Dane Finerfrock - comments on Rule

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Attachments:	Comments on Rule 1.pdf

Peter, Dane, and Pat:

Here are our comments on the draft rule. Attached to our comments is the letter to NRC we submitted as part of their consideration of the issue. This letter is referenced in our comments and is part of the record. Due to limitations of file size, I will be sending, separately, two maps that are referenced in our letter. These are also part of the record.

COMMENTS ON DRAFT RULE R313-25-8

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Introduction:

The proposed revision to rule R313-25-8 is inadequate because it is insufficiently protective of the natural environment. In particular, the quantitative performance period in part (2) (a): ***i)*** is too short, and ***ii)*** a qualitative analysis to the time of peak dose (peak activity), is, by definition, insufficient to demonstrate performance of the system and relies on faulty logic.

We deal with ***ii)*** briefly here and in the remainder of this document the problems with ***i)*** are addressed. However, in addressing ***i)***, we demonstrate that, properly worded, ***ii)*** can and should be met with a quantitative analysis. We do this through two "contentions" that are followed with supporting analysis.

The problem with a "qualitative analysis for the period where peak dose occurs" is that "peak dose," both in its timing and magnitude, cannot be estimated without a quantitative model. Dose refers to human exposure. This may or may not occur when DU has reached maximum activity. If the Board means "peak activity," then the solution is simple. The rule must extend to 1 million years, which is not a new figure in the regulation of radioactive wastes (See Nelson et al., 2009; attached).

Before proceeding with our analysis, we note the language of parts of rule R313-25-8 that have not been modified (except for numbering), but inform what the licensee must "demonstrate." (1) (a) includes exposure pathways in ground and surface water, including natural and engineered features of the site. (1) (d) includes "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." These criteria must be met within the context of the additional challenges posed by the disposal of large quantities of depleted uranium (DU).

Contention 1: There is a high probability the site will flood, and that probability is so high such that rigorous, quantitative analysis is required.

Flooding of the Clive site would constitute a "disruptive event," defined as follows: *"An off-normal event that, in the case of the potential repository, includes volcanic activity, seismic activity, and nuclear criticality. Disruptive events have two possible effects: (1) direct release of radioactivity to the surface, or (2) alteration of the nominal behavior of the system. For the purposes of screening features, events, and processes for the total system performance assessment, a disruptive event is defined as an event that has a significant effect on the expected annual dose and that has a probability of occurrence during the 10,000-year period of performance less than 1.0, but greater than*

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[1] Views expressed are those of these authors and not of their employer.

a cutoff of 0.0001."

NUREG 1804 relates to high-level waste disposal, and volcanic and seismic activity are specifically mentioned because those were examples of plausible disruptive events at Yucca Mountain, NV. The Board should also note that the 10,000 yr performance period has been changed to 1 million years (Nelson et al., 2009; attached). A definition for disruptive event specifically written for Clive would include flooding by changing levels of the Great Salt Lake—Lake Bonneville system.

The Board should recognize that the idea of a disruptive event is relevant to other nuclear waste programs. For example, for transuranic wastes currently disposed at the Waste Isolation Pilot Plant (WIPP) in New Mexico identified 245 relevant features, events, or processes (WIPP 2010). Of these 245, 244 were screened out as improbable or unimportant to the performance of the system. We offer two observations. First, we would invite the Board to review this document. Second, we would hope that the Board would require a semblance of equal rigor to protect the environment from DU releases.

10CFR63 contains similar language and probabilities to NUREG 1804, but generally uses the terms "features, events, and processes" instead of disruptive events. Notable, however, is the straightforward cutoff on how unlikely an event must be before it is ignored. The probability is 1 in 100,000,000 per year. Stated another way, the probability cutoff is 1×10^{-8}.

One of us (Oviatt) examined excavations at the Clive site in 1985. In the walls of a 20' high exposure, were three lacustrine (i.e., lake) sedimentary deposits predating Lake Bonneville. Although the precise ages of these deposits are unknown, they are younger than those of the 150,000 year old Little Valley lake cycle. At Clive, the Little Valley deposits are probably at significant depth. Thus, a complete record at Clive could show many more lake deposits.

