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BLACKFORD
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Mr. M. E. Blackford, MS-623ss
Project Officer, WMGT
Geotechnical Branch
Division of Waste Management, NMSS
U.S. Nuclear Regulatory Commission
Washington, DC 20555

SUBJECT: Trasmittal of Reference Memorandum Burkhard to McKague

Reference:

LLNL Memorandum Burkhard to McKague, dated 10 December 1986 (3 pages).
FIN A0297

Dear Mr. Blackford:

With this letter, I am pleased to submit for your information and also for other members of WMGT the reference LLNL internal memorandum.

In November 1986, I asked Norm Burkhard through Larry McKague to review USGS OF-Report 83-912, "An Evaluation of Seismic Reflection Studies in the Yucca Mountain Area, Nevada Test Site," and pages 61-66 of the final draft report by the Weston Geophysical Corporation on the "Survey of Geophysical Techniques for Site Characterization in Basalt, Salt, and Tuff." (Burkhard is an experienced seismologist for the area.) Burkhard's review was based on his years of experience in designing and supervising successful seismic reflection surveys in Yucca Flat for the Test Program at LLNL.

Briefly, Burkhard's opinion is that while the conclusions reached in both reports cited above are valid for the traditional long arrays, seismic reflection surveys cannot be written off as an unsuitable technique until arrays more suitable to the geologic and topographic conditions at Yucca Mountain are tried. He suggests that the stack array concept may yield more useful data. The seismic reflection surveys done for the Test Program have evolved towards that concept over the years. The more recent surveys could be considered a modified stacked array.

If you have any questions, please let us know.

Sincerely yours,

Dae H. (Danny) Chung
Project Leader

DHC/ic

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December 10, 1986

To: L. McKague
From: N. Burkhard
Subject: Review of the USGS Open File Report 83-912 and the Final Draft of the Weston Geophysical Corp. Report: Survey of Geophysical Techniques for Site Characterization in Basalt, Salt, and Tuff, p. 65-66.

The USGS Open File Report concludes that "the seismic reflection technique cannot discern a signal which can be seen above the noise level received from the tuffs that underlie Yucca Mountain" even with powerful source and receiver arrays. This problem coupled with the difficult terrain and the prohibitive expense of utilizing the increased power of arrays results in "our recommendation that the seismic reflection method should not be employed at Yucca Mountain". These conclusions are reached after reviewing the results of three surveys at Yucca Mountain.

The terse Weston Geophysical Corp. report is based on the USGS Open File Report. It states that seismic reflection techniques have been found to be of little use in determining the internal structure of Yucca Mountain. It proposes two geologic reasons to explain the poor quality of the seismic records. Like the USGS report, Weston's report concludes with a recommendation that surface seismic reflection methods are unlikely to be useful in site characterization studies at Yucca Mountain.

These conclusions might be warranted if they had evaluated whether or not the seismic data acquisition parameters employed in the three surveys were appropriate to the geologic and topographic conditions at Yucca Mountain. I suggest that the conclusions are NOT warranted until a seismic survey is run that does NOT use large arrays or does NOT employ high resolution techniques, as each of the three surveys at Yucca Mountain sited in the USGS Open File Report does.

The traditional approach used in the reported Yucca Mountain surveys utilized field arrays to attenuate source-generated noise across a geophone group array or seismic source array. Whenever the

source-generated noise includes long wavelengths, this approach leads to long arrays. However, long arrays attenuate the first breaks, lose the high frequencies at early time and long offsets, lose the high frequencies in rough terrain, and lose the high frequencies from dipping reflectors. The traditional long arrays in the field have the potential of removing any coherent reflected energy that might be present. The problems noted here concerning long arrays are exactly the set of problems that have been noted in each of the Yucca Mountain surveys. Each of these problems has been observed by this author while gathering reflection data in Yucca Flat at NTS. These problems would only get more severe in the rugged terrain around and on Yucca Mountain. So it is not entirely a surprise that the processed data gathered using long arrays contains little useful reflection information. The use of the standard long array technique could destroy useful data before it could be recorded. In other words, the powerful array techniques utilized could be the very reason that the method has failed to produce results. A different acquisition technique which does not utilize long arrays could be the answer to the problem of recording good quality data at Yucca Mountain.

The stack array concept junks the traditional approach to array design. Instead, the stack array concept uses the whole gather to attenuate noise in the processing phase, rather than in the field. The stack array concept also makes obsolete the long tedious process of noise testing. The stack array concept is also much easier to field. These two factors in combination mean that the stack array concept could be fielded more economically that the elaborate programs carried on to date. However, the concept must be fielded properly or else other problems associated with aliasing (because of inadequate sampling) will creep into the data. If this approach is tried, it is extremely important that it be supervised by someone who thoroughly understands the stack array concept and has experience in the fielding and processing aspects of the technique. The stacked array techniques are documented by Nigel Anstey in the IHRDC Video Library module GP305 and in a set of articles in the Leading Edge (Society of Exploration Geophysicists), March and December, 1986 issues.

The data processing in these surveys at Yucca Mountain appears

to be carefully done. Given this set of field data, the conclusions from this data set are correct for these set of surveys. However, the main point is that the data necessary to address the structural setting at Yucca Mountain may never have been recorded on the field tapes because the field data acquisition parameters were inadequate for the task.

I conclude by stating that the seismic reflection method at Yucca Mountain has not been deployed in the most optimal manner for the difficult topographic and geologic conditions. Any recommendation that states that seismic reflection techniques are not useful at Yucca Mountain is unwarranted until acquisition technqiues like the stack array approach are utilized. If carefully conducted surveys that retain the potentially useful data are run and the results are still negative, then the conclusions would be warranted.