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MEMORANDUM FOR: Malcolm R. Knapp, Chief
Geotechnical Branch
Division of Waste Management
Office of Nuclear Material Safety and Safeguards

FROM: Frank A. Costanzi, Chief
Waste Management Branch
Division of Radiation Programs and Earth Sciences
Office of Nuclear Regulatory Research

SUBJECT: RESEARCH STAFF COMMENTS ON PNL'S DRAFT REPORT: "PRELIMINARY
REVIEW AND EVALUATION OF NRC AND DOE GEOHYDROLOGIC FLOW AND
TRANSPORT, AND ENVIRONMENTAL CONSEQUENCE METHODOLOGIES FOR
PERFORMANCE ASSESSMENT OF GEOLOGIC DISPOSAL SITES FOR
HIGH-LEVEL NUCLEAR WASTE"

In response to your request on July 11, 1985, we have reviewed the
subject report and our comments are attached. We are also aware that Sandia
is reviewing the report. In some of our comments, we refer the reader to
Sandia's comments for more details. Any questions should be directed to John
Randall at x74633.

Frank A. Costanzi, Chief
Waste Management Branch
Division of Radiation Programs
and Earth Sciences
Office of Nuclear Regulatory Research

Enclosure: As stated.

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Research Staff Comments on the Draft PNL Report
"Preliminary Review and Evaluation of NRC and DOE Geohydrologic
Flow and Transport, and Environmental Consequence Methodologies
for Performance Assessment of Geologic Disposal Sites for
High-Level Nuclear Waste"

General Remarks

This report has a very narrow view of NRC's overall approach to compliance assessment and modeling. The authors imply that NRC will rely entirely on the computational tools prepared for NRC by Sandia to perform modeling exercises which will help NRC assess DOE's demonstrations of compliance with 10 CFR 60. Such is not the case at all. In addition to the work done at Sandia, NRC has an active research program designed to identify and reduce uncertainties in the compliance assessment process. The approach taken by the research program is to improve the understanding of currently poorly understood phenomena which are important to the performance of HLW repositories and to identify data needs for predicting such phenomena. The research program covers the areas of waste package performance; coupled thermal, hydrological, mechanical, and chemical interactions near emplaced HLW; hydrology; and geochemistry. In the past, research on environmental consequence modeling and dose to man calculations has also been done for NRC. The research program and its goals and approach were discussed at the September 1983 BWIP performance assessment workshop which the authors attended and mention several times in the report. However, their reaction to the workshop seems to be focused only on Sandia's computational tools and NRC's interpretation of EPA's proposed HLW radiological standard, 40 CFR 191.

In order for this report to give a truer picture of NRC's performance assessment capabilities, the authors should peruse NRC's Modeling Strategy Document, Licensing Assessment Methodology, and NUREG contractor reports by NRC contractors other than Sandia. The authors can find an introduction to NRC's HLW research program in the paper, "The Perspective of the Waste Management Research Program at NRC on Modeling Phenomena Related to the Disposal of High-Level Radioactive Waste," which is available on pages 397-402 of Volume 1 of the proceedings of the Waste Management 85 conference.

A clear statement of the scope of the report should be made in the Introduction. Specifically, the authors should state that they are not considering waste package performance or coupled thermal, hydrological, mechanical, and chemical interactions near emplaced HLW.

Other than the discussion of the adequacy of the advection-dispersion equation to represent transport of radionuclides, there is no discussion in the report on:

- 1) the importance of understanding adequately the phenomena which the mathematical models implemented by the computer programs discussed represent, or
- 2) the consequences of ignoring important phenomena in the mathematical models implemented by the computer programs.

The authors thus leave out the consideration of two very important sources of uncertainty in their discussions of uncertainty. It is especially surprising that there is no discussion of the current controversies over geochemical modeling.

There are two important ways in which NRC is misrepresented throughout this report:

- 1) NRC is chastised for advocating only "traditional" modeling and data analysis and interpretation techniques for use by DOE. NRC is receptive to new models and new data analysis and interpretation techniques provided that they have been shown to be reliable.
- 2) NRC is portrayed as advocating that DOE perform probabilistic risk analyses for HLW repositories similar to those done for reactors. This policy did not originate with NRC. It is NRC's interpretation of the proposed EPA standard that such an analysis will have to be done to meet EPA's requirements, provided that the final standard resembles the proposed one. In its public comments to EPA on the proposed 40 CFR 191, NRC objected to such a policy.

An additional report that should be discussed in this report is "The State of the Art of Numerical Modeling of Thermohydrologic Flow in Fractured Rock Masses," LBL-10524, prepared for DOE by the Lawrence Berkeley Laboratory. The LBL report discusses some computer programs which are discussed in this report and some which are not. In both cases, the level of detail given in LBL-10524 is greater than in this report.

A large part of this report is devoted to a discussion of environmental consequence modeling. However, the proposed EPA standard is written in such a way that DOE only needs to show that cumulative releases of radionuclides from the geosphere over the 10,000 year period following closure of the repository fall within certain limits in order to demonstrate compliance with the standard. There are no radiological criteria in NRC's multiple barrier requirements in 10 CFR 60. Therefore there is, at present, no regulatory need for NRC or DOE to have a capability to do environmental consequence modeling. For this reason, both DOE's and NRC's recent performance assessment efforts, as far as overall performance considerations are concerned, have concentrated on cumulative releases to the accessible environment. Since it is possible that EPA will include an individual dose requirement in its final standard, some comments are given in the following pages on the report's Chapter 3 on environmental consequence modeling. More detailed comments will be provided by Sandia.

