get us back in that situation where we would be proposing or trying to implement a requirement more stringent than the NRC when we don't have the technical studies and the written – the written conclusions to back us up?
Laura	I'm afraid I'm going to disappoint you. I'd have to look at the specific proposal and the reasons you were making your proposal before I could really answer that. Certainly there's a possibility.
??	You know, Laura, one other question is, you know, that I have here, and Energy Solutions, you know, did address to give their interpretation of it, I mean there is a state law that prohibits the B and C waste coming into the State, you know is this, you know I guess maybe technically that's not in violation with this – or is it? Was this contemplated when the deal was struck with Governor Husband some years ago that the blended waste – does that law capture blended waste? I mean what are – what is the policy here? You were part of those negotiations.

Speaker

Laura I was not part of those negotiations. I did, however, read the letter. I don't remember anything about blended waste specifically. But I could be wrong about that. The agreement with Governor Huntsman does not include B and C or blending. It's addressing the capacity, the State statute addresses B and C. But I also think in looking at the wording there is some issues there in exactly how the statute itself is worded in terms of blending. So, just a process thing, I think, in terms of, with respect to the idea of getting it out for public comment. But I think these types of things when first __________ appear to say, to take a broader look would be good; but I think also allowing staff to have a look at it and our counsel to have a look at it is a very positive thing before we take an action because it's a really _________ and there's a lot of technical issues that would be better addressed. And even in a public discussion if Laura were able to answer these specific questions.

Male Speaker And I agree with that completely. I'm not saying we vote on this.

Chairperson Dr. Trip

Dr. Trip Well it's obvious that you've done a fair amount of thinking on this subject and I agree with you. I recall I spent 7 years in management. I'm glad I'm back into academics. That's a different kind of management. But at any rate I always, the thing that I hated about management in essence was the so-called management by crises, rather than management of the whole issue. And I think if, obviously the DU situation has, we've tried to manage something by crises, and now we've blended waste, there's something else. So I agree with you. I think that we need to look at this whole thing. I don't happen to have Laura's document with me that she gave to us a month or so ago. I left it at home. But I recall that the State of Texas essentially tried to make a more broad stroke in terms of its management policy when it discussed the issues of disposal where there were long-lived activities. And I don't remember all the details of it, but in essence it put the onus on the disposer to essentially meet these very general criteria rather than trying to put on all these different rules and regulations being more specific. And then my other comment is that what brought on, what brought us to this particular point of dealing with depleted uranium? In essence, we're trying to deal with something that the NRC has essentially reclassified depleted uranium as A; but on the other hand, hasn't gone any further and doesn't appear to be going any further for at least a couple of more years before they come out with a so-called guidance document to tell us what they think we ought to do with it. And with the blended waste it appears as though the same sort of thing is going to occur. It puts us in a catch 22 in that regard and so I, rather than being caught in this crises, I think we need to look at a more general

	approach to the subject as you've indicated.
Peter	Maybe I could add a little bit more and clarify my idea a little bit more as to how I think we could word, and I'm not suggesting a specific wording, but I'm suggesting kind of an idea of an approach to a rule. And maybe I can explain what I think Board's role would be. Say for instance, instead of writing a rule specific to blending of waste, we were able to say, if this waste isn't specifically handled over here by the NRC, in other words, it would cause technical problems or compatibility problems or whatever, we're going to assume to a certain degree that the NRC has made the right decision. And then the waste is proposed to be accepted at the site, there would be a mechanism or there is a mechanism where the decision by the Executive Secretary could be appealed. And then at that time it would come to the Board and the Board then would have the opportunity of looking at it on a specific basis and saying, no, we feel that the Executive Secretary acted appropriately; or, the Board could also say, no, we feel there's enough here that warrants an additional study and then the wording of the rule could require the site-specific analysis be performed at that time. So, it would kind of be a catchall where as if it's not specifically addressed, you do your site-specific performance assessment. If there's some question about it, the Executive Secretary or Director has the authority to require a site-specific performance assessment. And if that can't be handled, then it comes to the Board and the Board has the opportunity to hear it and adjudicate it just as it would any other licensed condition. In other words, it makes us regulators; it doesn't make us overlords on this waste process thing. And I think that's important because I do not want to be in a position where we are telling somebody how to or to not do business if it does not affect the health and safety of the citizens of Utah. And I don't think that's what our role is here. In other words, that's why I would say that site-specific performance assessment—not only is it consistent with what the NRC is telling us and consistent with what's going on with the DU, but it's also consistent with what our role is. We would establish whether or not it is a health and safety issue so we couldn't get caught up in being used as a pawn in some other larger battle. But we would really be insuring the health and safety. That's what I wanted to emphasize. So, that's my proposal I guess.
Chairman	Pat?
Pat	Well, Dr., I do have questions about the findings and stuff that Laura wrote. I mean Texas, as much as it galls me, does have a really good regulation in place as far as looking globally at every waste stream, doing a site analysis just like what Peter is talking about. Now whether we

