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MEMORANDUM TO: Robert J. Wright
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FROM: Mysore S. Nataraja
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SUBJECT: NRC COMMENTS CONCERNING BWIP DATA REVIEW

During January 23-27, 1984, we performed rock mechanics data review at BWIP. A trip report was completed on February 27, 1984. In our trip report we had identified several phases of data review.

The attached report completes the first step of the data review process, namely, documenting our observations and conveying our recommendations to DOE. This report summarizes our observations and concerns about rock mechanics testing and testing procedures.

The information contained within the attached report has been coordinated with the Repository Projects Branch, and is for transmittal to BWIP.

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Attachment:
As stated

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DATE	04/18/84	04/19/84					

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INTRODUCTION:

During January 23-27, 1984, the NRC and its Contractors, Engineers International (EI) Golder Associates, Inc. (GAI), and Sandia National Laboratories (SNL) visited the BWIP site in Richland, Washington. The purpose of the visit was to selectively review the data and the data collection procedures in the rock mechanics area at the BWIP site. On January 24, 25, and 26, we reviewed some representative data and procedures for the block test, heater test, hydrofracture tests and some of the rock mechanics laboratory tests. We viewed video logs for the RRL-2, RRL-6 and RRL-14, and examined some rock cores along with color photographs.

Upon preliminary review of the test procedures and the data, we would like to convey our observations and recommendations to DOE/BWIP.

OBSERVATIONS/CONCERNS

Jointed Block Test

Purpose:

The purpose of the jointed block test is to determine the deformation characteristics of a discontinuous rock volume under thermal and mechanical loading.

Remarks:

Perhaps the most important rock parameter obtained from the block test is Young's Modulus. To calculate Young's Modulus one must first calculate the stress and strain in the direction of the applied load. The following are some of our concerns on the block test procedures and data:

- The lack of a bench mark reference point located outside the zone of test influence could have a significant impact on the value of the data collected in the block test. The lack of a reference point appears to be a serious short-coming in the test set-up and procedure.

- There seems to be some confusion concerning the calculation of Young's Modulus under the current block test procedures. Since only relative displacements can be measured, it is not apparent what modulus values are being calculated and what interpretation will accompany the modulus values calculated in different directions.

- The loading limits in the test appear to be controlled by the capacity of the flat jacks. One of our concerns is whether provisions can be made to increase the maximum compressive load delivered by the flat jacks to the test block. In order to produce meaningful data (data that may be extrapolated to the repository level), it will be necessary to raise the stress levels significantly.

- Modeling of the anisotropic behavior of the test block can be quite complex. It is not quite clear if the anisotropic conditions present in the test block are being modeled adequately.

- Because the current testing was performed under ambient temperature, there is no experience on the instrument behavior under heat. It is not clear if such an experience will be gained before at depth testing begins.

Full Scale Heater Test

Purpose:

The overall objective of the test is to assess the thermomechanical behavior of the rock mass. Specifically, the full-scale heater test is to provide an estimate of the thermal conductivity, thermal expansion and heat capacity of the in situ rock mass.

Remarks:

The following observations on the heater test procedures and data are made:

- We have concerns about instrumentation performance: for instance, only the thermocouples performed as specified, while the vibrating wire stress meters (VWS), multiple-position borehole extensometers (MPBX) and borehole deformation gauges (BDG) did not perform satisfactorily.

- Although the heater test was completed a year ago, it is not clear why the analyses of data are still not complete. Since the analysis of full-scale heater test data, when complete, provides a good comparison of the predicted thermomechanical response of the rock mass with the observed behavior, there should be a sense of urgency in completing the analyses of data.

- The DAMSWEL Computer Code was used to predict the response of the rock mass during the test, and the preliminary conclusions depict that the measured temperature profiles are in reasonable agreement with predicted profiles. The displacements measured however, are not in agreement with

the predicted values. It was claimed that a closer correlation was observed recently between the predicted and measured values of displacements. However, it is not clear whether the improved correlations resulted from better measuring techniques or better modeling techniques or changes in approach to interpretation.

Hydrofracture Tests

Purpose:

The objective of the test is to provide an estimate of the in situ stress field at the repository depth. Specifically, the magnitudes and directions of the stresses in the horizontal plane are being measured.

Remarks:

The following observations are made on the data and procedures of hydrofracture test.

