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ACNWC-0026

Lynn Deering
ACNW Staff Scientist
US Nuclear Regulatory Commission
Advisory Committee on Nuclear Waste
Washington, D.C. 20555

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Dear Ms. Deering,

This letter is in response to the questions faxed to me on December 7, 1994 with regard to the use of isotopic methods of estimating ground-water travel time (GWTT). Below you will find short and concise answers to the questions posed by Dr. Hinze. For more detail on these issues I refer you to my letter report on the October 21, 1994 working group meeting and my trip report on the DOE/NRC technical exchange on GWTT. In addition the following discussion must make an assumption regarding the NRC GWTT rule, its interpretation and application of a multiple barrier concept in general. That assumption is that the NRC will regulate on the fastest path of likely ground-water travel regardless of the significance of that path in terms of total system performance. This assumption is consistent with the views expressed by the NRC at the DOE/NRC technical exchange, with previous written correspondence from the NRC to DOE, and consistent with my understanding of the intent of this part of the multiple barriers concept.

Question 1. Is it likely that isotopic methods of dating ground water will be sufficiently credible that they will provide believable information on GWTT at Yucca Mountain by 1995, 1996, and 1997?
Answer: Isotopic methods of dating ground water have already provided the most valuable information gathered to date with respect to the fastest path of likely ground-water travel (i.e., the GWTT issue) in terms of: 1) demonstrating that rapid paths are not only "likely" but do exist at Yucca Mountain; 2) refuting previous DOE conceptual models of matrix only or composite porosity; 3) finally getting DOE to seriously look at the potential for fracture flow and; 4) beginning to put actual values to what the travel time of ground water could be.

Question 2. If isotopic methods are not going to be available are there alternative credible methods for ascertaining GWTT, and if so, what data are required?
Answer: As I stated above, I believe isotopic methods are currently available that provide credible information of potential GWTTs. However, prior to discussing other potential techniques let me state that the I believe the only possible and the only necessary estimate of GWTT is one that can be used to state that the fastest path of likely ground-water travel is less than or greater than 1,000 years. In other words, I do not believe estimates of the actual GWTT from the edge of the disturbed zone to the accessible environment will ever be available. In lieu of measurements of the true GWTT, isotopic methods provide the most direct and most credible estimates of what the GWTT could be.
I am aware of two general alternative methods of estimating GWTT. These are: 1) estimation of the GWTT from measurements of hydraulic properties and driving forces and; 2) estimation of GWTT in an average sense from calculations of water balance. Estimation of GWTT from the first method requires detailed measurements of hydraulic conductivities and effective porosities at various conditions of saturation and over a large spatial domain and measurements hydraulic potentials over large spatial domains and unknown temporal (the response time of fluid pressures in fractures is unknown and may be unknowable) domains. Given the non-linearity of unsaturated flow and the large degree of heterogeneity at the site, this approach requires extensive data that, in

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my opinion) can not be collected in the next several years. In addition, this approach has a much more serious problem. That is, this approach is only as good at the conceptual models upon which the data are collected and analyze. One only need to note that previous data collection and previous and current modeling efforts are based on conceptual models that have been invalidated by the isotopic measurements. Or another way to look at: if the isotopic measurements were never made, the project could have gone to licensing with estimates of GWTT that significantly overestimate the potential GWTT. The second alternative method of estimating GWTT is to calculate a net water balance for the mountain and equate the average net infiltration with the a ground-water flux rate which in turn is used to calculate a GWTT. This method requires measurements of fluxes at the earth surface including precipitation, evapotranspiration, and runoff as a function of space and time. Besides the very difficult problems of measuring the vertical flux of water upward from the land surface (included in the evapotranspiration), the heterogeneities below the land surface may control the local fluxes in such a way as to make this average estimate meaningless.
Note that ground-water flow models attempt to use information from both methods to estimate GWTT and in that sense benefit from the measurement made for each. However, ground-water flow models also share the problems of both methods and are totally dependent on the adequacy of the conceptual model they are based on.

In summary, I believe the isotopic methods provide the only direct evidence and the most reliable estimates of GWTT. Given the results of isotopic measurements to date, I believe the DOE needs to demonstrate that the horizons below the repository are significantly different from those between the land surface and the points of isotopic measurements because those measurements indicate that the site would violate the GWTT rule. If you have any further questions or would like me to clarify any of the points made herein please call at 505-848-0754.

Sincerely,

Paul A. Davis

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NRC ACNW MEETING
October 18, 1994

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Joe Dalugosz - Accelerated Saturated and Unsaturated Hydrology Program

1)ACCELERATED PROGRAM ISSUES

- The USGS says they will have incomplete knowledge at the time a decision on site suitability will be made but they believe that more knowledge is required and are planning to collect it. On the other hand, they say that they will have enough knowledge that they wouldn't change their mind on site safety with increased studies. The obvious question is then why take more data after the site suitability decision?

- TSPA model is driving force - not site safety or compliance.

- Accelerated schedule was based on an unknown combination of scope changes, resource increases, and increased efficiency. The statement was then made that "Increased risk is the cost of acceleration" – what does this mean and how is it quantified? Given that compliance is based on a probabilistic risk assessment this increased risk should be (and is) quantifiable.

- Ghost Dance Fault will not be characterized before site suitability decision must be made. This appears on the surface to be a fatal flaw.

- There is still no definition of "necessary" data. Is it necessary for compliance, for scientific understanding, or for some other purpose?