Speaker

abandon this specific thing, because we're reacting basically to a bunch of these issues, or we do something global, like what he's talking about, which I think absolutely makes sense—and Peter and I have been talking about that—or do both because in two quarters we have something coming down the pike. So, maybe we do a little bit of both. We react to this and do something here and rely on NRC guidance that says you really can't down blend into it, and also start a more global look at this. I think that way it puts us—like he says—in the form of regulators instead of reacting to every next stream that comes in. I would go both directions, myself.

Peter

The only question I would have on a specific rule is; your concern about a specific rule, is that you're concerned about time. And obviously we have a track record where we do need to be concerned about the time frame. I just wonder, though, the amount of precedence that is established in guidance and rule on how to blend wastes is staggering. And, there's many different regulations which, as anyone else can do can spend as much time as they want with the friendly neighborhood ____ system and read as much on this as they want. My only concern about trying to do a quickie specific rule is I still do not see how we could come up with the technical justifications to ignore all of the guidance and still proceed with a prohibited rule in a short amount of time. I'm not saying it's impossible; I'm just saying your concern was the short time period. How would we make a prohibitive rule and accomplish those tasks? I'm just asking from a practical standpoint.

??

It might be a bit difficult. Let's ask our Department how much work that would be.

Female Speaker

Well, I guess, this is just a random thought but it sort of is pertinent. In a perfect world we would rewind this situation and I've been aware of this rule or the idea of this rule for a number of months now. I think the responsible way to deal with the issue would be to kind of step through it in some sort of reasonable format where we could ask the Division to prepare and educate the Board on, I'm not saying it needs more work. But, sort of, what is the synopsis of all the information that's out there and guidance. What is—we tend to get into this issue and, of course, I'm new to it—Energy Solutions vs. ________, basically and those are the two parties that come before us and battle it out. What I would propose is that we actually ask the Division to sit down and guide us through what is the world that we're looking at, and what are the issues. Ask Laura to look into it; how would we substantiate our rule; is it possible to come up with the technical basis to do a rule; and have a discussion that's actually based on our ability to regulate it in that format. Rather than, and as much as I, and obviously even the Governor has weighed in on

Speaker

	this, I agree with the concept behind the proposed rule, I hate to just throw something out and do something quickly without knowing exactly where we're going because ultimately the Division will state, maybe in the position of defending of it in court. If we don't have that basis clearly lined out and the court hasn't actually gone through and stepped through a process of looking at all the issues, then we're not going to be able to ultimately defend what we do here anyway. That's my concern.
Male Speaker	So, it seems _______________; and, Laura, I guess it's kind of a question for you. What would you need from the Board in order to even begin weighing that? You would want some idea from the Board of which direction they were going, is that a correction assumption, or what would you like to see from the Board?
Laura	I think I'd have to probably ask for more than that, in which direction the Board would be going and why. And that goes to your question about technical basis. I think it's really hard to talk about this in the abstract.
Male Speaker	So, in other words, you would like to see the Board come forward with something that you could then concretely address? Is that correct? Or at least some ideas?
Laura	Well, if you're saying, if the Board is saying you would like to proceed, my recommendation would be similar to what we've done in the past. It would be a good idea to have a subcommittee working on the issue and creating, considering options and looking at justification. Does that answer your question?
Male Speaker	I think so.
Male Speaker	A typical lawyer's speech.
Laura	Yeah, I know, thanks!
Chairman	Yes, Pat?
Pat	If we decided to basically abandon this specific reactive role that we're talking about, timing wise, rule making is going to take just as long to do as global, kind of to look kind of similar to what the State of Texas has done where they require new analyses on any waste stream. If that's something that we could create a statement of basis like you did previously knowing if we have consensus on the Board that is kind of what we want to do, I think it would reduce our workload if we get into the proactive instead of reactive mode. I guess at this point, that's what I'd like to see done, I guess.

