

May 10, 2001

H. Lawrence McKague
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SUBJECT: REVIEW AND APPROVAL OF IM 20.01402.461.115: MODELING
MAGMA/DRIFT INTERACTION AT THE PROPOSED HIGH-LEVEL
RADIOACTIVE WASTE REPOSITORY AT YUCCA MOUNTAIN, NEVADA, USA

Dear Mr. McKague:

We have reviewed the above referenced document: As you are aware, because of its potential importance, this paper has undergone an extremely rigorous review. The original copy of this paper was transmitted to the U.S. Nuclear Regulatory Commission (NRC) on April 24th, 2001, and on May 1st, 2001 informal comments were transmitted back to the CNWRA (see attachment 1.). On May 10th the CNWRA provided a revision to the paper. In this revision all required modifications were made satisfactorily, and therefore the NRC considers that the paper is both technically and programmatically acceptable and can be submitted for publication.

In addition to the required modification the NRC made several suggestions on other modifications which, while not required, were felt would improve the quality of this paper. We note that no modification to the paper was made based on suggested changes 1, 2, 3, 8, & 11, but may be made at a later time. We continue to offer these as suggestions, we also note that due to an NRC numbering error that no suggestion number 5 exists.

The overall comments of all reviewers has been quite favorable, and we recognize the extreme quick turnaround which has been performed by the CNWRA. This paper provides the necessary background for many of the concerns which will be discussed with the DOE during the Appendix 7 Meeting on Igneous Activity which will be held on the 18th of May, 2001, which necessitated the quick turnaround. We wish to complement all personnel involved, especially Dr. Brittian Hill, for the timely and professional manner in which the comments were handled. If there are any questions, please contact John S. Trapp at 301-415-8063, or by e-mail at jst@nrc.gov.

Sincerely,

/RA/

John S. Trapp
Igneous Activity Program Element Manager
Division of Waste Management
Office of Nuclear Material Safety
and Safeguards

Attachment: as noted

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*See previous concurrence

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ATTACHMENT 1. COMMENTS MADE ON DRAFT OF APRIL 24, 2001.

Required Modifications

1. page 5, Implications: Change the phrase “models are consistent with observations of explosive basaltic eruptions and current knowledge of the underlying physics” to “models are consistent with general observations of explosive basaltic eruptions.” Basis: (a) We have no observations of eruptions into repository drifts; (b) the current calculations assume that the rock can withstand pressures that physics would say the rock should fracture - doesn’t seem to be consistent with physics (i.e.; the paper states the minimum fracture strength of the shallow crust is on the order of 2-3 MPa, however, the pressures in the shallow crust, under Case 3, at the repository level are on the order of 20 MPa or ten times more than the rock might support. This last point (i.e., excessive pressures for Case 3) seems to indicate that Case 3 may be more limited than assumed (i.e., rock will fracture and release magma before) - a thorough explanation of this large difference in pressure needs to be provided at the upcoming meeting with DOE.
2. Page 5, Implications: The text tends to imply that Case 3 is the correct model by stating: “models indicate that much of the repository will be quickly filled by magma.” Reword to something like “models indicate that intersected drifts may be quickly filled by magma.”
3. Page 6, Implications: Remove the phrase “it remains to be determined if these consequences result in unacceptably high risk”. It could be reworded to something like, “the consequences resulting from these models remains to be determined”.
4. Page 4, Steady Flow regime: The paper unnecessarily speculates on what might be done for human intrusion - remove the phrase “which would likely be blocked to prevent human intrusion into the repository,”
5. Abstract and 1st paragraph of Introduction: The term “performance period” should be replaced with proposed compliance period.
6. Introduction, 1st paragraph: In the introduction a reference to the proposed compliance period should be added directly after “period.” The reference should be to proposed rule published at Federal Register, Volume 64, Number 34, pp.8640–8679, Monday February 22, 1999. This change gets around the problem of the “performance period” being defined by reference 2 (Journal of Geophysical Research paper) and the inference that the Issue Resolution Status Report (reference 3) defines whether a probability is sufficient to require (only a rule can require) the potential impact to the repository be evaluated. The last sentence of this paragraph should reference the proposed rule and not the Issue Resolution Status Report.
7. Introduction, 2nd paragraph: A better characterization of repository design needs to be included to better frame the discussion. In particular the authors need to acknowledge that “The current design has an “exhaust main that will be excavated about 10 m below the emplacement drifts using a 7.62 m (25 ft) diameter tunnel boring machine”. [Viability Assessment, Volume 2, pg 4-44, see your reference 8 for complete citation]. In addition to the three assumptions stated, interactions with these other engineered features has been neglected in the calculations. Would suggest something like “(d) interactions with other engineered components has been neglected.” The authors don’t need to use those exact words but they should clearly indicate that the three scenarios neglect any interaction of the dike with excavations, such as the exhaust main, below the emplacement drifts.

Suggested modifications. These changes are not required for acceptance.

1. It is difficult to interpret Figure 5a. We think the problem is that the boundary condition at the surface is "choked flow", which is not a common phenomenon in ordinary hydraulics. It would be worthwhile to explain this better; e.g., flow is limited by the speed of sound because of the rapid expansion of the gas in the magma. Increased pressure cannot drive flow out the vent faster than the speed of sound.
2. In figure 5a. We didn't understand at first why the pressure in the magma could be below lithostatic. We think the reason is that the ductwork in the drifts is supported by the strength of the rock, rather than the hydraulic pressure in the liquid magma, which would be the case in the ascending magma column below the repository. This should be clarified with a line or two.
3. Under "Model Calculations", the authors state that "...then the pressure will build up to this level along the whole drift within about 10s[13]." We presume the antecedent is 10-20 MPa level of the shock pressure. However, If the drifts remain closed, and no new fissures develop along the drifts to divert magma from the main dike, then the pressures would have to fall back to the same level as the dike in Model 1, which would be approximately 5 MPa at steady state, according to figure 5a. This should be clarified.
4. Abstract; 5th line: change "ascending magma will be diverted" to "ascending magma can be diverted"
6. Page 5, Implications; 6th line: Change "with disruption of the contents" to "with potential disruption of the contents."
7. Page 4; last paragraph

In describing figure 4a-c, the text clearly identifies the area for Case 2 while the area for Case 1 is not provided and a second sentence apparently provides the area for Case 3. It would help to clarify the areas used and if the assumed area has a significant impact on the pressures observed in the calculations it may require a sentence or two to explain. This is something that would most likely come up in future discussions with DOE.
8. Figure 3a-: This figure is confusing. It would be very helpful to somewhere state where the X distance is measured for the dike and for the drift. In addition, different styles of lines for i-v should be used so that the cases can be followed in both the left and right portions of the figures.
9. Page 4; 3rd paragraph: change "In additional to" to "In addition to"
10. Reference 14: The year of publication for Stasiuk, Jaupart and Sparks reference is missing.
11. Figure 3: As reading left to right in the figure the dike (left) comes before the drift (right), the caption should read "position along the dike and drift" not "position along the drift and dike"
12. Page 4, second paragraph, first sentence: Change the order to dike-drift from drift-dike system to be consistent with suggestion 11.

13. Reference 8: Suggest that the following be added at the end of the citation. "In addition, a drift used for ventilation purposes would be beneath all emplacement drift and would be connected to each emplacement drift." This would be consistent with programmatic change 7, above. (See also Yucca Mountain Science and Engineering Report DOE/RW-0539 page 2-105 for a diagram of ventilation system, online at www.ymp.gov)