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Dan Dreyfus, Director
Office of Civilian Radioactive
Waste Management
U. S. Department of Energy
Washington, D.C. 20545

Dear Dr. Dreyfus:

The State of Nevada has reviewed the DOE Study Plan, "Quaternary Faulting Within 100KM of Yucca Mountain, Including the Walker Lane" (Study Plan 8.3.1.17.4.3, Rev.1) and its cited references, and is providing its comments in this letter and attachment. The State's comments address the adequacy, completeness, and technical accuracy of the Study Plan to meet the purposes of site characterization.

The State's primary concerns regarding the subject Study Plan are summarized as follows:

1. No rational basis or justification is provided in the Study Plan for limiting the investigations area to what appears to be an arbitrary 100 km radius from the proposed Yucca Mountain site.

2. The rationale and justification for the activities that are outlined in Study Plan 8.3.1.17.4.3 are vague, therefore, it is not reasonably possible to ascertain whether or not the scope, sequence, or timing is appropriate or likely to lead to useful or needed results.

3. The amount of work that will be required to complete the activities as proposed in this Study Plan appears to be extensive. Given the actual level of funding that has been allocated for these programs to date, we have strong

doubts that much of the work proposed can or will be completed, analyzed and assimilated in time to meet the present schedule proposed for license application.

4. The new limited low sun angle (LSA) photographic coverage proposed in the Study Plan for only Jackass Flats, Crater Flats and parts of the Amargosa Desert, will be inadequate to effectively map all of the Quaternary faults that probably exist within a 100 km radius of the site.

5. A major seismogenic source, the Pahrump - Stateline - Amargosa Valley fault, appears to have been completely overlooked in developing the Study Plan.

6. The principal geophysical reference (Oliver et.al. 1990) which forms much of the basis for this Study Plan has yet to be finalized. None of the other USGS geophysical references listed as Open-file have been made publicly available.

7. There are a number of notable references bearing on the Quaternary faulting element of the Study Plan that have been overlooked and omitted.

Should you have any questions, this office is available to meet with the Department and discuss the State's comments at any time.

Sincerely,

Robert R. Loux
Executive Director

ATTACHMENT
cc: R. Nelson, DOE/YMPO
J. Cantlon, NWTRB
J. Youngblood, NRC
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S. Kraft, EEI
D. Weigel, GAO

ATTACHMENT

State of Nevada comments on DOE Study Plan 8.3.1.17.4.3 "Quaternary Faulting Within 100 km of Yucca Mountain, Including the Walker Lane".

GENERAL COMMENTS

Study Plan 8.3.1.17.4.3 outlines the approach and techniques to be used in assessing seismogenic sources lying within 100 km of Yucca Mountain. Five activities each having specific objectives are proposed (p.1-1): 1) Conduct and evaluate deep geophysical surveys along an east-west transect across Yucca Mountain, the Walker Lane, and the Furnace Creek fault; 2) Evaluate Quaternary faults within 100 km of Yucca Mountain; 3) Evaluate the Cedar Mountain earthquake zone and its bearing on wrench tectonics of the Walker Lane; 4) Evaluate the Bare Mountain fault zone; and 5) Evaluate structural domains and characterize the Yucca Mountain region with respect to regional patterns of faults and fractures. An additional, but separate part of the study includes an analysis of bedrock rotation along wrench faults based on rotation of paleomagnetic poles.

Some of the activities listed above are generic in nature, while some are fault specific. Although not specifically spelled out in the Study Plan, our impression is that the relation between the planned activities and their bearing on the evaluation of the regional seismotectonic setting falls into four broad categories. We see these four broad categories as 1) reconnaissance level Quaternary fault investigations supplemented by selected site

specific exploratory trenching; 2) detailed investigation of selected faults (Bare Mountain and Furnace Creek faults); 3) geophysical surveys along a Furnace Creek-Yucca Mountain-Walker Lane transect; and 4) evaluation of seismotectonic styles and evidence for Walker Lane wrench-fault tectonics. The generic activities, such as the preparation of photogeologic maps and the modeling of Walker Lane wrench tectonics, are difficult to evaluate since the discussion of these activities is so generalized and incomplete. The adequacy of any and all of these studies will be strongly dependent upon the level of effort that DOE will actually devote to the studies in terms of manpower and funding. Based upon the actual funding to date, the State has every reason to believe that most of the proposed activities will never be undertaken.