Speaker	
Chairman	Ed Johnson?
Ed	Correct me if I'm wrong. If we are to propose regulatory restrictions or limitations, it's to be based on a health and safety issue, right, as opposed to it being a state's right attitude of; and I still firmly believe that we should not have to take everybody's waste in the world; but we have to, if we're going to take that position, I think we have to have a scientific reason to come up with a rule like that. And I think this position paper here __________ come out of the Governor's office, it's kind of just a state's right thing isn't it?
Chairman	Amanda
Amanda	I just wanted to clarify that the paper we handed out came from Dane's Division, from Dane, but it is consistent with what the Governor's policy is. He hasn't written anything. But I guess I have the same question, Laura; and that is, if we are to pass a rule, my understanding is that it has to be based in, at least if not stricter than, it has to be based on health and safety, not on a greater policy issue of we don't want to be taking the Country's waste.
Laura	It's hard to know where to begin with that question. I think that there are a couple of things that I would like to look at. But would perhaps go a different direction and I guess until there is a subcommittee or until I'm told otherwise, I will not be that vague. But for the most part, yes, if your purpose is to just say we don't want blended waste, and that's all that you do, I think that there probably would have to, yes, there would have to be a technical justification.
Peter	At least from idea that I'm thinking about that I've not proposed specific wording for, but it seems that it addresses both of those issues in a way. In other words, it doesn't prohibit an action unless there's a health and safety thing. It only would address those issues which are not addressed by rule or established guidance. And so, in other words, if you end up with a waste stream, and again, think of a fictitious waste stream that we don't know about today that might come to us in 6 months and says well it's kind of like this, but it's not really like that and we don't really know how to apply the guidance there, then Utah has a rule that says, okay, let's look at the health and safety before we do anything else here. And that's the type of rule I'm talking about.
Pat?	But ultimately, isn't it all coming down to performance assessment is what you're suggesting?
??	Yes, site-specific.

Speaker

Pat	Site-specific, so in that sense we may not be taking positions on a lot of these things. They go to Dane to review it, the site is set for . . .
Peter	Well, let me ask you a question. Do you believe it's within your scope to be in the business of telling somebody how to run their business? I guess that would be a question. In other words, if it is outside the scope of health and safety, do you believe, you in your role on this Board need to be involved?
Pat	No, and I'm not suggesting that I tell anybody how to run their business. However, if you get too broad I think it can circumvent what we're actually here to do and actually make some decisions.
Peter	For my, the thing that's inside my mind, the only thing that would need to be added additionally which I think, and that kind of addresses that, is that the Board would then need to make some policy stances on what is acceptable assumptions in performance assessments.
Male Speaker	Sure.
Peter	And that would need to be added to it.
Male Speaker	I'd like to make a motion to purse the Chair's direction on that and form a subcommittee and reports at the next meeting on how that would work, and working with the Attorney General's office to come up with a statement of basis for a little more comprehensive look at waste streams.
Male Speaker	Before that, ________ a word and _______________
Male Speaker	Who was on the agenda?
Male	Energy Solutions _______ public comment.
Male Speaker	Oh I'm sorry. Hold on. There is a motion on the table – that Pat made a motion – is there a second to the motion?
Male	I would second it.
Male	Okay, then before we call the question we will open it for further discussion. If in the interest of time you signed up on the public seat, I will allow you to address the agenda item.
Amanda	I guess I have an observation or a question and that is – going – it struck me that going with the motion that Pat is making really does address the health and safety issues and it goes to the ________ was sort of – would lead one to believe that as long as it is Class A waste, the facility has the

Speaker

	rights to take it – it's a given. And unless there is some significant difference in the type of waste stream that it is, then we as the Board are okay with that and if it's a different type of waste stream, it kicks it out to performance assessment value. But what that leaves out is the policy questions that we have dealt with which is okay. This isn't a foreign waste as an example. It's a policy issue about whether Utah wants to take foreign waste __________ in proposing that. I guess I would say that maybe the Board needs to kind of struggle with the concept that we don't pass rules on policy questions. Maybe a rule is not an appropriate response to a policy issue. A rule is an appropriate response to help you think the question. I'm just putting it out there but there are other ways the Board can make statements proposing. The Governor's office can make statements one way or the other. The Legislature in terms of taking class A VNC can make statements, but I think the Board needs to graffle with exactly what are we – what is the appropriate _______ of the rule.
Male	She stated what I was try to say much more eloquent. These are things we really need to look at.
Amanda	And unfortunately – I have been here six months. And my only experience is with uranium and that was a poor example of how to deal with an issue ___________. It's not anyone's fault but we ought to try to think about how do we
Male	Mr. Chairman?
Male	I'm curious – then are you suggesting that perhaps we should amend the motion or is the motion – or are you simply trying to put some guide rules into the motion.
Amanda	I was not trying to do either. I was just making a statement.
Male	I would agree with what Amanda said. I think that ultimately – what we are talking about – if blended waste is a health and safety issue, then we need to have a rule against it. But what I am suggesting is if it is a health and safety issue, let's not deal with everything. Let's look at the issue from a little bit more general perspective which would also the umbrella I think you used. Would also include that, but also some other possibility that we can't imagine right now.
Chairman	I think that is what past motion was.
Female	I agree.
Male	Absolutely and director's right when she cited policy versus technical issues. The trick is we need something that is also enforceable. A

Speaker

position statement is great, but we need some enforceable statute which what Texas has in place. It's something that spells out what the rule is.

Male — We are going to go by rule call. So I'll have you come up in a minute if that's okay. So those individuals who requested to address this item – there are ten. So I am going to ask you to keep your comments to two minutes a piece please, and in the interest of time, I won't allow you to share time. So passing off. Mr. D? – if I say this wrong, Camillo? When you come up, please state your name and introduce us to any affiliation you have?

Joe — Good afternoon, I will be very brief and thanks for the opportunity to come and talk to you today. My name is Joe ________. I'm general counsel to _________. I was – kind of put that in as a place holder but since we have a couple of issues I would like to clarify with respect to some of the statements made by Energy Solutions. First of all, who we are. We do in fact compete with Energy Solutions with respect to a Class A VNC resident. Their Class A resident for example would go to direct disposal for Energy Solutions. For us, we would use a volume reduction and stabilization process that would ________ processor. So that is where our competition is. We are also customer of Energy Solutions. We dispose of a fair amount of waste at Energy Solutions. And in that context we believe we are a stakeholder with respect to issues that we think will affect not only our business but the low level waste industry, and so that is why we have – we have come here to speak and why we have an interest in the blending issue. Very quickly I would just like to – we have had a couple quotes from various documents. I would like to give you just one quote and say that I would be interested in looking forward to working on this issue as it progresses through. The radiation control board – the NRC in their analysis of certain statements that were made in my letter to them. I made a proposition that large scale blending is "by a third party is outside the scope of the branch technical position." And NRC's response was current industry proposals seek to expand the historical practice of blending. I would just like the Board to consider that issue when you hear statements that clearly NRC's guidance allows this to occur. I think there is some – there is less clarity than that statement. For now, I think that is all I have to say. Thank you.

Chairman — Mr. ______________?

