UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

April 13, 1989

MEMORANDUM FOR: Ronald L. Ballard, Chief
Geosciences and Systems Performance Branch
Division of High Level Waste Management, NMSS

THRU: Cecil O. Thomas Jr. Chief
Policy Development and Technical Support Branch, NRR

FROM: Goutam Bagchi, Chief
Structural and Geosciences Branch
Division of Engineering and Systems Technology, NRR

SUBJECT: COMMENTS ON THE USE OF THE 10,000 YEAR CUMULATIVE SLIP EARTHQUAKE FOR THE YUCCA MOUNTAIN SITE CHARACTERIZATION PLAN

In response to your memorandum of February 16, 1989 to Cecil Thomas requesting NRR assistance in the review of the above topic we have reviewed the documents forwarded to us and are providing you with our comments. In general the use of both probabilistic and deterministic methods in seismic hazard analysis, as implied by DOE, is the best approach to arriving at robust solutions to complex geosciences issues. There are however several items that need to be clarified.

1. On page C-71 DOE indicates that conservatism of the approach shall not be an issue since it is a tool for defining the Site Characterization Program (SCP) rather than seismic design. This is an important distinction. If indeed it is only for the SCP, the acceptability of the approach should not be based on its conservatism but whether it will provide the needed information to determine the final design. Our reading of subsequent statements indicates that there is a request for, at least, implicit acceptance of the 10,000 year cumulative slip earthquake (CSE) as a seismic design basis. This needs to be clarified.

2. On page C-73 the argument is made that the 10,000 year CSE would result in ground motion exceedance between 10^{-3} and 10^{-4} per-year. It is also stated that because this level is that implicitly assumed in nuclear power plants, it should be acceptable for waste handling facilities since the risk profile is less than that of nuclear power plants. It should be pointed out that the oft stated reference to nuclear power plants is "on the order of 10^{-3} to 10^{-4}" and can be highly methodology dependent. For example the latest LLNL results for central and eastern U.S. Nuclear plants reveals a range of design basis exceedance of 10^{-3} to $2X10^{-5}$ per-year while an EPRI study reportedly indicates design basic exceedances ranging from 10^{-3} to 10^{-7} per-year. These are median estimates. Mean estimates, which may be more appropriate for risk and cost benefit analyses, would undoubtedly be higher. To assure the same level of design basis exceedance between nuclear power plants and waste facilities it would be necessary to have consistent methodologies and, to the extent possible, consistent inputs. This may be quite difficult because there are no nuclear power plants in

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the Basin and Range. The critical argument that might be evaluated is that with respect to the risk profile. If indeed the risk from a waste handling facility is significantly less than a nuclear power plant the role of seismic issues becomes less important and lower values than that normally required for a nuclear power plant may be acceptable.

3. With respect to seismic design some recent studies indicate that there is not necessarily a simple relationship between seismic design and vulnerability to earthquakes. A nuclear power plant's vulnerability may be controlled by active components or factors that do not necessarily scale with seismic design for example onsite off-the-shelf equipment or offsite ceramic insulators. There is no substitute for periodic and detailed assessments in providing true seismic resistance and putting in perspective, never-ending, yet sometimes meaningless (from the risk standpoint), discussions of seismological and geological issues.

4. If the statements on seismic margin on the bottom of page C-74 and the top of page C-75 are correct (a 0.4g seismic design would indicate a 95% confidence of light damage and no release at 1.0g) this should provide great comfort to those concerned. This indicates more conservatism than California coastal plants such as Diablo Canyon. It would appear that a strong effort spent substantiating and improving seismic margins prior to, during and after construction (incorporating adequate surveillance) could be very beneficial to protecting the public health and safety.

5. On page C-75 the statement that physical realizability is not a requirement for an adequate and appropriate design basis needs to be clarified. In that paragraph DOE recognizes that a fault following the characteristic earthquake model, subject to an average recurrence time of 75,000 years would not release 10,000 years of accumulated strain but somehow the 10,000 year CSE is still justified. The logic is not clear. If it is based upon the assumed 10^{-3} to 10^{-4} exceedance probability at nuclear power plants, the logic is not correct. Design basis earthquakes for plants subject to known earthquake sources such as capable faults are based upon on assessment of the maximum magnitude of those faults. The only reason for disregarding such long return periods in assessing maximum earthquakes would be if it were felt that the return period (e.g. 75,000 years) was quite stable over many cycles and that the lifetime of the facility was taking place early during that cycle. Algermissen and others (USGS. OFR. 82-1033) in assigning maximum magnitude of 6.0 to parts of the Nevada Seismic Zone relied upon the occurrence of earthquakes of magnitude 7.0 and greater in this century. Other parts of the Nevada Seismic Zone where large historic earthquake had not occurred, were assigned larger maximum magnitudes. Another rationale for accepting maximum magnitude earthquakes less than that determined by fault parameters such as length and displacement would be a demonstration that there was sufficient seismic margin to conservatively withstand the larger maximum earthquake. In any case the maximum credible earthquake which may be different from the 10,000 CSE, needs to be assessed and addressed.

6. Reliance upon fractional fault length, for the determination, or justification of maximum magnitude (C-76) can be very region dependent. For example certain faults in Japan have been shown to rupture along their total length during one earthquake.

In spite of the above caveats the decision to use both probabilistic and deterministic assessments of seismic hazard as described on p. 8.3.1.17-65 of Attachment 3 is a good approach. Similarly the statement on p.8.3.1.17-74 indicates that the cumulative slip methodology along with the probabilistic analysis will provide all the information needed to develop a design basis for different methodologies. It would be prudent for the NRC to ascertain that this is indeed so and that there are no hidden asumptions that would preclude freedom of choice in both the method of establishing the design basis and its level. Based on past experience both DOE and NRC may be a lot smarter after site characterization. Finally there is no substitute for understanding all the steps of the design process, its integrated conservatism and the risks to the public from exceeding the design basis in order to assess the significance of individual elements in determining the design basis. Defense in depth measures such as periodic surveillance and assessment of the facility while in operation should substantially enhance public health and safety.

If you have additional questions please contact Leon Reiter, (X-20841).

/S/

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NAME	:LReiter	:GBagchi	:JRichardson	:CThomas	:	:	: :
DATE	:04/7/89	:04/7/89	:04/7/89	:04/11/89	:	:	: