See Packet 5 for ON.

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Dr. Robert J. Wright
Repository Projects Branch
Division of Waste Management
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Dr. Wright:

RESPONSE TO THE NUCLEAR REGULATORY COMMISSION (NRC) REVIEW LETTERS

References:
(1) Letter, November 4, 1983, Nuclear Regulatory Commission to Department of Energy, Richland Operations Office, "Van der Kamp Method in Slug Test Analysis"

(2) Letter, March 2, 1984, Nuclear Regulatory Commission to Department of Energy, Richland Operations Office, "Numerical Modeling of Parametric Uncertainties (PORSTAT)"

(3) Letter, March 9, 1984, Nuclear Regulatory Commission to Department of Energy, Richland Operations Office, "Follow-up Comments on the ES Test Plan"

(4) Letter, April 6, 1984, Nuclear Regulatory Commission to Department of Energy, Richland Operations Office, "Analysis of the Two-Well Tracer Tests with a Pulse Input"

(5) Letter, May 29, 1984, Nuclear Regulatory Commission to Department of Energy, Richland Operations Office, "Hydrologic Test Data Review"

The above letters, papers, and plans have been discussed by your staff and mine over the past year, culminating in recent technical positions by the project office. At this point, we wish to provide you a status of activity on each point and some pertinent background information. First, please thank your staff for this interaction and be assured that this effort has had a positive influence on maturation of project plans. Second, we have placed formal response to these letters lower in priority to large-scale program documents, including the EA and SCP, as I am sure you can appreciate. The following is a status of activity for each letter.

On Reference 1, BWIPO understands the principal issue is the applicability of the Van der Kamp method to the deep basalt environment. It is the BWIP position that in part of the past testing, the technique does have utility. The coming large-scale hydrologic tests are configured to explore this utility and will be used as a basis for continued discussions with the NRC. Enclosure A gives a discussion of

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the NRC comments on Reference 1, and we anticipate that a workshop environment may be necessary to fully resolve any remaining elements of the issue.

On Reference 2, BWIPO understands the issue to be validation of the PORSTAT method as appropriate for the RRL geology. It is our position that sensitivity studies are necessary to identify the relative importance of parameters included in PORSTAT. These studies are in the program during FY 1985-86, and will be the subject of continued discussions with the NRC during this period.

On Reference 3, BWIPO has received and is in the process of dispositioning all NRC comments on the ES test plan. After internal review of these dispositions (scheduled for approximately December, 1984), BWIPO will request a close-out meeting with NRC to ensure appropriate resolution. This meeting is currently being projected for about April 1985.

On Reference 4, BWIPO understands the issue to be whether the Two-Well Tracer Tests method is appropriately applied. Our position is that there is an area of applicability, and it is discussed in a publication since NRC review of Reference 4 (Enclosure B). We feel that many NRC concerns are addressed in this publication; however, future discussion in a workshop environment may be required (perhaps in the December meeting).

Reference 5 raised questions about the utility of single test interval data for licensing; in particular for rigorous quantitative applications such as travel time estimates. It is the BWIPO position that as the program passes into successively more detailed studies, the basis for such estimates will be revised and improved to reflect current information. These changes will be fully discussed with the NRC as refinements are made. Reference 5 is addressed in Enclosure C.

A separate issue raised during the discussion of these letters involves the utility of "old" program data in the context of licensing and the admissibility of these data in the context of the EA and SCP discussions. The BWIPO position is to establish the extent of utility of these data in testing now being planned. As far as can be stated, the EA and SCP will contain statements pointing to applicability of the data.

If there are any questions regarding the nature of or schedule for responding to the above letters, please contact J. E. Mecca, D. H. Dahlem, or K. M. Thompson of my staff.