Randy — My name is Randy _________. I'm a Salt Lake ____________ was retained by _____________ because the eight years I spent managing the Salt Lake county's landfill – that point because they do ____________ an awful lot of – what I inherited was landfill in 1990. We had 15 years life left on it. Which meant ________ we would have to build a new landfill

Speaker

in 2005. But because of volume reduction _________ we were able to extend the life of our landfill to 45 years. The idea that the management of the landfill – in this particular landfill, ______ is very important. Mr. Johnson said something that was so amazing – we need to start with what he said. The fact of the matter is that acceptance of VNC blended waste is really a subrogation subversion of what I believe the legislation and the agreement that was signed by the Governor. What happens is you become – because you are the only acceptor of a waste in a commercial facility – you become the de facto acceptor of all the VNC – if you can take all the VNC waste particularly in the resin arena – blend it and _________ - what that does is – and here's the public policy position – is also the health and safety position and that is you increase the number of __________ in the __________ - the idea that it is the same consistency that comes in is _______ by Energy Solutions, but when you blend it you bring in a higher waste VNC is a blended sort of disguise waste with a _________ - you increase the radiation and that is the health and safety concern that we are talking about. I think what Amanda said is important. This public policy issue – you guys. I hate to tell you that is why you make the big bucks. Is like me at the Salt Lake counsel – we have to do crazy stuff. We are the decision makers. You are charged with the responsibility of health and safety and I think frankly the public policy of radiation disposal.

Chairman — Thank you. Mr. O'Neill?

James — James O'Neill from Provo. I'm pleased that I only had to wait 2 ½ hours today – I had to wait 5 hours the other day to make a public comment of 2 minutes. I have cut down by presentation here. My guess on this – I have been studying what the NRC says, okay? I'm going to read a couple of things here. I apologize for reading it. The low level radioactive waste facility in Barnwell, South Carolina closed in 2008 to out of compact radioactive waste generators. That means that 36 states have no disposal option for C&B low level radioactive waste. They now have to store it onsite. The scale of this program is the reason for increasing interest in vending VNC with ________. Energy Solutions would be available for blended radioactive waste turned Class A. Thirty-six states that can no longer __________ the more dangerous VNC waste to Barnwell, South Carolina could send it to Utah blended with Class A. NRC regulations only require radioactive waste to be classified when it's ready for disposal. If it's mixed and sent to a different place, the origin of it may be unknown at a future time. _____________, Appendix G, Section A allows radioactive generators to divert classifying waste until the time the waste is ready for disposal and does not require generators to classify waste before they ship from the generator to a processor. Classification then will be subject to a ________ potential in accuracy.

Speaker

	Now I'm a word person. I'm not an engineer. Blend out of the dictionary – to combine or associate so that separate constituents so that lines of demarcation cannot be distinguished. That's blending. Dilute – to diminish the strength, flavor or brilliance by adding a mixture. This blending is diluting. Okay. I don't care what the NRC says – that is what it is. It's diluting – it's a way to get around a problem. Now ___________. All of you?
Chairman	You're out of time. We have a board member who has to leave – the board member made the motion so we need to respect his time. I allotted two minutes – I think you used your 2 minutes.
James	I did as much as I could.
Chairman	I appreciate your comments. I have to cut you off. The remaining board members – I will restrict your ________ - so please respect the time or you will be cut off. Mr. ________ would you like to speak? At the end of the meeting.
Male	I'll pass.
Chairman	Mr. Thomas? Please keep it to 2 minutes.
Mr. Thomas	Just a couple of quick points. If I'm not mistaken the state of Texas also have a rule specific blending. Could be wrong about that – but that's my understanding. So I just want to submit – there may not be all of these technical issues that have been identified. What I have learned from the depleted uranium issue is if there is another state that has done something, it's good to kind of follow and see what they have done rather than blaze a new trail. I have immense respect for the chairman of this board, I have to disagree with the idea we can make this more of a general rule. I think it's going to be very difficult – more difficult than doing something and kind of trying to do the same thing that Texas has done before. I think in terms of policy, yes, there is a huge policy issue here, and I just address board member. I think you summed it up very well. If Utah takes all of the nation's Class A waste and almost all of its Class B waste, there is very little incentive for the rest of the country and the regions around the country to develop their own disposal solutions. So by not addressing this issue, I think it's locking us as a state to being de facto nation's low level waste dump site for as long as continue to develop more disposal capacity. So I don't think necessarily that this has to be a health and safety finding because it's not addressed in federal rules. That no more strict than as to do with federal rules as we said. This is not addressed in federal rules so I think the board should absolutely go forth with closing this hole within its own regulations

