

June 1, 1995

MEMORANDUM TO: Joseph H. Holonich, Chief
HLUR/DWM/NMSS
FROM: Michael J. Bell, Chief
ENGB/DWM/NMSS
SUBJECT: REVIEW OF DOE SITE CHARACTERIZATION PROGRESS REPORT
NUMBER 11

As requested by Mark Delligatti's note of April 13, 1995, attached are the results of ENGB's review of the subject Progress Report. Our review was conducted consistent with the steps laid out in Section 3.3 of the "Review Plan for NRC Staff Review of DOE Site Characterization Plan Progress Reports." DOE did not identify any open items to be closed based on information presented in the Progress Report.

ENGB's review has resulted in the identification of three comments and five questions (see Attachment A). For our continuing review of DOE's site characterization activities, we are requesting a number of references (see Attachment B). Several of the documents are published, but not readily available. We request that these references be transmitted to the staff as soon as possible. Other references have not yet been published, therefore, we are asking that the latter documents be provided to the staff upon publication.

We do have a general concern regarding the content of the Progress Report. For the most part, technical information provided in report sections/subsections is insufficient to conduct a detailed review of DOE site characterization activities performed during the reported period. Although there are many instances where it is stated that studies have been conducted, the technical information is not contained within the report. We suggest that DOE provide more technical information within the progress report.

This review was performed by Kien Chang and Tae Ahn of the Engineering and Material Section, and by Banad Jagannath and Steve McDuffie of the Geosciences/Geotechnical Engineering Section. If you have any questions, staff can be reached at the following numbers: K. Chang (415-6612), T. Ahn (415-5812), B. Jagannath (415-6653) and S. McDuffie (415-6684). Harold Lefevre may be contacted at 415-6678.

Attachments: As stated

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Attachment A

**ENGB CONCERNS
SITE CHARACTERIZATION PROGRESS REPORT NUMBER 11**

Section 3.13.1 Potential for Ash Fall at the Site

COMMENT 1

The Perry and Crowe (1987) document which reportedly contains analyses sufficient to address this topic is found by the NRC staff to be inadequate. Although the staff agrees with some of the conclusions for the ash fall potential at the site during preclosure, in its present form the report is not suitable as the sole input to design of repository surface facilities. Furthermore, the additional discussion of this topic supposedly included in the Los Alamos Volcanism Status Report is not apparent to the staff.

BASIS

- The Perry and Crowe (1987) report states that it is concerned with possible interference to preclosure repository operations from volcanic ash fall. However, the report does not address the manner in which ash could affect the repository and surface facility, such as HEPA filters.
- Perry and Crowe (1987) estimate 2-3 cm of ash fall during preclosure as a worst-case scenario, although the volcanic hazards map of Mullineaux (1975) shows the repository location subject to approximately 5 cm of ash from a large or very large eruption.
- A supposedly conservative assumption is made in Perry and Crowe (1987) that a scoria deposit of 1 meter thickness from a basaltic eruption would have unacceptable effects on the operation of surface facilities, but it would not cause structural damage. Although a 1 meter accumulation is highly unlikely during preclosure, no justification is presented that this mass will not cause structural damage to surface facilities. Furthermore, there is no description of what would be the unacceptable effects from 1 meter of scoria.
- The Perry and Crowe (1987) document was completed prior to the Site Characterization Plan (SCP) in 1988. As the SCP calls for further study on the potential for ash fall at the site, apparently Perry and Crowe (1987) was not considered sufficient by DOE in 1988 to resolve this issue. The 1987 document is considered sufficient in 1995, but with no explanation.

RECOMMENDATIONS

Characterize the potential hazards to the repository and surface facilities from ash fall during the preclosure period (i.e., effects on HEPA filters, radiation safety structures, systems and components).

Specify the exact page or section in the Volcanism Status Report where additional information on preclosure ash fall may be found.