Our conclusion from reviewing the Study Plan is that if all of the planned activities are conducted as stated and at a level consistent with the implicit degree of proposed detail, the results could provide necessary representative data that might be adequate for characterizing the Quaternary seismotectonics of the region. However, we note that these activities are all very labor-intensive, and based on the schedule shown in Figure 5-1 the proposed studies will require tens of person-years to adequately complete and assimilate. Even without the discovery of any major geologic surprises, the results will probably be unavailable in time to play any significant part in the site suitability and licensing decisions. For example, the activity to evaluate

Quaternary faults within 100 km of the site is scheduled to include mapping of all Quaternary faults and "verifying the tectonic origin of scarps, lineaments in the field, and for those found to have a tectonic origin, estimate their age, amount of displacement, and recurrence interval of surface faulting events" (p.2-8). Based on a preliminary compilation of Quaternary fault scarps and lineaments in the 100-km region by the U.S. Bureau of Reclamation, there are tens, perhaps hundreds, of possible tectonic features in the region, making this one proposed activity a formidable task. Experience by the Nevada Bureau of Mines and Geology in other similar regional Quaternary fault studies has shown that characterizing the slip history of all Quaternary features within such a large area (33,000 km2) will require numerous years of focused research.

The State realizes that the Study Plan is based on a site characterization plan that does not necessarily require the testing of any hypotheses. Without some specific mention of the potential consequences of the findings within the context of the viability of the proposed repository, this Study Plan simply degrades into a litany of tasks. There is no substantive basis to decide (1) whether the area being covered is sufficient; (2) what the potential consequence of the findings is to the viability of the proposed repository site, and (3) to what level (in both time and money) the activities should or will be pursued. For example, consider the Death Valley fault zone and its potential impact on

the proposed repository. An intensive mapping and possible trenching effort is proposed for this fault zone to provide information bearing on fault slip rates, recurrence times, and its role in the general tectonic framework. However, if DOE simply assumes a worst case scenario for the fault: very high slip rate and very frequent earthquakes of very large magnitude, will it make any difference in the ultimate decision regarding viability of the proposed repository site? Seismic hazards and hydrogeological modeling should be able to determine the answer to that question now. If the answer is no, then it seems the need for further detailed study of many of the regional structures is obviated. If on the other hand the answer is yes, then a more suitable study can be designed to determine whether or not the fault model is correct and more specifically define the impact on design and performance parameters.

Another example is the planned reflection profiling. The justification for this activity apparently stems from the desire to provide evidence for the width, continuity, and depth of major faults, fault zones, and other structural features. Further on it is stated that "definition of faults in the subsurface by these means will contribute significantly in efforts to constrain the location and character of potential sources of ground motion and rupture within 100 km of the potential site." Besides the fact that not all of the potentially significant sources will be evaluated as part of this study, there is no information provided

in this Study Plan stating how any of the resultant information will bear on the integrity of the proposed repository. With currently available information regarding the location of faults and possible fault models, the question should be asked and modeling efforts should take place early to determine whether or not or how the different models would effect the proposed repository. There appears to be a good likelihood that there would be minimal difference in the impact of the different models, in which case discerning which is correct may not be all that important. If analysis shows that, for example, one of the models would impact the site critically, then an experiment could be designed to determine whether or not that model is viable.

As currently written, the rationale and justification for the tasks outlined in this Study Plan are so vague that it is not reasonably possible to ascertain whether or not the scope, sequence, or timing of programs is appropriate, cost effective, or likely to lead to useful or needed results. We suggest that each activity outlined in this and other Study Plans be accompanied by a specific statement detailing (1) what hypotheses or models the activities are designed to address and (2) how the different model scenarios differ in their potential impact on the proposed repository. An outcome of this exercise should be a determination of whether or not it matters which model is correct and, hence, whether the motivation for the study and proposed attendant expenditures are realistic. DOE's present approach appears to be

to study everything and arrive at one universally accepted model of the Yucca Mountain system. It is well recognized that it is easier and less expensive to pose an experiment to confirm or deny a given hypothesis than it is to design a study to determine exactly how a system works. Indeed, in any given region, arguments of what is the correct 'model' will always continue, whereas there are many models that can be ruled out with simple observation. Hence, with upfront analyses, the tasks of the DOE Study Plan(s) could be designed more efficiently to address those issues which represent the potentially greatest impact on determining the viability of the proposed repository system.

On the other hand if the results of this study are intended to provide some all encompassing basis for defining the geologic setting, as originally implied in the SCP and required as input to 10CFR60, then the plan does not go far enough geographically and is improperly sequenced. As the State has pointed out previously, there is no justification for limiting the investigation to a 100 Km radius. Any source, regardless of the distance, that could generate strong ground motion in excess of 0.1g at the site needs to be considered in both the facilities design and in the post closure risk assessment. In addition, by limiting the study to a few specific features within a 100 Km radius, DOE will severely limit their ability to defend the tectonic models that they eventually use to support a site suitability determination and submit in a license application. The state is not suggesting that

the same level of investigatory effort proposed in this Study Plan be also applied to significant sources outside the arbitrary 100 Km radius but only that these sources be specifically considered in a scientific manner. A systematic compilation and analysis of data from existing literature may suffice in most cases. An exception might be distant but significant earthquake sources that occur within the regional boundaries of the Yucca Mountain geologic setting and either trend into the immediate site area, connect with other significant sources that do, or are possible analogs for sources that are closer to the immediate site. Once all of the potentially significant sources have been established, a more realistic plan could then be developed that would be both time and cost effective.