Speaker

	rather than trying to do something more _______. I think could be done at the same time, but I would say please do not abandon – it's on our doorstep I don't want it to cross us over again like it has in the depleted uranium issue.
Chairman	Thank you Mr. Thomas. And I will say to everybody including Mr. O'Neill, you may address the board after this – if you like. Ms. Kelly Nichols? I can't read this Steve, citizens education project? George Chapman?
George	I'm George Chapman. I'm representing myself and I agree with the chair that safety is important. That is your job. I just want to remind the board that public safety just doesn't affect Utah, but if you can assure the safe disposal at ________, you also affect the stockholders with Energy Solutions. Because if you don't assure that that facility is safe for the long term, you directly impact Energy Solutions. They are not going to be a viable long-term company if you can't set standards, make them long-term safe. Also I want to point out that you have barrels, stainless steel barrels buried there in a salt desert. Stainless steel doesn't normally hold up that long, and I suspect 70 percent of the barrels will be intact in 50 years. You have to address it – from a public safety standpoint – in a 100 years that is what Class A was supposed to be. A hundred years it will be safe. Blending with VNC creates a public safety issue because you don't know what nuclids are in that waste stream and it could be going a lot longer and be much more unsafe for 500 years which means you have to increate your remediation fund and closing fund.
Chairman	Thank you. Helene Como.
Helen	I'm Helene Como from Salt Lake City, and I'm representing myself and the people of Utah. I don't see this as between the board or Energy Solutions or ________. There is just no line that we set that way. We are looking at the people of the future generations in Utah, and to make a broad ruling so that these things don't keep happening, we really need to look right now at the blanket issue. I'm just really here to thank you all for taking this – and I feel very disappointed in our elected officials, Senator Hatchett, Senator Bennett, are not taking a stand on importing _________ waste, but no one has sponsored this in the Senate. And we need the elected officials looking after the people in Utah – not the business interests. I think Governor Hooper waited way too long to write a letter about the depleted uranium. He knew about this and then once the _______ he writes this letter which is _______ both ways. I feel very sad about our elected officials and we really are looking at your to protect not only us right now but our future generations. When the NRC guys were here, and basically on a lot of these issues – they don't know yet.

Speaker

So until they know, that is what we are looking to – since _________ working at the background to do all this work, we really need to put a halt on this until we have the answers with site analysis, knowing what the blended needs and this DU thing has gone totally out of hand. And I'm here to thank you but also we got to put some teeth in this and we have to do it now and then we can't stop until we know what the answers are. But if we take it out, it's too late. And so please just get the work that needs to get done. I sincerely thank you for taking this on.

Chairman — Is there any other discussion from the board. Pat, could you restate your motion and we'll call.

Pat — I would like to move that we form a subcommittee to look at this report for our next meeting and come up with a statement of basis, and also come up with some recommendations for our next board, whether we want to start producing global regulation, _________ or both. Come up with a menu for the board to look at and vote ___________.

Chairman — I think that was significantly the same. The motion was previously seconded by Dr. _________. The chair will call the question. All of those in favor of the motion proposed by Pat, indicate by "I".

All — I.

Chairman — Anybody opposed? The chair abstains, the motion carries. I ask for volunteers to be on the subcommittee. Kristin Gardner, Pat Cohen, Dr. Trip, Ed Johnson, Pete Jenkins, Amanda Smith. That's it. We cannot have 7. Okay. So the membership would be Kristin Gardner, pat Cohen, Amanda Smith, myself, Dr. Trip, Ed Johnson. If there are other board members that would like their opinions considered, do it informally, one on one. Who would like to act as chairman? Pat.

