

## Memo

To: Leon Reiter, Staff, Nuclear Waste Technical Review Board

Subject: Report on Meeting of the Volcanic Consequences Peer Review: Presentation of Interim Report, September 8, 2002, Las Vegas, NV

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Date: September 23, 2002

### Background

The DOE and the NRC's CNWRA<sup>1</sup> have prepared assessments of the consequences of disruption of the repository by a dike mainly by numerical simulations, little constrained by experimental or observational data. Although the estimated probability of intersection of the repository remains extremely small, the consequences include disruption of waste containing canisters that could result in release of fairly high-levels of radioactive nuclides to the environment accessible to humans (soil, air, groundwater)<sup>2</sup>. The assessments of DOE in various technical reports and the paper by Woods et al. (2002)<sup>3</sup> are the starting points for the Panel's work.

The report<sup>4</sup> and presentations at the meeting gave, as intended by the Panel, the opportunity to (1) see where the review had reached, (2) where it was headed, and (3) to invite input into the process of assessing the consequences of intersection before completion of their report. Their final report, targeted for early next year, will be important in guiding DOE's future work on the complex problems of consequence analysis. The valuable work of the Panel includes original analyses and recommendations of additional critical issues that DOE ought to investigate.

The work done and underway is limited by lack of suitable analogs in the geologic record (not one but many) and suitable experimental data to test most of the numerical models. The models dealing with the distribution and thickness of air-fall ash, are, however, constrained by numerous field studies.

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<sup>1</sup> The Nuclear Regulatory Commission's Center for Nuclear Waste Regulatory Analysis

<sup>2</sup> Civilian Radioactive Waste Management System, Management and Operating Contractor, *Total System Performance Assessment for the site recommendation*, TDR-WIS-PA-000001, Revision 00 1CN01, North Las Vegas, Nevada: DOE Site Characterization Office, 2000 (normally referred to as TSPA)

<sup>3</sup> Woods, .W., Sparks, S., Bokhove, O., LeJeune, A., Conner, C.B., and Hill, B.E., 2002. Modeling magma drift interaction at the proposed high-level radioactive waste repository at Yucca Mountain, Nevada, USA. *Geophysical Research Letters* 29 (13), 19-1 - 19-4 (PDF version)

<sup>4</sup> Yucca Mountain Igneous Consequences Peer Review Panel, Interim Report, 23 August 2002, 76 pages plus three appendices.

## Discussion

Robert Budnitz, Chair, emphasized that the report is a work in progress. And, indeed, much progress has been made. Looking to the future though a number of important issues remain. The Panel is aware of some of these and they are touched upon in their report,

(1) The work on rheology and volatile contents of the likely intrusive magma built upon and extended the DOE's work. The DYMB (Disruptive Yucca Mountain Basalt) was defined and characterized by the Panel and builds upon the work in the TSPA<sup>2</sup>. Especially critical is a full treatment of the dynamics of what will happen when such a magma inners a drift, including an evaluation of the Woods et al.<sup>3</sup> model. The Panel notes this critical need<sup>5</sup>.

Views differ as to the energetics of the transition of magma to a pyroclastic event during degassing into the repository. The modeled results range from the generation of an intense shock wave<sup>3</sup> to a very weak one or none at all<sup>6</sup>. One of the major deficiencies is the lack of a written analysis of Edward Gaffney's (LANL) views. The Panel is aware of this short fall, as is DOE. Gaffney's proposed modeling (the CFDLIB numerical simulation package) was discussed by the Panel as a promising approach to assessing dike intersection<sup>7</sup> consequences. I look forward to its application in the final Panel Report or in the work that arises from the reports recommendations.

(2) In this same context, we are still lacking more precise analyses of the consequence of canister-magma interactions. Is it accurate to assume that any canister-pyroclastic "blast"-lava flow interactions must inevitably result in the release of all radionuclides? The Panel begins such an analysis<sup>8</sup> and recommends experiments on the effect of high temperatures (up to ca. 1200°C) and corrosive gases (acidic) on canister welds and casing and to identify conditions that would lead to complete release of all waste. The processes of fragmentation of the canisters and waste are outside the expertise of the Panel and they note the need for other specialists. These are critical missing analyses.

(3) Magma moving down one or more drifts and then upward to the surface (the "Dog-leg" model of Woods et al.<sup>3</sup>) is the worst case (most conservative) scenario for release of radioactive waste. The Panel discusses the importance of this scenario and the complexity of numerical simulations<sup>9</sup> of the process. Still, the relative probabilities of the Woods et al. scenario and other scenarios (such a direct rise of dike to surface without significant passage down drifts, along with a range of dike-property models, such as flow rate, and so on) need to be developed. Questions will remain, though, given the complexity of the processes.

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<sup>5</sup> Peer Review Report, p. 48.

<sup>6</sup> Meeting comments by physicist Edward Gaffney of the Los Alamos National Laboratory

<sup>7</sup> Peer Review Report, p. 52

<sup>8</sup> Peer Review Report, pp. 65-67.

<sup>9</sup> Peer Review Report, p. 74.

(4) The Peer Report contains an extensive and impressive review of the mechanics and flow models of dike emplacement, and begins to extend the results to the specific case and complex case at Yucca Mountain. This ongoing focusing of the dike models to the specifics of drifts and the Yucca Mountain stress fields, including the short term expansion of drift wall from heating by the canisters, will be an important part of future consequence analysis, and, I believe, will be done well.

(4) Characterization of ash fall that might result from a worst-case scenario remains an essential component of consequence analysis. The recommendations of the Panel<sup>10</sup> offer reasonable suggestions for moving forward, including a simple experiment to trace ash distributions.

## **Conclusions**

In summary, this meeting and report, I believe, are on track with regard to the major issues of dike intersection and its consequences. I am awed by the ability of the Panel members to deal with the complex issues of consequence analysis. I look forward to a most useful final report.

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<sup>10</sup> Peer Review Report, pp. 67-69.