Address and resolve discrepancies between ash fall estimates in Perry and Crowe (1987) and Mullineaux (1975), or a more recent volcanic hazards map if one exists.

Justify the assumption that a 1 meter scoria accumulation will not cause structural damage to surface facilities, and specify how such a deposit is assumed to cause unacceptable effects.

Explain why the study which was inadequate in 1988 is considered sufficient for design inputs in 1995.

REFERENCES

DOE (U.S. Department of Energy), 1988. Site Characterization Plan: Yucca Mountain Site, Nevada Research and Development Area, Nevada, DOE/RW-0199, Office of Civilian Radioactive Waste Management, Washington, DC.

Mullineaux, D.R., 1975. Preliminary Overview Map of Volcanic Hazards in the 48 Conterminous United States, USGS Miscellaneous Field Studies Map MF-786.

Perry, F.V., and B.M. Crowe, 1987. Preclosure Volcanic Effects: Evaluations for a Potential Repository Site at Yucca Mountain, Nevada, TWS-INC7-2/87-01, Los Alamos National Laboratory, Los Alamos, New Mexico.

COMMENT 2

DOE considerations on long-term subsidence are insufficient, which may actually overlook the potential long-term deformation.

BASIS

- This section states: ..."ground surface subsidence is usually caused by collapse or failure of the pillar and the collapse or failure of the drift roof." However, these are not the only sources of long-term deformation. All types of underground rock excavations disturb the in situ state of stress in rock masses. As a result, deformation and, in some cases, fracturing occur around any underground opening. Therefore, it is the process of stress adjustment around the openings that causes ground movement, including the long-term ground movement. In most cases, gradual ground movement often occurs without obvious failure or collapse of pillars or drift roofs, as long as the process of stress adjustment around the opening continues. Although this process is more significant in soft rocks, it should not be neglected in hard rocks, such as tuff. Theoretically speaking, any rock can creep under stress over a sufficiently long period of time.
- The progress report also states: "Current repository layouts are based on a conservative excavation extraction ratio of 30 percent within the waste emplacement areas. This value corresponds to a drift spacing such that parallel drifts are barely subjected to the stress effects of adjacent drifts, which limits the stress in the pillars. The proposed extraction ratios of 30 percent may be considered overly conservative for conventional mining, but they may not necessarily be conservative in evaluating the stability of the emplacement drift area when long-term deformation and deterioration effects are to be considered. This concern is particularly true when backfill is not used in the openings.
- Although the extraction ratio may result in "relatively low pillar stress," thermal loading may significantly change this "low stress" profile in the pillars.

RECOMMENDATION

Systematic monitoring of ground movement, including closure measurement, should be conducted during construction and operation of the repository. Also, numerical modeling should be conducted to study long-term ground behavior around the openings, taking into account both the openings and major geological structural profiles.

DOE should address these concerns on long-term deformation around the openings in subsequent progress reports.

Section 4.5 Seal Characteristics

COMMENT 3

The staff has the following concerns on DOE's sealing strategy based on the details provided in the Sandia report by Fernandez, et al. referenced in Sections 4.5.3 and 4.5.4 (1994):

- Lack of a field testing plan aimed at assessing long-term seal performance.
- Lack of consideration of previous NRC guidance and NRC-sponsored research relevant to sealing.
- Lack of integration of analyses supporting the development of borehole seal strategy and other relevant aspects of the DOE HLW Program, such as Total-System Performance Assessment and Site Characterization Activities.
- Lack of justification for selection of specific seal performance measures/goals for restricting vertical flow through boreholes.
- Superficial treatment of potentially important issues in the development of the seal strategy.

BASIS

- Some of the DOE laboratory and *in situ* tests to evaluate the performance of candidate sealing materials (DOE Study 1.12.2.3), as well as the development of a sealing and backfilling strategy for the Exploratory Studies Facility/Repository openings (DOE Design Activity 1.12.4.1.), appear to rely on recommendations provided by Fernandez, et al. (1994). The justification for selection of seal performance measures/goals, as well as the important issues addressed in the development of the sealing strategy, have direct relevance to these two DOE activities specifically with regard to overall performance of the sealing system for exploratory boreholes.

