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December 15, 1985

Dr. M. S. Nataraja
Engineering Branch
Division of Waste Management
U.S. Nuclear Regulatory Commission
7915 Eastern Avenue
Silver Spring, MD 20910

Dear Dr. Nataraja:

The enclosed monthly report summarizes the activities during the month of November for FIN A-1755.

If you have any questions, please feel free to contact either myself at FTS 844-8368 or E. J. Bonano at FTS 844-5303.

Sincerely,

Robert M. Cranwell

R. M. Cranwell
Supervisor
Waste Management Systems
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Enclosure

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A-1755 PDR

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PROGRAM:	Coupled Thermal-Hydrological-Mechanical Assessments and Site Characterization Activities for Geologic Repositories	FIN#: A-1755
CONTRACTOR:	Sandia National Laboratories	BUDGET PERIOD 10/85-9/86
DRA PROGRAM MANAGER:	M. S. Nataraja	BUDGET AMOUNT: 175K
CONTRACT PROGRAM MANAGER:	R. M. Cranwell	FTS PHONE: 844-8368
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PROJECT OBJECTIVES

To provide technical assistance to NRC in the assessment of coupled thermal-hydrological-mechanical phenomena and site characterization activities for high-level waste repositories.

ACTIVITIES DURING NOVEMBER 1985

Activities and Accomplishments

The BWIP exploratory shaft test plans and conceptual design reports were reviewed in preparation for two meetings. The first of these meetings took place in Silver Spring, Maryland with NRC staff and consultants on November 19 and 20, 1985 (see attached trip report). The second will be in December with BWIP/DOE. A total of six BWIP documents were reviewed; a copy of written comments for four of the documents is attached (Attachment 1). Two additional documents on performance assessment were also reviewed at NRC's request. Limited progress was made on the Teknekron Benchmark problems. A tape with the waste isolation version of the STEALTH code was received from SAIC. This code is being installed on the Sandia computer system in support of the assistance effort to Teknekron.

Travel

K. Wahi travelled to Silver Spring, Maryland to attend a meeting with NRC and several other consultants on November 19 and 20, 1985 to discuss the BWIP"s ES test plans, design and construction (Trip report is Attachment 2).

Problems Encountered

None.

ATTACHMENT 1

Exploratory Shaft - Phase I
Title II Design Report System Design Description

Document No. SD-BWI-DR-001

REVIEW COMMENTS

Page 2-7, 2.2.3 Hydrology - -

Explain why fluid loss would be of significant consequence only if the fluid level drops below the bottom of the surface casing?

Page 2-14, 2.2.7 Design Life - -

The last sentence refers to possible longer term utilities in a second, larger shaft. What would this longer term be? Also, all the other documents pertaining to the ES facilities state that the diameter of the second shaft will be the same as that of the first one (i.e., 6 ft).

Page 2-15, 2.2.9.3 In-Service Inspection - -

Will the inspection of the grout seal and construction-affected zone of the host rock be performed from portholes?

Page 3-6, Table 3.1 Water Demand - -

The peak water demand for the main hoist house is larger than the total system design flow of 880 gal/min.

Page 3-29, 3.7 Heating and Ventilating - -

What does the "degree days" design value represent?

Page 4-1, 4.1.1 Rock Mechanics Considerations - -

The given horizontal to vertical stress ratio of 2.0 is considerably lower than the 2.5 value indicated by RRL-2 data.

What data are there to support the assertion that the flow top and interbed moduli are ~ 1/10 of the dense interior value? What are the stress ratios in the flow tops and interbeds in the candidate horizons?

Page 4-2, 4.1.1 Rock Mechanics Considerations - -

The elastic stress values shown near the top of this page are based on a stress ratio of 2.0. A more representative value of 2.5 would result in a higher maximum induced stress. This combined with possibly lower compressive strength values (lower than 30,000 psi) could indicate failure at the hole wall. The margin of safety seems pretty low.

Page 4-3, 4.1.2 Shaft Size - -

What are "EX" and "NX" size holes?

Page 4-5, 4.1.3 Shaft Lining Design - -

Using hydrostatic pressure as the design load for the liner appears to be non-conservative. Stresses intermediate between hydrostatic and in-situ rock stresses are likely to act on the liner.