- The statement was made that the problem will be "bounded" at the time of the decision. However, 1) one must have knowledge of reality to bound the problem(therefore you must have sufficient characterization accomplished); 2) bounding total releases for a non-linear problem is difficult if not impossible and; 3) if they successfully bound the problem and the results show compliance with the regulations then why continue site characterization beyond that time?

- Statements of what they can and can not take to TSS are ill- defined, non-quantitative and therefore of little value (for example: " good understanding", "knowledge of framework", "probabilistic understanding").

2) APPROACH TO ACHIEVING REASONABLE ASSURANCE (this should also be equivalent to defining when site characterization is complete)

- The overall approach is based on measuring and predicting REALITY. Statements made along this line include - 'we will be happy when we "predict" stratigraphy "accurately" before we drill'. - 'I will have a warm feeling when we "predict" the hydrologic parameters at each grid block before we measure them'. In fact what is being proposed is that reasonable assurance will be had when the project feels that they can reasonable "predict" a few independent model parameters and even fewer dependent parameters --- where all of the dependent parameters are very indirectly related to regulatory quantities of interest (pressures in the unsaturated zone for example).

- There are two fundamental problems with this approach one having to do with relation between this approach and regulatory compliance and the other related to the technical and programmatic aspects of the implementation of the approach.

  - The first problem is that there is no direct (or it appears indirect) connection between the level of uncertainty that is acceptable for "predicting" measured values and regulatory compliance. The regulations that guide this work are probabilistic in nature and do not assume any unacceptable levels of uncertainty. In fact little knowledge may be required for unimportant parameters whereas less uncertainty may be acceptable for important parameters. Furthermore, the only context to determine importance is through assessments of compliance (PA) - not by comparisons of predictions of independent variable.

  - As I understand it, the approach is based on estimating the value of a parameter and the variance of that value at a location proposed for future measurement and then measuring the value at that location and evaluating whether or not the measured value falls within the range predicted. There are numerous technical problems with this approach. These include:

    - how do you determine what level of "accuracy" is acceptable and whom judges adequacy?
    - the method of quantifying the uncertainty is not independent of the data, therefore,
      - if the data are incomplete with respect to being able to reliably quantify uncertainty, then the estimate of uncertainty is wrong
      - if the data are complete with regard to estimating uncertainty, then you may be done depending on the results of compliance assessment and this approach would not be able to provide you that information
      - given that the reliability of the uncertainty estimates will be unknown then the following problems arise:
        - if the method overestimates uncertainty, then the analysts will be overconfident
        - if the method underestimates uncertainty, then the analysts may never be confident and should have been.
      - -ALSO -- the estimates of uncertainty should be continually decreasing and therefore may be impossible to meet by definition

3) APPARENT DRIVE TOWARD A DETERMINISTIC UNDERSTANDING OF YUCCA MOUNTAIN

The following statements were made that, along with the approach to reasonable assurance outlined above, indicate that the USGS is striving for a "deterministic" understanding of the Yucca Mountain hydrology:

- 'won't have detailed "deterministic" knowledge of infiltration under FUTURE climatic conditions'. (no one will ever have a deterministic knowledge of the future)
- 'we'll have to rely on a probabilistic understanding for site suitability'
- -'always will have discomfort with the amount of data because of the scientist in me' (does this indicate that reasonable assurance is impossible?)
- 'there is a probability of 1 that a fast pathway exists or will exist with change in climate' (this infers total knowledge of the site with no uncertainty)

The problem with this approach is that a "deterministic" understanding is neither possible or necessary for compliance with a probabilistic standard that contains a provision for 'reasonable assurance'.

COMMENTS BY THE STATE AND PUBLIC

(my comments about these statements are in italics)

Comments on the Proposed Program Approach-State of Nevada

1. long-term performance will be based on inadequate data
2. performance confirmation is not met to be an extended site characterization - *(I agree with this point)*
3. NAS review process is not an adequate for making the site suitability decision because the process is closed to the public, in fact DOE (Hazel Oleary) has proposed guidelines that the NAS couldn't meet for public involvement

Affected Units of Local Government

- Stan Simms -- Geotechnical Concerns

- *the stated goal of this group is to protect human health and the environment. However, in their eyes this does not appear to be equivalent to achieving regulatory compliance. The problem then become what is a sufficient demonstration of safety and who decides.*
- *they appear to be doing some data collection away from the site in the saturated zone - Is the QA up to YMP standards? They are working with DOE to develop consistent procedures but what about records/training etc.? In the end, can DOE and NRC use the data?*
- "TRW jobs should be here" not Virginia
- site suitability is not licensibility

Geotechnical Issues Include: Future Climate, erosion, seismic hazards, pneumatic pathways, and volcanism, *however the speaker never stated his concerns. Namely, is he concerned with these as technical issues (if so, we all are -- so what?) or is he concerned that the DOE is not adequately addressing these concerns (if so then he should be specific - data collection Vs performance assessment for example) or is he concerned that the NRC is not paying enough attention to these issues (if so he should specify what he wishes NRC to do)*

Socioeconomic Impacts

- *only looking at the negative impacts which seems a little disingenuous given that has legalized gambling and prostitution along with having above and underground nuclear explosions in the past (while the tourist economy grew!)*
- *what's the point of this talk? Which of the following inferences could be made?*
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Transportation Activities

- is the infrastructure adequate?
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