RECOMMENDATION

In the next progress report, DOE should provide an integrated sealing strategy which provides details of long-term testing and justification for performance goals/measures.

Section 3.11.3

Study 8.3.1.15.1.3 – Laboratory Determination of Mechanical Properties of Intact Rock

QUESTION 1

Since the creep testing program is still ongoing the conclusive statement by DOE on the creep behavior of tuff seems premature. Is there a report that presents the details of tests presented here?

BASIS

- DOE states in this section on the creep behavior of tuff that "...very little primary or secondary creep is exhibited by these welded tuffs under these repository-type conditions." Some of the important test conditions, such as the actual test duration and strain rates, are neither provided nor referenced. Insufficient technical information is provided in the SCPR to support the DOE conclusion on the creep behavior of tuff.

RECOMMENDATION

DOE should provide more supporting information in a future progress report or refer to a published report.

Section 6.4 Accidental Radiological Release

QUESTION 2

DOE has conducted a preliminary probabilistic risk assessment study for accidental radionuclide releases initiated by either a rock fall or waste transporter accident. However, no details are provided related to this study. Was this study conducted on the Multi Purpose Canister (MPC)?

BASIS

- Waste packages design is changing, and even the latest proposal includes a different number of assemblies in each MPC.

RECOMMENDATION

To better evaluate the DOE study, more detailed information about the probabilistic risk assessment study to predict performance of the waste containers under different conditions should be provided.

QUESTION 3

This section states that 2-m drop of a "canister" has been adopted to simulate handling accidents. The simulation will evaluate the effects of the 2-m drops and will focus on end drops, corner drops, and slap down drops onto an essentially unyielding surface. The 2-m drop tests are different from current Waste Acceptance Preliminary Specifications in which 7-m drop of a HLW "glass canister" is adopted to simulate handling accidents [Plodinec and Marra, 1991]. Does the 2-m drop "canister" refer to a 2-m drop of multi-purpose canister (MPC)? What is the basis of the 2-m drop test and the relation to the 7-m drop test?

BASIS

- DOE has developed Waste Acceptance Preliminary Specifications to manufacture HLW glass monoliths. One of the Specifications for canisters is 7-m drop test of glass monoliths (in a poured canister). The drop height of 7 m is based on design height during repository operation. The 2-m drop test is less severe than the 7-m drop test.

RECOMMENDATION

In future PR studies, include bases for taking the 2-m drop test.

REFERENCE

Plodinec, M. J. and Marra S. L., DWPF Waste Form Compliance Plan (Draft Revision) (U), WSRC-SW4--6, Westinghouse Savannah River Company, 1991.

QUESTION 4

This section summarizes DOE's models developed to assess the oxidation and the atmospheric corrosion of container. NRC reviews of the PR reference by McCoy [McCoy, 1994] show that corrosion rate increases exponentially with relative humidity. Is this correlation valid at all temperatures above room temperature?

BASIS

- The DOE's McCoy model correlates atmospheric corrosion rate to relative humidity in an exponential form at various temperatures. However, most data on atmospheric corrosion have been measured at room temperatures. Therefore, it is not clear whether the correlation has been validated with experimental data obtained at temperatures higher than ambient temperatures.

RECOMMENDATION

In future PR studies, explain how the correlation of atmospheric corrosion rate to relative humidity has been validated for higher than ambient temperatures .

REFERENCE

McCoy, J. K., Interoffice Correspondence from J. K. McCoy (Civilian Radioactive Waste Management System Management and Operating Contractor) to D. Stahl (Civilian Radioactive Waste Management System Management and Operating Contractor), August 5, 1994, regarding corrosion model for corrosion-allowance materials, 1994.

