State of California The Resources Ag

Memorandum

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Date : March 27, 1989

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Subject : Proposed Yucca Mountain Nuclear Waste Repository
Memorandum of Review of Final Site Characterization Plan Overview

Preface

The Environmental Protection Program of the Division of Mines and Geology (DMG) has reviewed the Site Characterization Plan (SCP) Overview for the proposed Yucca Mountain High-Level Nuclear Waste Repository. Comments, presented below, are directed toward potential issues relevant to the State of California. Issues within the State's purview involve potential contamination of eastern California groundwater by radionuclide waste migrating from the proposed waste site. Issues specific to the Yucca Mountain site may be indirectly relevant to California if they involve the repository's ability to contain the waste.

Due to the brief time available to DMG's Environmental Protection Program for the SCP review, the comments below are limited to the SCP Overview. We submit the following:

General

The SCP is not intended to provide a final description of the site's environmental characteristics. At this time, many site parameters, which are critical to the final site selection process, need verification. The purpose of the SCP is to summarize 1) the relevant data currently assembled from preliminary studies, 2) the definite conclusions which can be drawn from the data, 3) the significant questions which remain or have surfaced, and 4) the proposals for further investigation. To this end, the SCP should address the range of possible interpretations of the data, and the program of future study necessary to produce and verify an accurate final site characterization.

The determination of appropriate future studies should proceed as the results of current studies are developed. DMG recommends that the Department of Energy (DOE) inform all interested and qualified agencies of the Site Characterization progress, and solicit feedback from interested agencies on a regular basis.

Groundwater

The most important geologic issue relevant to California is groundwater contamination. The potential for migration of radionuclide contaminants into eastern California aquifers (i.e., into the Death Valley regional groundwater basin) is a legitimate concern. Preliminary site studies conclude that Death Valley is hydraulically connected to, and down-gradient of, the aquifer beneath the Yucca Mountain site (Waddell et al., 1984).

DMG defers to the California Water Resources Control Board, or other governing agencies dealing with groundwater quality, on more precise comments regarding 1) specific aspects of aquifer characterization, 2) the potential for contaminant release at the site, 3) the potential for subsequent migration into eastern California, and 4) the adequacy of the SCP in addressing those issues.

The premise for all contamination issues is the potential for accidental radionuclide release at the site. It may be impossible to absolutely assure that radionuclide release will not occur over the 10,000 year post-closure period. Therefore, future site studies should include complete regional, as well as local, aquifer characterization, with emphasis on qualifying and quantifying the potential aquifer characteristics down-gradient of the site.

Investigation techniques and practices should be carefully planned to produce reliable data, while avoiding degradation of desirable aquifer characteristics. For example, exploratory boreholes and shafts should be designed to prevent radionuclide migration in otherwise low permeability (desirable) materials. Since boreholes may act as connections between the site and the underlying aquifer, their location, depth, drilling method, testing method, and closure should be carefully planned and conducted. Furthermore, final site characterization should evaluate the impact, over the post-closure time frame, of the total subsurface exploration conducted on the site.

The SCP Overview describes the site's hydrogeologic regime in terms of a relatively simple conceptual model, assuming steady-state conditions similar to those which exist today (p.26-30). Future studies outlined in the Overview (p.104-107) emphasize refinement of the knowledge of existing hydrogeologic characteristics of the "saturated" and "unsaturated" zones underlying the site, to develop precise models to predict the conditions that would be expected over the post-closure period. Important aspects of the hydrogeologic regime include the relative importance of liquid and gas flow through rock fractures and the rock matrix.

A revised conceptual hydrogeologic model, incorporating "dynamic" processes, has been proposed (Szymanski, 1987). This model suggests that significant, periodic changes occur in the hydrogeologic environment, which could increase the potential for the escape of radionuclide contaminants into the surrounding environment. Future studies should concentrate on developing an accurate local and regional hydrogeologic model, with consideration of factors of the hydrogeologic regime that are dynamic over the post-closure time frame. These studies should have a high priority, as the conditions predicted by the alternative conceptual model may result in the disqualification of the Yucca Mountain site (Syzmanski, 1987). This model is further discussed below.

Volcanic Hazards and Hydrogeologic Conceptual Models:

Szymanski's (1987) alternative conceptual model applies to the hydrogeologic regime of the Yucca Mountain subbasin, and to the greater Death Valley groundwater basin, of which the subbasin is a part. This conceptual model incorporates a "two phase, heat-field coupled, flow field developed in a deforming fractured medium". It is dynamic, in the sense that it allows for "evolutionary loops" in the hydrogeologic regime resulting from deformational cycles in the region. In this model, the characteristics, and relative importance, of rock matrix and fracture flow could change significantly.

The dynamic model incorporates post-closure regional geologic/tectonic factors more comprehensively than the existing (steady-state) conceptual model. Therefore, the "dynamic" model would seem appropriate for site characterization over the post-closure period.

The significant deformational cycles may be associated with episodes of volcanic activity nearby. The current knowledge about the age and character of a) the adjacent Crater Flat volcanic field, and b) local faulting, together with the history of past caldera formation in the area, suggest that future periodic volcanic activity and regional deformation episodes can be expected. The SCP should evaluate the association of deformational cycles and volcanic episodes, with emphasis on the timing and character of both such episodes. The possibility of renewed local volcanic activity during the post-closure period, and the resulting possible impacts to local hydrogeologic conditions should be fully addressed. Other studies should address the effects of heat and water chemistry induced by such volcanism on the repository performance.