Page 4-6, 4.1.3.4 Deep Casing - -

It is not clear why the radial displacement of the grout and rock mass would not be just as much as that of the liner. It would be useful to see some analysis.

Page 4-7, 4.1.3.5 Seismic Effects - -

At shallower depths, the fractional change due to dynamic stress increase could be substantially more than one-tenth the existing stresses.

No consideration seems to have been given to the potential failure of grout due to cyclic loading.

Page 4-16, para. 2 - -
What is the "liquid spacer" material? What happens to it after grouting is completed?

Page 4-26, para. 2 - -

If the submersible well pumps should need repair or replacement, how accessible are they?

Exploratory Shaft - Phase I
Functional Design Criteria

(SD-BWI-FDC-003 Rev. 2)

REVIEW COMMENTS

Page 10, Figure 2 - -

What data and models were used to predict the depth and thickness of different formations and members at the RRL-2?

Page 14, 3.1.4 Human Engineering - -

Are there established or standard procedures to optimize operator performance and maximize personnel safety?

Page 14, 3.1.6 Metrification - -

Reference is made to English units and U.S. units; are they the same thing?

Page 19, 3.5.3 NWRB Interface - -

The intent to retain maximum flexibility has been stated. What QA provisions and requirements will be imposed to permit the incorporation of the ES facility into the repository?

Page 20, 3.6.1 Facility Expansion - -

For a proper interfacing between ES-I and ES-II, it is not acceptable to have activities beyond ES-I "undefined".

Page 20, 3.7.1 Performance - -

What is the basis of assuming that drilling will result in less rock disturbance around the shaft than would blasting?

Page 21, 3.7.2 Shaft Liner - -

How does the factor of safety of 1.5 for the steel liner compare with industry practice for lined shafts?

Page 21, 3.7.3 <u>Analyses</u> - -

In making an assessment of the shape and extent of the disturbed zone around the shaft and the test area excavations, how is the method of construction entered into the analysis? Are the analyses transparent to whether drilling, blasting or a combination of the two has been utilized?

In the second line of the last paragraph on p.21, does the term "rigid" refer to the dense interior? Are there field data to support the assumption of a 1/1/1 in-situ stress ratio for interflows and interbeds? Are one set of stress ratio assumptions appropriate for all flows (i.e, a ratio of 1/3/2 is appropriate for Umtanum, Cohassett, McCoy etc)?

Page 43, 3.10.2 <u>Classification of Systems</u>, - -

It is stated that no radioactive, hazardous, or toxic materials will be involved in ES-I. Does that preclude conduct of tracer tests from the shaft?

Page 46, U.S. NRC Regulatory Guides - -

What is the relevance of applying "Design Response Spectra for Seismic Design of Nuclear Power Plants" to subsurface shafts?

Functional Design Criteria
Exploratory Shaft Phase II - Project B-474

Document No. SD-BWI-FDC-007 (Rev. 2)

REVIEW COMMENTS

Page 11, Human Factors Engineering - -

Are there established or standard procedures to optimize operator performance and maximize personnel safety?

Page 13, 3.2.5 Facility Disposition

It is not clear why "the design shall not incorporate features whose only function is to support decommissioning . . . ." Earlier on the same page, "decommissioning at repository startup" is given as a possible final disposition of the ES facilities!

Exploratory Shaft Test Plan, Volume I: Exploratory Shaft Test Program

Document No. SD-BWI-TP-007 (Rev. 1 Draft)

REVIEW COMMENTS

Page 2-9, 2.5 Coupled Testing - -

The definition given for coupled testing is unnecessarily stringent in that THMC (all four) parameters are to be measured in the same test. A test involving two or three of these processes or parameters is also coupled.

Page 2-11, 2.6 Test Program Interfaces - -

The statement is made that, "The subsequent use of test data in analysis and design is not within the scope of the ES test Program." However, a rational test program must take into account the data needs of subsequent analysis and design. It is hoped that the test plan has been developed with the purpose of obtaining the necessary and sufficient data for the multiple applications of the test results.

Page 3-2, Table 3-2 - -

In stating the Phase II Objectives, no mention is made of in-situ stress measurements in the overburden.