We do have two more items on the agenda. Item 7 on the agenda is our monthly board information item from the division secretary. Is there – are there any comments about that report you have in your board packet? Are there any questions for Dain concerning any issues on that summary report? Okay. I assume that means no.

Final thing then is – back to comment. I apologize to Mr. O'Neill for cutting him off and ask if he would like to finish his comments to the board.

Male — Can't heard. Laughing.

Chairman — I believe Mr. __________ was next.

Speaker

Male — I just want to draw your attention to something that both Kristin Gardner and Dr. Trip pointed out in a different way is that we are all dancing around this central issue that the NRC made a really bad decision when they classified depleted uranium as low-level waste. And we are feeling the consequences of that decision on their part. It seems to me that depleted uranium changes everything because it runs in so many ways counter to the general tendency of low level waste. For example, to become less radioactive over time. And so I see this impacting the decisions that you are considering today in several ways. First of all, the possibility of DU now classified just as low-level waste which it wasn't before entering a blended stream and allowing a back door method for bringing this waste into the state. Secondly, with regard to the analogy that was given regarding the glasses of water. As you consider your performance assessment for DU, I think it's really important that your intruder scenario not be limited simply to be the assumption of an arid isolated site as Energy Solutions likes to pitch their facility. The real possibility exists that the site will be compromised by a return of water to the area in which case the results are unpredictable. Specifically the concentrations of waste that could build up in pockets – so we are not dealing with a homogenous solution any more. We are not dealing with a slight – sort of uniform radioactivity. But a large base in which could have pockets of high radioactivity as carried by currents and other forces geologically at work now on the site.

So this isn't a glass of water and you could well find yourself intruder scenarios where concentrate packets of material and therefore radioactivity find themselves in places that are not currently foreseen in your intruder scenario. And I hope you will consider that as you look at the criteria for your site assessment and analysis. Thank you.

Chairman — The next meeting is schedule for February 9 in this room. If there is no other business for the board, we stand adjourned.

4711035_1.DOC

Radiation Control Board Minutes
January 12, 2010

Speaker

	Aye
Chairman	Any opposed?
	I just abstain, I wasn't here.
Chairman	Okay. Note that for the record. Thank you Pauline??
Chairman	Uh, so the motion carries. The minutes are adopted. We're going to change our agenda around a little bit. We'll go ahead I think with agenda item 5 to begin with. If the division staff member is here. John are you here? Are you ready to present? Okay. So we'll go ahead with item 5A first which will be presented by John Holquist from the division.
John	Thank you members of the Board, Chairman. Give you an update on the license condition 35 public comment period. We received about 20 comments from 8 commenters or individuals. I kind of grouped them together just for means of summarizing this for us. There was one comment made based on the characteristics of DU that there is not a problem with the disposal at the ___ facility. There were two comments regarding the burial depth of 10 feet that was in the license condition. There was a comment regarding the extension of the public comment period and a public hearing. There was a comment regarding the license condition 35A and there was a lot of editorial language in it and it wasn't relevant to the compliance, to the facility out at 5?? and they provided some revisions to that condition. There was a comment regarding the stability of the disposal site after ___ closure and site closure itself. There was a comment about institutional requirements. There was a comment about the period of performance. There was two comments regarding remediation measures. I think condition E or F, E, talked about removal of that material at some later date if performance assessment was not adequate. We had two comments regarding the surety which I believe was condition F, 35F. We had another comment regarding the proposed language and they provided new language for condition 35 and then there was just one general comment regarding misinformation on radiation subjects in general. Not sure really applied to the condition itself but just the health, physics and radiation safety that the public deals with. So that kind of summarizes how many comments we [pause in tape] what we have to go through. The public comment period request in the public hearing was denied by the division director because there was opportunity for the rulemaking process to add additional comments and there was going to be a public hearing during that phase which we are