We have not evaluated the adequacy of the planned geophysical surveys as proposed in this Study Plan since they are covered under separate study plans for the most part and the principal references (e.g. Oliver et. al. 1990) have not been made available. However the proposed geophysical surveys appear to be reasonable within the context of the need to define subsurface structural connections. The geophysical studies comprise a major portion of this Study Plan, but they are clearly necessary in order to resolve geologic uncertainties associated with regional tectonics. We therefore agree in concept with the geophysical activities as outlined in the Study Plan pending the public release of the so called geophysical "white paper" (Oliver et.al. 1990) and the other referenced

"Open-file" and "In Press" studies. After a review of these released documents, further comments on the geophysical program may be warranted.

SPECIFIC COMMENTS

On page 1-3, under Section 1.2, "Rationale and justification for the information to be obtained," the general statement is made in the 1st paragraph that the information "is needed to assist in designing the repository and in evaluating its future performance." Without belaboring the point, explain how this information, once it becomes available, will be translated into repository design? Also explain why this important design information is not required for the underground portion of the ESF prior to the beginning of construction if the ESF is to be included as part of the final repository?

On page 2-2, in the "Rationale for Selecting the Study" paragraph it is stated that the Furnace Creek, Rock Valley, and Bare Mountain faults are the largest, most active faults in the Yucca Mountain region and that"...it is unlikely but still possible that one or more Quaternary faults that would fit into the above category have yet to be identified in the region." Since this conclusion will be proven or disproven by the proposed study, it is premature, and likely incorrect, to conclude that these faults comprise the principal seismogenic sources at or near Yucca Mountain. For example, the Pahrump-Stateline Amargosa Valley fault

system, first suggested by Lauren Wright of the U.S. Geological Survey, may extend north to the Crater Flat area and/or connect with the Rock Valley fault zone based on the studies of Hoffard (1991) and Donovan (1991). These studies document Holocene offset. Based on length-magnitude relations, this fault system is capable of maximum credible earthquakes of M>7, The lack of discussion of this fault zone in the Study Plan (except for a brief reference to it on p. 2-1) is a major omission since the zone may be more proximal to the site than many of the other major faults.

On page 2-2, in the last sentence of the 1st paragraph under Section 2.1, the statement is made that "if the planned (geophysical) tests are successful, the results may provide sufficient data to meet the needs and objectives of several activities in Study 8.3.1.17.4.7, Subsurface geometry and concealed extensions of Quaternary faults." What alternatives will be used if the geophysics programs are not successful?

On page 2-3, in the 2nd paragraph, the use of teleseismic P-wave residuals and Pv/Sv variations is discussed. The statement is made that the results of applying the technique on a limited basis has yielded controversial results. The paragraph goes on to state that the data and interpretations will be reviewed by Los Alamos National Laboratory before deciding on a future course of action. The distinct impression given is that since LANL has already decided that the results do not support their

interpretation, therefore the technique is invalid. We are not optimistic that any further internal review by LANL and the USGS will alter that position. DOE needs to recognize that regardless of how controversial the results may be, if they are permissive of adverse conditions that could impact the site suitability decision or performance, they must be addressed in a substantive manner.

On page 2-7, under Activity 8.3.1.17.4.3.2, the DOE proposes to conduct a variety of surficial geologic studies to provide the basis for a final map of Quaternary faults within 100 km of the site. A major element of this activity involves the preparation of a photogeologic map of Quaternary scarps using conventional and low-sun-angle (LSA) photographs (p. 3-10). Medium-scale LSA photographs will only be utilized for portions of Jackass Flats, Crater Flat, and the Amargosa Desert suggesting that the only LSA photographs to be used will be those previously provided by Nevada Bureau of Mines and Geology (NBMG) and that no new photography will be flown. Given the level of detail proposed by the Study Plan, it is imperative that additional LSA photography be flown of the entire 100-km radius region. This area contains approximately 33,000 km2 which is comparable to two 1 degree x 2 degree sheets (1:250,000-scale), an area that can photographed at suitable scale (e.g., 1:40,000) at minimal costs relative to other parts of the proposed Study Plan. Similar studies by Bell (1984) have demonstrated the need to utilize comprehensive LSA coverage. We therefore regard the lack of such LSA coverage for the entire study

area as a major Study Plan deficiency.