Page 3-3, Table 3-2 - -

Subobjective (d) amounts to a coupled Thermomechanical test; earlier on p. 2-9 it is stated that this test plan does not address coupled testing. A related, previous comment questions the definition of a coupled test as used in this document.

Page 4-3, Table 4-2 - -

What is "fracture persistence"? Why is the fracture length not one of the characteristics?

Page 4-7, Table 4-5 - -

Planned laboratory tests associated with the measurements of effective porosity, dispersivity, and host rock ground-water geochemistry should be included as an item in this table. As it is, no planned tests for those test data needs are identified in Table 4-5.

Page 4-10, 4.4 Geomechanics Characterization - -

The discussion does not recognize the constraints and complications introduced by the retrievability requirements.

Page 4-11, 4.4 Geomechanics Characterization - -

The use of overcoring testing is presumed to verify and increase the reliability of stress magnitudes and directions. How reliable is the overcoming technique in closely jointed media?

Page 4-12, Table 4-8 - -

Do the planned tests that address "rock mass deformability" data needs provide strength and plasticity data?

Page 4-14, para. 3 - -

It is stated that, "Site-specific data with determinate uncertainty are required as primary data for repository planning." How does the test plan or the analysis propose to determine uncertainty?

Page 4-15, para. 4 - -

Reference is made to a comparison of stress, deformability, fracturing etc. between conditions of ambient and elevated temperatures. The tests that will provide data for such comparisons need to be identified.

Page 5-24, Table 5-2 - -

The comparison of in-situ stresses for various candidate horizons does not provide the stress ratio for the intermediate principal stress component. Furthermore, what stress ratios occur in the flow tops?

Page 5-25, Table 5-2 - -

The preliminary performance assessment results for ^{129}I activity show a variation of four orders of magnitude among the candidate horizons. What other factors, aside from hydraulic conductivity differences, account for this variation?

Page 5-32, 5.3.2.2 Cluster Tests - -

Cross-hole and radial tracer tests are "anticipated to require long test periods." What are the approximate test durations, and do they conform to the overall schedule for ES testing?

Page 5-32, 5.3.2.4 Hydrochemical and Tracer Tests - -

Possible conduct of these tests in the flow tops is contemplated if safety problems can be resolved. What are the specific safety concerns, and how might safety problems be resolved without rendering such tests (if conducted) meaningless?

Page 5-34, 5.3.3.4 Borehole Jacking Tests - -

These and other rock-mass deformability tests are discussed on pp. 5-34 to 5-35. If anisotropic behavior is anticipated (or observed), what are the additional data needs? Do the instrumentation and test orientations permit determination of five elastic constants for a transversely isotropic material?

Pages 5-34, 35 5.3.3.6 - Plate Bearing Tests - -

Use of finite-element models is planned in interpreting the load deformation data. Will this model be capable of simulating non-linear behavior? What types of non-linearities are known to exist in the candidate basalts?

Pages 5-35, 36 5.3.3.9 Canister Hole Drilling Tests - -

Is there a plan to line the hole if it is too unstable without support?

Page 5-38, para. 2 - -

The hydrostatic pressure of the drilling mud is expected to maintain hole integrity. For large in-situ horizontal stress and the resultant stress concentrations following excavation, the mud pressure may not be sufficient to provide hole integrity.

Page 5-44, Figure 5-17 - -

The conceptual arrangement shown in this figure differs from the arrangements shown in other documents. Specifically, the rock mechanics drifts and the mine-by drift are to the west of the main drift in the ES-II Conceptual Design Report (Figure 2-1, p. 2-2) as compared to Figure 5-17, which shows these openings on the east side of the main drift. Secondly, ES-II CDR shows a "second exit" drift between the hydrology drift and the rock-mechanics drift 1; this second exit drift does not exist in Figure 5-17.

Page 6-4 Table 6-3 Expected Results I-3 - -

The predicted ranges for water inflow appear to be in error in the m^3/s units; the correspondence between the gal/min value and the metric units would be correct if litres/sec were the units that accompany the 0.2 to 0.4 range. Furthermore, the values given for the "normal water inflow" are not consistent with anything.

