**Sandia National Laboratories**
Albuquerque, New Mexico 87185

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'86 DEC 18 P3:34

December 15, 1986

Mr. John Peshel
Engineering Branch
Division of Waste Management
U.S. Nuclear Regulatory Commission
7915 Eastern Avenue
Silver Spring, MD 20910

Dear Mr. Peshel:

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 me at FTS 844-8368 or L. R. Shipers at FTS 846-3051.

Sincerely,

Robert M. Cranwell

Robert M. Cranwell
Supervisor
Waste Management Systems
Division 6431

RMC:6431

Enclosure

Copy to:
Office of the Director, NMSS
Attn: Program Support Branch
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WM-Res
WM Record File
A1755
SNL

WM Project 10, 11, 16
Docket No.
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LPDR ✓ (B, N, S)

Distribution:
J Peshel
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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: 10/86 - 9/87

DRA PROGRAM MANAGER: J. Peshel

BUDGET AMOUNT: 250K

CONTRACT PROGRAM MANAGER: R. M. Cranwell

FTS PHONE: 844-8368

PRINCIPAL INVESTIGATOR: L. R. Shipers

FTS PHONE: 846-3051

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 1986

Activities and Accomplishments

Work progressed in three areas during the month of November: 1. BWIP Shaft Cross-Section Model; 2. STEALTH 3D Code Installation; and 3. Review and Analysis of a BWIP "Computational Brief" on Evaluation of Damaged Rock Zone Around Repository Openings (by S. J. Mitchell).

Computer runs of a two-dimensional STEALTH model of a horizontal cross-section at repository depth were made. As indicated in the October monthly report, representative dimensions of the liner thickness, grout thickness, and rock mass were included. Due to a lack of reliable data and the non-availability of the Hoek-Brown failure model in STEALTH, a Tresca Failure model was used in the analysis. Recall that the Tresca model updates were developed for STEALTH applications at SNLA under the Teknekron Benchmarking assistance effort. A copy of these updates is included in Attachment I. The results obtained from this analysis are currently being analyzed. While the yield strength values used in the Tresca Failure model were somewhat arbitrary and are likely too high for basalt, the progress to date on the analysis of results is also reported in Attachment I.

A tape containing "STEALTH-GEN" files was received from EPRI in mid-November after signing a royalty-free license agreement. These files contain one- , two- , and three-dimensional versions of the "General Purpose" STEALTH Code. The files have been copied onto the Sandia Computing System and are being manipulated to appropriate formats for execution. To our surprise and disappointment, the files were not in Update format and have to be converted manually. Our first priority is to convert the 3D file and the associated plot and library files.

A technical review of the "Computational Brief" authored by S. J. Mitchell was performed at NRC's request. In addition, independent analyses were performed of the state of stress in underground openings using Mitchell's input data sets and SNLA's analysis procedures and models. One additional case, not considered by Mitchell, was also included to provide a more realistic estimate of thermomechanical stresses. A write-up of this work is in preparation and will be submitted with the next monthly report.

Travel

None.

Problems Encountered

None.

ATTACHMENT I

Progress on STEALTH 2D BWIP Model:

Two sets of STEALTH calculations have been performed for the horizontal shaft cross-section using representative rock properties and in-situ stresses. The two horizontal stress components prescribed as boundary stresses for the model are: $h_1$ = 61.5 MPa and $h_2$ = 33.0 MPa. A dynamic relaxation technique is used in the STEALTH code when simulating static or quasi-static problems. The selection of a numerical value for the relaxation frequency can be difficult when disparate multiple media and/or complex geometries are considered. The selection of a inappropriate value of this relaxation frequency can sometimes result in the convergence of the code to the wrong answer. In the input data set, this value is defined on Card Type 514. The value of the relaxation frequency must be selected in concert with an appropriate time-step value (which for a static problem has no physical significance). In one calculation, the relaxation frequency was set equal to 0.50, and in the other it was set equal to 0.75. The "time-step" was set equal to 0.1 seconds in each case. While the character of the solution was similar for each of the two cases, the predicted peak stresses in the liner were not similar. This leads to the suspicion that the prescribed relaxation frequency values are causing an overdamping in the system. We expect to have the problem resolved soon.

```
C          ** UPDATES  TO  INCORPORATE  THE  TRESCA  YIELD  CRITERION  **
*C STEALTH
*D ZONSDV2.105,106
C     ** DEFINE ESTIMATED TOAL STRESSES **
   70 SIGXX = SXXN - (PRHN+AVSH)
      SIGYY = SYYN - (PRHN+AVSH)
      SSUM = SIGXX + SIGYY
      SDIF = SIGXX - SIGYY
C      ** DEFINE UNADJUSTED PRINCIPAL STRESSES **
      SIG1 = SSUM/2. + SQRT(SDIF**2/4. + SXYN**2)
      SIG2 = SSUM/2. - SQRT(SDIF**2/4. + SXYN**2)
      PANG = 0.
      IF(SDIF .EQ. 0. .AND. SXYN .EQ. 0.)GO TO 71
C     ** PANG IS THE PRINCIPAL STRESS ORIENTATION IN DEG. **
      PANG = 28.6364 * ATAN2(2.*SXYN, SDIF)
   71 CONTINUE
      YSTN = SIG1 - SIG2
      EX1N = SIG1
      EX3N = SIG2
      EX4N = EX4O
      EX5N = PANG
      IF(YSTN .LE. SMLNUM) GO TO 990
*D ZONSDV2.119,120
   80 ADJN = YLDN/YSTN
C     ** EX4N IS A MEASURE OF PROXIMITY TO YIELD SURFACE **
C     ** WHEN EX4N IS GREATER THAN 1, NO PLASTIC FLOW OCCURS **
      EX4N = ADJN
*D ZONSDV2.128,131
C     ** ADJUST STRESSES ACCCORDING TO TRESCA CRITERION **
   90 SSUM = ADJN * SSUM
      SDIF = ADJN * SDIF
```

```
      SXYN = ADJN * SXYN
      SIG1 = ADJN * SIG1
      SIG2 = ADJN * SIG2
C     ** DEFINE ADJUSTED TOTAL STRESSES IN X-Y DIRECTIONS **
      SIGXX = 0.5 * (SSUM + SDIF)
      SIGYY = 0.5 * (SSUM - SDIF)
      SXXN = SIGXX + (PRHN+AVSH)
      SYYN = SIGYY + (PRHN+AVSH)
      SZZN = - (SXXN+SYYN)
C     ** EX1N IS THE MAJOR PRINCIPAL STRESS **
C     ** EX3N IS THE MINOR PRINCIPAL STRESS **
C     ** EX5N IS THE PRICIPAL STRESS ORIENTATION **
      EX1N = SIG1
      EX3N = SIG2
      EX5N = PANG
```

A-1755
1628.010
October 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) | 0.3 | 0.6 |
| II. | Direct Loaded Labor Costs | 0.0 | 3.0 |
| | Materials and Services | 0.0 | 0.0 |
| | ADP Support (computer) | 0.0 | 0.0 |
| | Subcontracts | 0.0 | -13.0 |
| | Travel | 0.0 | 0.0 |
| | Other (computer roundoff) | 0.0 | 0.0 |
| | TOTAL COSTS | 0.0 | -10.0 |

III. Funding Status

| Prior FY Carryover | FY 87 Projected Funding Level | FY 87 Funds Received to Date | FY 87 Funding Balance Needed |
|---|---|---|---|
| None | 250K | 250K | None |