Very truly yours,

R.P. Saget for

O. L. Olson, Project Manager
Basalt Waste Isolation Project Office

BWI:KMT/DHD

Enclosures

cc: D.H. Dahlem, BWIPO
J.E. Mecca, BWIPO
R.P. Saget, BWIPO

See folder for Mr. to
Wright fm. Olson
11-1-84

Enclosure A

Response to letter, November 4, 1983, Nuclear Regulatory Commission to Department of Energy, Richland Operations Office, "Van der Kamp Method in Slug Test Analysis"

Nuclear Regulatory Commission Letter Review

A. November 4, 1983, Nuclear Regulatory Commission letter to Department of Energy-Richland Operations Office: Review of a Basalt Waste Isolation Project (BWIP) draft report entitled "Applicability of the Van der Kamp Method in Slug Test Analysis."

The Nuclear Regulatory Commission (NRC) review was conducted on a preliminary interval draft document completed in July 1983 by Dr. F. A. Spane, Jr. of the Drilling and Testing Group, BWIP. The report examines the applicability of the approximate solution documented in Van der Kamp (1976) for analyzing under-damped slug test response. It should be emphasized that the "Van der Kamp" method refers to an analytical solution for only under-damped slug tests. The BWIP, as part of routine field-studies, utilizes a number of standard test methods to hydrologically characterize an individual test interval. Standard BWIP tests include: constant discharge, constant drawdown, slug, pulse, constant head injection, and tracer tests. Approximately 20% of the 230 intervals tested to date have had slug tests performed for which the approximate solution may be appropriate.

Considerable progress has occurred in the evaluation since the original draft report was written. Areas of improvement include:

- o expansion of the original draft report, specifically in examining additional test cases and greater discussion of factors influencing the under-damped slug test response.
- o a modification to the approximate solution, to solve for varying test casing diameter, e.g., for test cases such as borehole DC-14.
- o performance of field tests designed to examine surface and downhole pressure response during under-damped slug tests.

In addition Dr. Garth Van der Kamp has been retained as a consultant to the BWIP to examine the possibility of incorporating the effects of test system friction in the analytical solution. Results of these studies will be documented in a final report by early calendar year 1985.

The following addresses the "Principal Comments" contained in the November 4, 1983 letter.

Principal Comment

1.a, Page 1, "The summary of the theoretical basis <u>for the development of the Van der Kamp method for slug test analysis in shallow systems, for which it was originally designed</u>, is brief but adequate for a document of this nature."

Response

1.a As a point of clarification, the Van der Kamp method refers to an analytical solution which is applicable only for under-damped slug test response. Slug tests respond in an under-damped (i.e., oscillatory) manner when inertial forces within the well-aquifer system become important. These conditions are more apt to occur for wells which are deep and/or intersect aquifers of high transmissivity.

Principal Comment

1.b, Page 2, "...we are concerned that the theoretical development does not adequately highlight certain critical simplifying assumptions that are important in considering the application of the method in the deep basalts of the Hanford Reservation. In particular, the effects of well (tubing) friction cannot be neglected...and a more detailed analysis of wellbore compressibility is needed..."

Response

1.b Additional discussion which will examine the effects of well casing friction on under-damped oscillatory behavior and its significance in calculation of hydraulic properties will be included in the text. Where appropriate, the recent modified Van der Kamp method (Van der Kamp, 10/84) which accounts for test system friction will be used.

With respect to well bore compressibility, these effects are dominated by the effects of the compressibility of water, C_w, in the system, which is taken into account by the storativity term in the equations developed by Van der Kamp. If this were a pressurized response and not a free-water oscillation, well bore compressibility could be significant and evaluated quantitatively utilizing the relationship presented in Neuzil (1982).

$$C_{obs} = \frac{dV/Vw}{dP} \qquad (1)$$

where

C_{obs} = observed test system compressibility

dV = change in volume injected or withdrawn from the well system

V_w = total well system volume

dP = pressure or stress level applied to the test system.

If C_{obs} is found to be greater than C_w, well system compressibility can be incorporated into the approximate equation and accounted for. However since this is a free-water and not a pressurized response, the compressibility of water is considerably greater than the compressibility of the test system; and therefore is the appropriate term used in the analysis.

Principal Comment

Pages 1 & 2, 2.0 "The section on test procedures is not sufficiently comprehensive to answer some fundamental questions concerning the apparatus installed in the borehole and the methods used to produce the pulse. For example,

2.a Is the borehole packed off at the top of the column or left open to the atmosphere with a pressure transducer located below the water surface?