The ranges given for the hydraulic conductivity are not consistent with those in Table 6-8 for flow interiors. Table 6-3 gives a predicted range of 10^{-11} to ~ 10^{-5}, whereas Table 6-8 gives a range of 10^{-11} to ~ 10^{-15} m/s.

Page 6-9, Table 6-9 Expected Results II-3 - -

Magnitude of canister hole deformation of ~ 1 mm appears to be not conservative given that localized failure (spalling, etc.) will occur.

What is the definition of "rock mass deformation modulus"? Is it the same as Young's modulus? Do the values given span directional variations in the moduli?

Page 6-10, Table 6-9 Expected Results II-3 - -

Is the range of thermal conductivity given for dry, saturated,or as-received samples?

When the excavation-induced stresses are added to the thermally induced stresses, the compressive strength of the rock may be exceeded.

Page 7-1, 7.1 Test Instructions - -

Will the NRC be given an opportunity to review the test instructions that are to be written for implementing specific tests?

Page 7-2, 7.5 Instrument Calibration - -

It is planned to repeat an entire test or portion of a test if calibration control limits have been exceeded. What will the priorities be if such repetitions cause schedule delays?

Page 13-2, 13.2.4 Objective I-4, Completion Report Shaft Station Geohydrology - -

It is stated that, "The report will include an assessment of repository performance insofar as hydrologic isolation is concerned." It is difficult to see how the shaft station data will allow such an assessment. More needs to be said about how the report will address repository performance.

Page B-8, B.2.1 Site Charact. Program Objectives - -

The third paragraph concluded that the test program must be largely based on statistically designed and conducted test and study processes. The discussions presented in the main text fail to show where such statistical considerations were given in developing the test plan.

The fifth paragraph ("The general approach . . . ") implies that sensitivity studies and performance assessment were used to select the most important conditions, properties, and design variables. Where are these reported; what specific results were obtained?

Page B-17, Item B. Identify Tests and Studies - -

What does the statement, "Where there are a limited number of accepted methods for obtaining the data, the data needs suggest required tests/studies to a much lower level of detail.", mean? Does this mean more or less; how is a higher level of detail different from a lower level of detail?

Page B-18, C. Formulate Work Requirements - -

The second item from the top of the page proposes that tests in a given group are to be done in the same lab, location or area. Why is this necessary? There appears to be no relevance to this requirement.

Page B-20, Table B-1 Data Quality - -

Item 3 re. "Limit Value" needs more elaboration, it is not clear what is meant.

Page B-31, Figure B-10 Systems Requirements Tree - -

Does the tree have two primary branches or are some of the branches (3.0, 4.0, etc.) not shown?

ATTACHMENT 2

Trip Report

November 19, 20, 1985

On November 19 and 20, 1985 K. Wahi travelled to Silver Spring, Maryland to participate in a meeting with NRC staff and consultants. The meeting was to discuss BWIP's exploratory shaft (ES) test plans, design and construction with emphasis on Phase I of the ES. Participants had been given six BWIP documents related to ES to review prior to the meeting.

Comments by various consultants were discussed and debated in preparation for an upcoming meeting in December with BWIP/DOE. During the meeting on November 19, two other documents related to Performance Assessments were brought up. K. Wahi and A. Brown were asked to provide a review with particular emphasis on their relevance to ES-I activities. Hand-written comments were given by K. Wahi to John Buckley (NRC). Meeting minutes were prepared and signed by the participants at the end of the meeting on November 20.

A-1755
1628.010
November 1985

THIS IS AN ESTIMATE ONLY AND MAY NOT MATCH THE INVOICES SENT TO NRC BY SANDIA'S ACCOUNTING DEPARTMENT.

	Current Month	Year-to-Date
I. Direct Manpower (man-months of charged effort)	0.7	2.2
II. Direct Loaded Labor Costs	6.0	23.0
Materials and Services	0.0	0.0
ADP Support (computer)	1.0	2.0
Subcontracts*	1.0	32.0
Travel	0.0	0.0
Other	-1.0	2.0
TOTAL COSTS	7.0	59.0

Other = rounding approximation by computer

III. Funding Status

Prior FY Carryover	FY86 Projected Funding Level	FY86 Funds Received to Date	FY86 Funding Balance Needed
31K	156K	125K	None