The lake system has almost certainly reached the elevation of the Clive site many times in the past 150,000 years. We can demonstrate a minimum of five flooding events: a) the three pre-Bonneville deposits in the excavation, and b) Lake Bonneville itself as it filled and receded, for mean return interval of 30,000 years. This translates to a minimum annual probability of flooding at Clive is 3.33×10^{-5}, or more than three thousand times higher than the cutoff for excluding a disruptive event.

Another way to look at this is that the site has a 33% chance of flooding over the proposed 10,000 year time period in the draft rule! Disruptive events are normally considered "low probability, high consequence events." This demonstrates that flooding is a high probability event. The analysis in a subsequent section shows that it also has serious consequences.

Before leaving this topic, the Board should note that 50,000 years ago the Bear River drainage was diverted from the Snake River into the Bonneville Basin. This increased the mountainous catchment and attendant runoff by 33% (Nelson et al. 2009; attached and references therein). Thus, from that time forward and into the future, the west desert of Utah has an increased sensitivity to climate-driven lake level changes.

We invite the Board to examine aerial images (Figs. 1&2) captured from Google Earth. The first shows the southern end of Pilot Valley north of Wendover, Utah. This valley was in communication with the rest of the Bonneville Basin such that water levels in this valley correlate to lake levels in the rest of the basin, including Clive.

The pin symbol Pilot Valley 1 in Figure 1 is at an elevation of 4280', the approximate elevation of Clive. The pin at Pilot Valley 2 is at the summit of a low pass leading into Pilot Valley at an elevation below the maximum depth of Lake Bonneville. Note that the red line between the pins crosses numerous arcuate features, or fossil shorelines. Many of these shorelines may have been created as Lake Bonneville retreated, but many of them may have formed as the lake advanced, even if that advance were temporary.

Fluctuating lake levels illustrate an important concept for the Board to appreciate. Lake Bonneville and the Great Salt Lake should not be considered as separate entities. The are parts of a single dynamic expanding and contracting system responding to natural variations in climate over time.

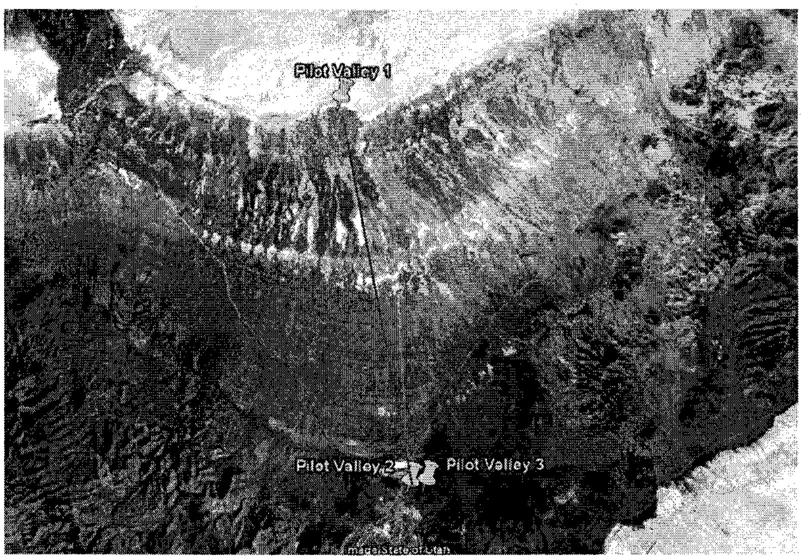

Figure 1. Aerial image of the southern end of Pilot Valley, Utah.

Figure 2 is an image of the Clive site and surrounding areas. Although the surface has been modified by stream erosion and blowing silt and sand, lake processes dominate the overall geology. Within the dark circle are clearly visible shorelines.