Comments on specific items in the report are given on the following pages.

Specific Comments

Page

Comment

- 5 Line 5: Does "rock mechanisms" mean "rock mechanics"?
- 7 Paragraph 1 of Section 2.1.2, second bullet: NRC's analysis (NUREG-0960) of BWIP's Site Characterization Report had a very strong emphasis on the quality of the conceptual models of a site and the importance of considering alternative conceptual models. The issues raised in the first, third, and fourth bullets are receiving extensive examination in NRC's research and technical assistance programs.
- 8 Table 1: Is SWENT a derivative of SWIFT or a precursor to SWIFT? It can not be both. How closely do the two programs resemble each other?
- 9 Table 1: DNET is not a transient version of NWFT. The two programs have very little in common with each other. See Sandia's comments on this item.
- 10 Table 1: NRC does not have and does not know about a computer program called KONBRED.
- 12 Paragraph 3: NRC's position that data be evaluated in light of accepted physical concepts is just a demand for good scientific practice. On the whole, this paragraph is very confusing. The discussion of hydrogeologic testing at BWIP confuses analysis of test data with mathematical modeling of the site.
- 13 Paragraph 2: Some comments should be added to this paragraph on what the Performance Assessment National Review Group (PANRG) has accomplished in peer review of DOE's performance assessment efforts.
- 17 First bullet: In their presentations to the PANRG, NNWSI personnel indicated that they had not selected any sensitivity analysis techniques and would delay doing so until they had a better understanding of the Yucca Mountain site.
- 17 Last bullet: Under contract to NRC, Sandia is reviewing sensitivity and uncertainty analysis methods. Sandia has modified its Latin Hypercube Sampling procedures to account for correlated variables. Sandia is reviewing and evaluating other methods such as the adjoint method. Sandia is also examining how various geostatistical data analysis methods can be factored into sensitivity and uncertainty analyses. See also Sandia's responses to this report's comments on sensitivity and uncertainty analysis methods.
- 17 Paragraph 1 of Section 2.3.1: This paragraph should also mention uncertainties associated with a lack of understanding of the phenomena that can affect HLW repository performance. Some detailed discussion of such uncertainty should be included in Section 2.3.1. The report should point out that sensitivity and uncertainty analyses are only as good as the models used in performing the analyses.

Page

Comment

- 24 Equation (2.7) is described as providing first-order and second-order estimates of variance. Should there be two equations here?
- 25 First mathematical expression: The second "-" should be "+".
- 31 The discussion of kriging should be expanded to a level of detail comparable to that in the discussion of the adjoint method.
- 33 Last sentence: What does this sentence mean? NRC does not have unlimited resources for making licensing decisions about HLW disposal.
- 35 Paragraph 3, on the shortcomings of applying extensive probabilistic risk analysis to HLW repository performance, has some very important points which should be addressed directly to EPA.
- 36 Paragraph 3 of Section 2.4.2 implies that field testing has no impact on modeling or deciding what mathematical models are appropriate for a particular field situation. In fact, modeling and field testing should be coordinated in an interactive process to understand site characteristics so that some confidence can be developed in long-term performance predictions.
- 37 Paragraph 2, last sentence on spatial correlation: The meaning of this sentence is not clear at all.
- 38 Paragraph 2: If DOE and NRC cooperate to develop a common approach to quantifying uncertainties in groundwater systems, NRC may lose credibility as the licensor of HLW disposal.
- 39 Paragraph 1, lines 13 and 14: In HLW applications, what environmental consequence models would not require data on releases of radionuclides from the geosphere?
- 39 Section 3.1 is poorly written. One is left with the impression that the authors believe that environmental consequence models, by themselves, can be applied to all aspects of repository performance assessments.
- 41 Line 6: There is no way that PABLM could be used to assess the tuff geology at NTS or anywhere else because PABLM, a computer program used in environmental consequence modeling, has no geological aspect.
- 42 Line 10: Here and elsewhere there is a confusion of mathematical models with the computer programs that implement them.
- 43 Last 2 lines and first 3 lines on page 44: If two parameters are as important as any other parameter, then all of the parameters may be equally important. Is that the conclusion of this sensitivity analysis?
- 51 Sandia has performed and documented sensitivity analyses for PATH1. See Sandia's comments for additional details.

Page

Comment

- 55 Line 2: Change $f\{t\}$ to $f_i(t)$.
- 57 Lines 7-9: NRC disagrees with the idea that the validity of a computer program can depend more on the accuracy of input data than on the formulations used in the program. If the mathematical model implemented by a computer program is incorrect, there is no reason to have any confidence in the results obtained from the program.
- 57 Line 13: Sandia has performed and documented sensitivity analyses for DOSHEM. See Sandia's comments for additional details.
- 62 Line 6: There is no prior description of what the "zone" mentioned in this line is.
- 63 Third and second lines from the bottom: What is meant by solving dissolved and particulate forms of a radionuclide? Do you mean solving the transport equations associated with the dissolved and particulate forms of a radionuclide?
- 69 Paragraph 3, lines 5-8: If the phenomena which affect HLW repository performance are not adequately understood, no amount of sensitivity and uncertainty analysis and diversity of conceptual models will compensate for the inadequacy of site characterization data.
- 71 The statement,
- Uncertainty in boundary conditions, recharge, conceptual models, and stratigraphy are (sic) not being addressed in any way by either NRC or DOE.

certainly does not apply to NRC. See NUREG-0960.