Section 5.6.6

Activity 1.4.2.4 - Degradation Modes Affecting Ceramic-Metal, Bimetallic/Single Metal, or Coatings and Filler Systems, Subactivity 1.4.2.4.3 - Assessment of Degradation Modes Affecting Bimetallic/Single Metal Systems and Subactivity 1.4.2.4.4 - Laboratory Test Plan for Bimetallic/Single Metal Materials Systems.

QUESTION 5

DOE has been studying bimetallic metal systems for container design. Bimetallic metal systems have been considered to have many advantages over single metal systems. One of the advantages is offered by the outer layer which is sacrificed galvanically to protect the inner cathodic layer. Is this protection achievable over a very long period?

BASIS

- The galvanic corrosion of the corrosion-allowance outer layer is a type of localized corrosion. This corrosion can take place rapidly or become passive depending on environmental conditions [Sridhar et al., 1994]. In a geologic period, fast dissolution of the outer layer is likely to happen when the inner layer is separated from the outer layer, maintaining the areas of the anode and the cathode the same. Under this scenario, the outer layer dissolves fast and the inner layer is not protected. These sections of the PR do not discuss the likelihood of the loss of protection offered by corrosion-allowance.

RECOMMENDATION

Future PRs should include discussions on the advantages and the expected lifetime, as computed for repository conditions, of bimetallic metal systems.

REFERENCE

Sridhar, N, Cragolino, G. A., Dunn, D. S. and Manaktala, H. K., Review of Degradation Modes of Alternate Container Designs and Materials, CNWRA 94-010, Center for Nuclear Waste Regulatory Analyses, San Antonio, Texas, 1994.

Attachment B

ATTACHMENT B

**ENGB REQUEST FOR NOT READILY AVAILABLE REFERENCES
SITE CHARACTERIZATION PROGRESS REPORT NUMBER 11**

Fridrich, C.J., B.M. Crowe, M.R. Hudson, V.E. Langenheim, and G.A. Thompson, in prep. Structural Controls on Basaltic Volcanism in the Southwest, presented in an administrative report.

Perry, F.V., and K.T. Straub, in prep. Geochemistry of the Lathrop Wells Volcanic Center, Los Alamos National Laboratory, Los Alamos, New Mexico.

Perry, F.V. et al., 1994a. Progress Report on Geochronology Studies, letter report, Los Alamos National Laboratory, Los Alamos, New Mexico.

Perry, F.V., B.M. Crowe, S.G. Wells, and L.D. McFadden, 1994b. "Field, Geochemical and Geochronologic Evidence for Polycyclic Volcanism at the Lathrop Wells Volcanic Center, Southwestern Nevada," Abstract, Eighth International Conference on Geochronology, Cosmochronology, and Isotope Geology, Berkeley, California, June 5-11, 1994.

Valentine, G.A., and Groves, in prep. Entrainment of Country Rock during Basaltic Eruptions of the Lucero Volcanic Field, New Mexico, Los Alamos National Laboratory, Los Alamos, New Mexico.

Valentine, G.A., et al., in prep[a]. Use of Natural Analog and Modeling Techniques to Constrain the Effects of Magmatic Activity on Long-term Geologic Repositories, Los Alamos National Laboratory, Los Alamos, New Mexico.

Valentine, G.A., B.M. Crowe, F.V. Perry, in prep[b]. "Dikes vs. Sills in Shallow, Extensional Settings: Paiute Ridge, Nevada," submitted to Journal of Geophysical Research; also LA-UR-94-1805, Los Alamos National Laboratory, Los Alamos, New Mexico.

Wells, D.L., and K.J. Coppersmith, in prep. "New Empirical Relationship Among Magnitude, Rupture Length, Rupture Area, and Surface Displacement," prepared for Bulletin of the Seismological Society of America, U.S. Geological Survey, Denver, Colorado.