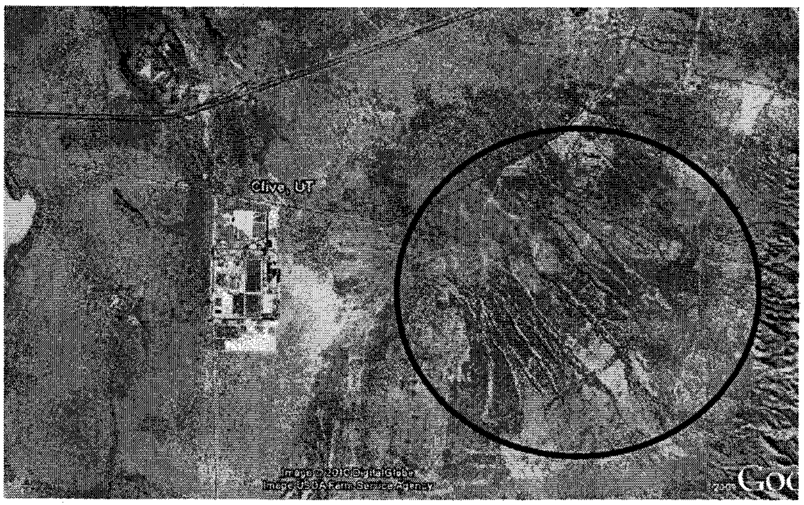

Figure 2. Aerial image of the southern end of the Clive, Utah area.

The Board should also carefully consider the quantitative analysis of the sensitivity of the Lake Bonneville system to climate change. Lake volumes are a function of the balance of all of the ways water can enter or exit the water body. Unless the lake refills to the elevation of the Provo Shoreline (about 4740'; the approximate elevation of the U of U campus), the only way for water to exit the system is by evaporation. Evaporation, in turn, is strongly dependent on average temperature.

The analysis in Nelson et al. (2009; attached) shows that for very small increases in average precipitation (3-6 mm/yr; 0.12-0.24 in/yr) lasting 1000 years, the lake will rise to the elevation of Clive *with no change in average temperature.* In contrast, reduced evaporation rates (cooler temperature) will cause lake levels to rise *with no change in average precipitation.* Predictably, cool intervals are often accompanied by increased precipitation. Millennial scale and century scale climate variations will unquestionably be accompanied by lake level fluctuations.

This is well-illustrated in the attached map of Lake Bonneville and the Great Salt Lake (Curry et al., 1984; attached). There have been enormous decade to century scale changes in the surface area of the Great Salt Lake as lake levels have varied by about 25 feet since 1700 A.D. and 19 feet since 1847. Climatically-driven Lake Bonneville elevations varied by 490 feet between 14,500 and 10,000 years ago.

The Board need not merely rely our word. The USGS (1990a) recognized that Lake Bonneville was likely to return: "*Recurrence of climates that existed in the Pleistocene potentially would refill Lake Bonneville to the level of the Provo shoreline...*" The US Geological Survey recognized the issue of climate change in the analysis of the suitability of the western US for high-level radioactive waste disposal, including the Bonneville basin (USGS, 1989; USGS, 1990a,b). USGS (1989) acknowledges that: "*The longer lived...isotopes, such as uranium-238...and their daughters in the decay chain, such as radium-226, and long-lived isotopes such as technetium-99...persist for millions of years....*"

Twenty years ago, the USGS (1989) understood the implications of climate change on waste disposal. Great strides in climate science have been made since then, but the main point—that climate change will continue to occur on relevant time scales--remains valid:

"*Biological processes and surface- and ground-water systems are greatly affected by climatic change accompanying the expansion and recession of ice sheets. Geomorphic and hydrologic processes that are affected include runoff, erosion, aggradation, and ground-water recharge. Variations of climate during the late Pleistocene Epoch indicate that a significant change in climate may occur within the next 10,000-20,000 yr. Such time spans are well within the period of concern in the evaluation of waste-isolation environments. In this section, the information on the magnitude of climatic change is reviewed and consideration is given to the effect of climatic changes on geomorphic and hydrologic processes.*