On page 2-8, under Section 2.2.2, "Rationale for selecting the number, location, duration, and timing of the tests," the second paragraph states "studies....will probably be concentrated within approximately 45 km because faults in this area are considered to have the greatest potential for producing ground motions that may affect repository design and performance." How large does the vertical ground motion (VGM) have to be to affect repository design and performance? How will the VGM be translated into design and performance? It seems that there is no basis for this statement since there is no more than a crude conceptual repository design under consideration at this time. Once basic design parameters including thermal loading are established by DOE, it may then be possible to determine more specifically the potential effects of strong ground motion. In the interim, the State suggests that the DOE broaden this study to include identification and consideration of all seismogenic sources that could produce VGM in excess of 0.1g, regardless of the distance from the proposed site.

On page 2-11, Activity 8.3.1.17.4.3.5 proposes to evaluate the nature of structural domains and regional fault and fracture patterns through the analysis of Landsat Thematic Mapper (TM) and side-looking airborne radar (SLAR) imagery. Fracture and fault patterns and densities mapped from the imagery will apparently be used to evaluate the concentrated nature of faulting near the

repository site. We believe that it unlikely that the goal of this activity will be achieved if based solely on the use of TM and SLAR imagery. Such high-altitude imagery is best suited for enhancing large-scale structural features and lacks the resolution necessary for discriminating smaller scale features such as Quaternary fault scarps and fractures. In a similar study in the Walker Lake 2 degree sheet, Rowan and Purdy (1984) used Landsat MSRR imagery to map faults and fractures within the central Walker Lane. A comparison of their map with the companion map of Cenozoic faults (Dohrenwend, 1982) and the geologic map of the Walker Lake 2 degree sheet (Stewart et al., 1982) indicates that Landsat imagery failed to detect numerous critical Quaternary faults, including the Benton Spring and Indian Head faults, as well as historic fault scarps associated with the 1932 Cedar Mountain and 1934 Excelsior Mountain earthquakes.

Under Section 2.5.1 on page 2-12, first paragraph, item (3) proposes to map "surfaces with a coating of desert varnish to aid in defining areas of tectonic stability." How are these data definitive of tectonic stability and what are the supporting references? Later in the same paragraph, the statement is made that "the techniques involved are not well established, and additional feasibility studies may be required...." What kind of feasibility studies are being considered and how much time and money will be required to qualify the technique?

Beginning on page 3-1, a description is given of tests and analysis proposed to be carried out under the Activity 8.3.1.17.4.3.1: Conduct and evaluate deep geophysical surveys in an east-west transect crossing the Furnace Creek fault zone, Yucca Mountain, and the Walker Lane. It is our opinion that this activity could be one of the most important parts of the study in terms of the information that would result that bears on possible design and performance issues. We agree conceptually that geophysical tests will be necessary in order to resolve the geologic uncertainties associated with the regional tectonics. What concerns us however is that the type and extent of geophysical tests proposed seems to be predicated more on the capabilities and bias of the authors rather than on any objective focused effort to identify all the relevant seismic source structures within the immediate geologic setting of Yucca Mountain. The proposed geophysics program seems to be predicated on the results of limited field tests that were conducted over ten years ago. These earlier feasibility tests were not always conducted under optimum conditions or necessarily in ideal locales. The geophysics part of the study needs to be refocused towards identifying all of the major potential tectonic features within the geologic setting that could be contributors to the seismic hazard. In order to accomplish this result, the DOE should focus the study in terms of using the best techniques and contractors/researchers available to solve the problem.

The list of references beginning on page R-1 is incomplete for a plan of this scope and contains numerous typographical errors (e.g., the Bender and Perkins (1987) citation is incomplete). There are numerous notable references missing that are important to the Quaternary faulting elements. As previously noted, the theses by Donovan (1991) and Hoffard (1991) are important data sets not discussed in the Study Plan. Importantly, there are numerous other references relative to Walker Lane tectonics missing (c.f., Nielsen, 1965, Shawe, 1965, Walker, 1985). The omission, and lack of discussion, of Stewart (1988) is a major deficiency of the Study Plan.

We are also concerned that the principal references used in support of the geophysical programs (e.g. Oliver et.al. 1990 and Ponce, In Press (1992?)) have not been distributed outside of DOE, or finalized. In addition, the State feels that it is unacceptable to use personal communication references (e.g. Mooney and Schapper, 1991; page 3-6, 2nd paragraph) and/or references to USGS Open-file reports that are not available outside of the DOE unless written copies of these documents accompany the Study Plan.

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