Szymanski (1987) suggested a study, among others, that would compare interstitial and fracture porewater at the site to test the validity of his conceptual model. Such a test may or may not prove conclusive. The comparison apparently would assume that the effects of the most recent deformational episode were not overprinted by a past wetter climatic cycle. Whether a wet

climatic cycle, such as the last (Wisconsinian) ice-age, could have overprinted the hydrogeologic effects of a cyclic deformational event should be ascertained. The potential for climatic overprinting becomes more substantial if the timing of the last significant deformational cycle pre-dates the end of the Wisconsinian ice-age.

Paleoclimatic Effects

Paleoclimatic factors are crucial to the assessment of the repository site over the post-closure time frame.

The SCP Overview indicates that the proposed Yucca Mountain Repository Site has existed in an arid to semi-arid climate during the Quaternary period (p.31). To put that in perspective, most of the Central Valley in California has a semi-arid climate. The combination of cumulative precipitation and evaporation determines the aridity. Obviously, long-term changes in temperature, as well as precipitation, are important factors. However, additional factors need to be considered for a hydrogeologic evaluation. For example, the amount of groundwater originating from adjacent geographical regions may be significant, and should be evaluated. Groundwater from outside sources may include runoff from nearby mountainous watersheds, percolation from neighboring aquifers, and surface flows originating from wetter regions.

Long-term climatic change is an important consideration for site hydrogeologic characterization over the post-closure period. The response of the groundwater elevation to changes in climatological factors would depend to a large degree on the relative importance of fracture vs. matrix (interstitial granular) flow and permeability. Appropriate investigations and monitoring should be conducted to address potential climatic change factors, and resulting aquifer response. In addition, potential changes in local and regional aquifer characteristics (permeabilities, flow paths, etc.), resulting from groundwater elevation adjustments, should be fully evaluated.

Seismic Hazards

Seismic hazards in the vicinity of the proposed Yucca Mountain Repository Site are of concern to California, given that such hazards could release radionuclides to the environment.

The SCP Overview describes numerous normal faults at, or in the vicinity of, the site. According to the Overview, the Ghost Dance fault crosses the repository area and has a significant amount of vertical offset. Although the Ghost-Dance fault is not identified as having evidence of Quaternary-age movement, other similar faults nearby display such evidence (SCP Overview, p.22). Apparently, all of these faults formed in response to the same tectonic environment. Therefore, the Ghost Dance fault should be assumed to be potentially active until evidence can be produced that precludes its activity.

The SCP Overview states that "geologic field evidence suggests that in terms of major tectonic activity Yucca Mountain has been relatively stable for the past 11 million years" (p.22). However, the Overview should clarify this statement with respect to the activity of specific site faults. Faults with a potentially active status should be included in assessments of rupture and strong motion hazards.

The SCP Overview states that estimated seismic strong ground motion for the preliminary design of the proposed facility is 0.4g, based on a M6.8 event on the Bare Mountain fault, 11 miles away (p. 22). While this estimate seems conservative for the pre-closure time frame, the context in which it is given suggests that deterministic methods were used in its derivation. A probabilistic assessment is a more appropriate method for estimating the design-basis strong ground motion. A probabilistic analysis would consider the potential size and number of events from all seismic sources in the vicinity, and the uncertainty of strong motion estimation, given an assumed level of risk. The Overview should clarify whether their strong motion estimate is derived by probabilistic or deterministic methods, and whether it, or some other value, applies to the post-closure time frame. If probabilistic seismic hazard methods are utilized, the Overview should describe the assumptions and input parameters assumed in the ground motion assessment.

The SCP should also fully address disturbance associated with strong ground motion from continued nuclear weapon detonations at the Nevada Test Site.

<u>Cooperation in Geological and Seismological Studies</u>

DMG is interested in any geological/seismological studies conducted in California that the U.S. Geological Survey, the Department of Energy, or any other agency involved with site characterization studies may perform in conjunction with further evaluation of the Yucca Mountain site. The U.S.G.S. has proposed seismic refraction exploration, as part of the Yucca Mountain Repository Site studies, in Death Valley National Monument. Furthermore, other California regions may provide useful analogies to test conceptual models of groundwater flow behavior theorized for the site and its vicinity. Such information may prove to have scientific and economic importance outside the realm of the site selection, and, therefore, be valuable to the State. DMG would like to be informed of planning for geologic and seismologic investigations planned in California, and would appreciate the opportunity to provide input for such studies. The information exchanged could be useful and valuable to all concerned.

Waste Transportation Routes

Potential slope mass-movement hazards, such as rockslides and avalanches, may be significant along nuclear waste transportation routes in California as well as Nevada. Slope raveling, erosion, sedimentation, flooding, and other geologic factors, may temporarily close routes and necessitate continual route maintenance. These problematic factors could limit the timing of waste transportation opportunities, or require temporary alternate routing, which are not in the best interest of waste transportation operations. Route selection will depend heavily on security factors. None the less, DMG encourages the consideration of geologic hazards and problematic conditions in transportation route selection.

Closing

Questions on any of the above comments may be referred to Jeffrey Howard of the Division of Mines and Geology's Environmental Protection Program. He can be reached at (916) 323-4399.

References

Waddell, R.K., Robison, J.H., and Blankennagel, R.K., 1984, Hydrology of Yucca Mountain and vicinity, Nevada-California -- Investigative results through mid-1983; U.S. Geological Survey, Water Resources Investigation Report 84-4267.

Szymanski, J.S., 1987, Conceptual considerations of the Death Valley groundwater system with special emphasis on the adequacy of this system to accommodate the high-level nuclear waste repository; U.S. Department of Energy, Nevada Operations Office, Waste Management Project Office, Las Vegas, Nevada, November.