Knowledge of climates during the past 2 m.y., the Quaternary Period, comes from a combination of historical, archaeological, geological, and biological records. A broad overview of the roles and methods of Earth science in climate research during the Quaternary Period and longer is given in Smith (1976). Substantial changes in climate have occurred in the past 1,000 yr. Within the past 15,000 yr, the transition from the last major continental glaciation into the current postglacial condition has occurred. The past 150,000 yr includes the last glacial stage and the preceding interglacial stage. Multiple advances and retreats of continental sheet margins occurred during this period. Repeated glacial and interglacial cycles occurred during the past 1 m.y. The astronomical theory of the glacial-interglacial climate procession holds that variations in eccentricity, precession, and obliquity of the Earth's orbital geometry affect climate by changing seasonal and latitudinal distribution of incoming solar radiation. Because these changes can be calculated with great precision for the past several million years, it is possible, in principle, to test the theory by comparing the record of Pleistocene climate with a predicted pattern of climate changes. Imbrie and Imbrie (1980) have prepared a model driven by the Earth's orbital variations that compares favorably with the record of Quaternary northern-latitude, continental glacial record from deep sea cores. The model has been used to predict the climate for the next 100,000 yr in the absence of anthropogenic or other sources of variation (Imbrie and Imbrie, 1980). The model was designed to achieve the closest correspondence with the expansion and contraction of glacial ice using the enrichment of oxygen-18 in deep-sea cores as an index of the volume of continental ice. The model predicts that a long-term cooling trend which began about 6,000 yr ago will continue for the next 23,000 yr."

USGS (1989) notes: "*Because a repository site in the unsaturated zone is designed for effective operation in that zone only, the site* ***<u>must remain above the water table</u>*** *for the effective duration of the repository.*" (emphasis added). Plate 2 in USGS (1990a) is attached. It outlines areas considered potentially suitable for disposal due to thick unsaturated zone. Clive is clearly outside of this area. Does the Board think it proper to allow EnergySolutions to attempt to engineer around a bad site?

Despite DRC staff statements, the site will flood in the future and the consequences cannot be ignored or subjected to "qualitative" analysis. The rule clearly calls for the consideration of natural processes in system performance, including ground and surface water effects on erosion and compaction of the piles. The rule, as previously written, was probably sufficient for short-lived conventional waste streams, but given the quantity of material and long-lived nature of DU, the revised rule is inadequate in terms of reasonable assurance of environmental protection.

Contention 2: The consequences of flooding are unacceptable

Erosion: We are aware from the audio of the Dec. 3, 2009 Board Meeting that EnergySolutions intends to include flooding of the site in its performance evaluation. We do not contend that they will do so, but isn't the very notion of a submerged landfill, or a landfill at the shoreline of a large lake absurd at face value? Isn't the mere fact that this has to be accounted for in their evaluation an implicit admission that this is the wrong place for DU? As noted above: "*the site **must remain above the water table** for the effective duration of the repository (USGS, 1989).*"

That said, we recognize that at least three factors related to flooding that must be accounted for. First, is enhanced seepage and complete saturation of the landfill interior. Second, the lake has the potential to reach the elevation of the Provo shoreline (4740 feet), where it will spill into the Snake River drainage. Thus, the performance evaluation must also consider compaction, and compaction-induced failure of the liner and cap systems due to ~460 feet of overlying water.

The most serious issue is erosion of the piles. We consider their breach very likely. A lake at the elevation of Clive will have a large fetch (i.e., stretch of open water for waves to accumulate by blowing winds). For example, from the northwest there would be on the order of 50 miles of open water.

The past history of the lake provides compelling evidence of the potential erosive power of the lake. Schofield et al. (2004) report that the wave-cut shoreline of the Bonneville level at the base of the mountain between Little Cottonwood and Corner Canyons in the Salt Lake Valley is about 160 feet. The wave-cut platform of the Bonneville level on the north side of Traverse Mountain is well in excess of 1000 feet wide in many places. In fact, this platform is sufficiently wide to permit housing development on it.

Figure 3 shows a south-facing bedrock headland west of West Wendover, Nevada. This platform, as indicated, is 350 feet wide. Note that Nelson et al. (2009; attached) contains model outputs of bedrock erosion by waves where 15-foot wide platforms can be eroded in bedrock in 100 years. These piles are currently covered by loose rock debris, not bedrock. The implication is obvious: The lake will have enormous erosive potential, which causes us to wonder what engineering steps will have to be taken to preserve the piles. Can the output of any computer model that shows the piles surviving flooding be taken seriously?