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Sandia National Laboratories

Albuquerque, New Mexico 87185

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March 15, 1986

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 February 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  
Division 6431

RMC:6431:jm

Enclosure

Copy to:

- 6400 R. C. Cochrell
- 6430 N. R. Ortiz
- 6431 R. M. Cranwell
- 6431 E. J. Bonano
- 6431 K. K. Wahi
- 6431 L. R. Shippers

WM-RES  
WM Record File  
A1755  
SNL

WM Project 10, 11, 16  
Docket No. \_\_\_\_\_

PDR   
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A-1755 PDR

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: 156K

CONTRACT PROGRAM MANAGER: R. M. Cranwell FTS PHONE: 844-8368

PRINCIPAL INVESTIGATORS: E. J. Bonano FTS PHONE: 844-5303  
L. R. Shipers FTS PHONE: 846-5275

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 FEBRUARY 1986

K. Wahi had several discussions with J. Pearring (NMSS) regarding the contents of a draft working paper on thermal considerations for waste package emplacement. Review comments and suggestions on improving the paper were sought from SNLA, and will be discussed in a meeting with NRC later on. SNLA was asked to evaluate the capabilities and limitations of a number of thermal/mechanical codes and models, and present that and other information at a meeting in Silver Spring, Maryland on February 28, 1986. A trip report is attached. In preparation for the meeting, K. Wahi and L. Shipers reviewed several codes and performed sample calculations of three-dimensional heat conduction using an analytical solution. Additionally, new ideas for developing semi-analytical capabilities for heat transfer close to a waste package were conceptualized. Preliminary level-of-effort estimates for the proposed ideas were presented to the NRC. Copies of K. Wahi's vu-graphs used at the meeting were transmitted to the NRC.

New documentation and instructions to access and use SANCHO (a thermo-mechanical code) and COYOTE (a heat conduction code) were acquired at Sandia. Some of the effort during February was applied in studying this material.

The analytical solution for one-dimensional steady-state temperature distribution in a composite cylinder was generated and programmed to run on a Personal Computer by L. Shippers and K. Wahi. A floppy disk containing the input and executable files was given to John Buckley (NMSS). A potential application of this program is to perform bounding calculations of temperature, and subsequently a mechanical response in the vicinity of a heat-generating waste package.

Work continued on the preparation of a report concerning the 3-dimensional Conduction Code with an embedded finite-volume heat source.

A trip report by K. Wahi to the NRC Model Validation Workshop held in January is also attached as mentioned in the last monthly report.

#### Travel

K. Wahi travelled to Silver Spring, Maryland to meet with staff of the Engineering Branch on February 28, 1986 and discuss capabilities of several thermal/mechanical codes and models reviewed by SNLA.

#### Problems Encountered

Additional funding of \$125K had been anticipated for this project during FY86. However, it is now our understanding that these funds are no longer available. This reduction in funding will definitely result in a cut-back in the activities of this project for FY86.

## ATTACHMENT I

Trip Report  
by  
K. Wahi

A meeting was held between the NRC and SNLA on February 28, 1986 in Silver Spring, Maryland. The purpose of the meeting was to review combined thermal/mechanical performance modeling capabilities for waste package/host rock interactions in a geologic repository in salt.

After introductory remarks, J. Pearring presented a discussion on DOE's present viewpoint regarding waste package configurations in a salt repository. Possible combined disposal of spent fuel and defense high-level waste (DHLW) is under consideration. It is noted that the design did not include re-processed high-level waste. Thermal loads appear to be considerably lower than before on an areal basis (i.e., kw/acre), but higher on a canister basis (i.e., kw/canister). At this point, thermal considerations appear to be driving the repository design. Two important constraints are a maximum cladding temperature of 375° and a borehole wall temperature less than 250°C. A mine-design description highlighted emplacement and backfill sequence, ventilation systems, and retrievability considerations. Some concern was expressed over the planned 10-ft separation between holes for the DHLW as such a short separation between 3-ft diameter holes may cause thermomechanical instabilities.

The contents of "Thermal Considerations for Emplaced Waste Packages: An EA Review Draft Working Paper" were discussed at length. The consensus seemed to be that while the conclusions were valid and relevant, many of the arguments and examples used to arrive at those conclusions were either inappropriate or over-simplified.