2.b Are the transducers located near the bottom of the hole near the test interval or near the surface of the water column in the borehole?

2.c What is the time interval involved in creating the pulse?"

Response

2.0 The section of the draft report (p. 6) devoted to test procedures briefly describes the two ways that are commonly employed by the BWIP to initiate slug tests. The section will be expanded; however, the manner of test initiation has no particular relevance to the question of applicability of the Van der Kamp solution for under-damped slug test analysis.

2.a The text will be amended to reflect that the under-damped response refers to a free-water (i.e., open to the atmosphere) oscillation. The terms water-level and slug test, which are used throughout the text, are meant to imply this association.

2.b Placement of transducers will be discussed in the Test Procedures section. The effect of well system friction on pressure response for various transducer depth settings will be discussed in an addition to the report which describes in greater detail the effects of test system friction on under-damped response.

2.c Van der Kamp (1976) and Spane (1982) both state that the slug initiation is either "instantaneous," "sudden," or "abrupt." These descriptive terms are meant to imply that the time frame of test initiation is insignificant in comparison to actual observed under-damped slug response. For clarification on this point, however, additional discussion on manner of slug initiation will be included in the text.

Principal Comment

3.0, Page 2, "A reasonable correlation appears to exist between results obtained by the Van der Kamp method and other analysis methods for the selected test cases cited in the document. However, the correlation is less apparent upon examination of a larger selection of test data.... Using Figure 8 of the subject document and the test data obtained by the NRC staff at the July, 1982 hydrogeology workshop held in Richland, Washington, approximate transmissivities determined from the Van der Kamp method were plotted against effective length of the water-filled tubing.... Based on under-damped (Van der Kamp) water-level response, seven transmissivity values plot in the over-damped (wrong) region; based on over-damped response, seven values plot in the under-damped (wrong) region.... The uncertainty associated with transmissivity values calculated using the Van der Kamp method appears to be substantially greater than that indicated by the four selected test cases presented in the draft document."

Response

3.0 The lack of correlation of some preliminary data obtained by the NRC in the July 1982 workshop is a result of the qualitative nature of Figure 8 in the draft report. The figure was developed solely to illustrate the predicted slug test response for the aquifer/test system characteristics and under-damped response criteria specified. As noted in the text (Spane, 1983, p.22)

> "...It should be noted again that relationships presented in Figures 7 and 8 are specifically for the well-aquifer system parameters specified previously.

Under-damped well response conditions would be expected to vary, therefore, with different values of S, r_c, and r_f. Of these parameters, the under-damping response appears to be most sensitive to variations in r_c."

It is not surprising, therefore, that a number of the preliminary data obtained by the NRC in 1982 (which were obtained over a wide range of aquifer-test system conditions) failed to fit in the proper well response regions indicated on Figure 8.

Principal Comment

Pages 2 & 3, 4.0 "The document has not adequately assessed the validity of past tests or developed clear acceptability criteria for future applications of the method. For example, Van der Kamp (Water Resources Research, V. 12, No. 1, 1976) developed criteria to evaluate conditions under which frictional losses may be neglected for both laminar and turbulent flow....While potential problems...(for test cases examined)...are noted in the document, the potential for error in the other test results is not evaluated. As a necessary step in demonstrating the applicability of the method in specific cases, BWIP should establish values for the criteria which are judged to be acceptable, and then apply that (and other relevant acceptance criteria) to each test."

Response

4.0 Additional discussion and expansion of the "Test Procedure and Analysis Recommendation" section of the report will be included in the final report. For example, Analysis Recommendation 2 (p. 31) states that:

> "The effects of friction should be assessed using equations (28), (29), and (30). Efforts should be made to analyze only late-time response data, which is beyond the domain of turbulent flow."

Analysis recommendations and criteria will be revised in the final report to be more specific concerning under-damped response periods to be analyzed and when and how to account for the effects of test system friction. In addition an overview of past under-damped slug tests conducted at the Hanford Site will be performed for the purpose of identifying those test intervals for which the Van der Kamp analysis method is or is not applicable.

Enclosure B