- It is generally recognized that (1) the hydrofracture test provides the only method for estimating in situ stress from the surface, but (2) the estimate is subject to considerable uncertainty. At BWIP, only a limited number of successful tests have been completed to date. Therefore, it is important to explicitly express the uncertainties in the BWIP test results whenever these are reported out.

- Poor depth correlations appear to exist among different logs. This can lead to selection of inappropriate test locations. We understand from discussions with the Rockwell staff that preparation of comprehensive geomechanical logs are being proposed. These logs are to contain summary of field and laboatory data. It will be useful to include information on possible discrepancies in depth measurements on these logs.

- Borehole data and video pictures from RRL-2 indicate that several tests have been conducted in intervals with extensive borehole spalling. The effects of spalling on the results of the hydrofracture tests should be established.

- Recording of hydrofracture test procedures remains incomplete due, in part, to changing procedures. Pre-SCR hydrofracture data have little or no traceability to documented procedures and equipment. Current hydrofracture test procedures, equipment and documentation show improvement, thereby increasing the reliability of recent data. Because of the developmental nature of the test technique, it is important that

every effort be made to qualify all the tests under adequate QA procedures. Otherwise, test data could be subject to disqualification or could be of limited value during the licensing process.

Rock Mechanics Laboratory Test

Purpose:

Rock mechanics laboratory tests provide measurements of the physical properties of the intact rock and the discontinuities on small scale specimens.

Remarks:

Based on our visit to the laboratory we do not have any comments to offer.

Computer Modeling

Purpose:

Computer modeling provides a method of estimating long range results through the extrapolation of current test data.

Remarks:

The following remarks are made on the status of rock mechanics modeling work.

- Numerical modeling of geomechanics oriented problems appears to have received very low priority. Modeling activities should receive increased attention.

- Attention should be paid to integrate testing, instrumentation, and the desired constitutive models used for characterizing the rock deformation response. For example, more effort is required in incorporating the failure criteria as observed in tests into the computer models.

Video Pictures of Boreholes

Video pictures of boreholes RRL-2, RRL-6 and RRL-14 were viewed. The following are our major observations:

- Intensive borehole wall spalling was observed in the video pictures. This supports the high horizontal to vertical stress ratio suggested by the observed profuse rock core disking in several bore holes within the RRL.

A cursory examination showed some correlation between the depths of core discing and the depths of borehole spalling.

Rock bursting problems are generally associated with high horizontal to vertical stresses. Worker safety could be a problem under such conditions. Construction costs (due to increased needs for elaborate roof supports) and schedules (due to increased construction time) could be affected due to the stress conditions at BWIP. The new evidence (spalling in boreholes) has increased the concern of our staff and consultants on the issue of constructibility of emplacement holes and retrievability of waste canisters.

Do the current schedules in the exploratory shaft test plan allow for contingencies such as rock bursts that could delay construction?

- Upon examination of core photographs and video logs, the rock quality from a geomechanical point of view appears to be extremely variable ranging from very good to very poor, between the rock surface and the repository horizon. The exploratory shaft design should account for this rock quality variability. Specifically, potential mud-loss problems and rock-fall on drill bits should be considered in the design and schedule preparations.

Recommendations

In summary, our recommendations to the technical staff involved in rock mechanics testing and data gathering are:

- Attention to details should be paid in designing each rock mechanics test and related instrumentation. Peer review should be performed on tests prior to key testing;

- Coordination should be planned in advance among (a) the information needs; (b) the tests, test methods and test procedures; and (c) models, analytical and numerical methods available to reduce and analyze the data;

- Documentation of procedures should be systemetized so as to develop traceability of data gathered. For example, documentation for in situ stress tests prior to the SCR are clearly inadequate. The Q.A. program should be implemented to assure that this does not happen in the future;

- Higher priority should be given to developmental needs in instrumentation;

- More effort should be expended on numerical modeling activities, so as to be fully prepared to analyze all rock mechanics data from exploratory shaft testing; and

- Our observations of extensive spalling in borehole video pictures has increased our concern on the constructibility of emplacement holes and retrievability at the BWIP site. Therefore, we recommend that a peer review be conducted to critically examine the existing data on in situ stress field and in situ strength and determine whether the stress field is adequately accommodated in the repository design.