A presentation on "Performance Modeling Capability" was given next by K. Wahi. A brief description of the computational techniques, capabilities, limitations, and availability of several thermal codes - - FLLSSM, THAC-SIP-3D, SPECTROM-41, HEATING 5, and DOT, and two thermomechanical codes - - STEALTH and SANCHO, was given. A discussion of model input parameters, assumptions, and data needs followed. Examples of previous analyses using HEATING5 and a very recent SNLA analysis with VSRC3D (a 3-D analytical code) were shown to demonstrate and compare strengths and weaknesses of different approaches. The difficulty of reliable creep modeling was expressed as a major concern.

With respect to future endeavors, analytical, thermal solution development for 1-D cylindrical, 2-D cylindrical, and 2-D planar geometries was proposed. Possible thermomechanical models of waste package/host rock interaction using SANCHO or STEALTH were described and proposed informally. Further discussions among NRC staff may result in a decision to allocate funds for all or part of the proposed work.

## ATTACHMENT II

### Validation and Verification Workshop Trip Report by K. Wahi

The following is a trip report based on Krishan Wahi's participation in the Workshop on Validation of Mathematical Models for Waste Repository Performance Assessment - Confidence Building Through Synthesis of Experiments and Calculations." The workshop was sponsored by the office of Nuclear Regulatory Research and held in Bethesda, Maryland from January 27, 1986 to January 29, 1986.

The primary objective of this meeting was to start the process of identification of experiments and procedures needed to validate predictive techniques (models, computer codes, analytical solutions) for repository performance. The organization consisted of two days of discussion of natural barriers and one day for engineered barriers. The natural barrier discussions were sub-divided into thermally disturbed and undisturbed zones. The entire proceedings were tape recorded, to be transcribed at a later date. For each major topic or issue, there were speakers selected to present their research and understanding of the problem. In addition, panels were formed to discuss further the major issues. Each panel member was given the opportunity to make a short ( 10 minute) presentation. K. Wahi was a panel member for the Geomechanics/ Coupled Processes panel discussion. Copies of his vu-graphs were transmitted to John Randall (Research, NRC) prior to the workshop.

Because a summary of each talk and the question/answer material is planned for publication, this trip report will only mention the salient points with emphasis on geomechanics. Lynn Gelhar (MIT) proposed the use of stochastic modeling to deal with spatial heterogeneities with respect to hydrologic and transport properties. He cites field investigations where stochastic methods are being applied to correlate observed and predicted behavior. S. Neumann (University of Arizona) insisted that a model must be validated under the same set of initial and boundary conditions as the system is going to experience. There was considerable sentiment in favor of using natural analogs for validating geochemical behavior predictions. However, the difficulty of knowing the history of the hydrologic system is a major obstacle for natural analogs. J. Daemen (U of Arizona) cautioned against taking short-term problems too lightly. From a geomechanics point of view the greatest uncertainty exists prior to construction. He also felt that retrievability would

be a major concern in terms of the ability to predict the conditions at the time of retrieval. C. Fairhurst (U. of Minnesota) alluded to the UDEC Program for modeling jointed rock behavior. They were able to successfully "predict" the deformation response of an in-situ block test with that model. Two questions to ask would be: can this model simulate plastic deformation of blocks, and how is the joint dilation handled? K. Wahi was of the opinion that, at least in geomechanics, there are enough field data and on-going, carefully monitored in-situ field tests that would allow one to proceed with validating thermomechanical codes/models. His statement that the number of codes targeted for validation be narrowed down to a manageable size generated objections from many in the audience. C. Carnahan (LBL) introduced the concept of using "phenomenological coefficients" for describing coupled processes. D. Langmuir (CSM) suggested several alternatives to the bentonite backfill that deserve consideration. M. Molecke (SNLA) presented information and data from the WIPP heater tests. The amount of brine accumulated around the canister was unexpectedly large and could not be explained by diffusion calculations. The speculation is that at the WIPP site, brine flow could be occurring along clay seams or other interfaces. In the discussions on corrosion, many felt that corrosion data from other industry sources could be used. Apparently, some data exist at Lawrence Livermore laboratories on corrosion under a steam environment and on corrosion rates for non-uniform coverage of the surface. Wahi pointed out that the steel liners of existing mine shafts or those of exploratory shafts could provide useful data on corrosion mechanisms and rates.

The meeting was adjourned with F. Costanzi (NRC Research) urging all participants to think about and propose relevant experiments that could be performed under NRC's research funding that would result in providing validation tools and data.

A-1755  
 1628.010  
 February 1986

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)	1.2	5.0
II. Direct Loaded Labor Costs	13.0	52.0
Materials and Services	0.0	0.0
ADP Support (computer)	1.0	3.0
Subcontracts	12.0	85.0
Travel	0.0	0.0
Other	<u>0.0</u>	<u>0.0</u>
TOTAL COSTS	26.0	140.0

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