



**Sandia
National
Laboratories**

**YUCCA
MOUNTAIN**

**YUCCA
MOUNTAIN
SITE
CHARACTERIZATION
PROJECT**

Monthly Status Report

June 1992

DISCLAIMER

Quality assurance checks on data contained in this report have been performed only to determine that the data have been obtained and documented properly. The SNL Project Department cautions that any information is preliminary and subject to change as further analyses are performed or as an enlarged and perhaps more representative data base is accumulated. These data and interpretations should be used accordingly. Milestones have not been baselined and are included only to show status.



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Sections At-A-Glance

1.2.1	Systems	1
1.2.3	Site Investigations	13
1.2.4	Repository Investigations	20
1.2.5	Regulatory and Institutional	25
1.2.6	Exploratory Shaft Investigations	27
1.2.9	Project Management	28
APPENDIX A: Reference Information Base		31
APPENDIX B: Technical Data Base Input		31

WBS Elements Without Reportable Activity This Period

1.2.1.2.1	System Requirements and Description
1.2.1.2.2	System Studies
1.2.1.2.4	Systems Engineering Implementation
1.2.1.2.6	Yucca Mountain Site Characterization Project (YMP) Support to the Management Systems Improvement Strategy (MSIS)
1.2.1.4.8	Performance Confirmation
1.2.3.2.8.4.2	Location and Recency of Faulting Near Prospective Surface Facilities
1.2.4.2.1.1.4	In Situ Design Verification
1.2.5.2.1	NRC and NWTRB Interaction Support
1.2.5.2.3	Regulatory Review

Highlights

Sandia National Laboratories staff completes the 1991 Total System Performance Assessment document by incorporating editorial revisions resulting from Project Office review.

See **1.2.1.4.1 Total System Performance Assessment** on page 5

Purdue Research Foundation personnel deliver document on uncertainty modeling to Sandia National Laboratories staff.

See **1.2.1.4.4.1 Pre-Waste-Emplacement Ground-Water Travel Time** on page 7

Sandia National Laboratories staff completes and documents calculations estimating surficial water effects on repository performance.

See **1.2.1.4.7 Supporting Calculations for Postclosure Performance Analyses** on page 11

Sandia National Laboratories distributes four Yucca Mountain Site Characterization Project documents:

- Preliminary mapping of surficial geology of Midway Valley
- Summary and evaluation of existing geological and geophysical data near prospective surface facilities
- Transportation cask decontamination and maintenance
- G-Tunnel pressurized slot-testing evaluations

See **1.2.9.1.1 Management** on page 28

Sandia National Laboratories staff provides strong computer support to the Yucca Mountain Site Characterization Project Mission 2001 schedule and resource planning activities, culminating in the successful electronic transfer of data to the Project Office.

See **1.2.9.2 Project Control** on page 29

TABLE OF CONTENTS

WBS No.	Page	WBS No.	Page
1.2.1	Systems	1	
1.2.1.1	Management and Integration (Schelling)	1	
1.2.1.2.5	Configuration Management Plans and Procedures Control (Schelling)	1	
1.2.1.3.1	Site and Engineering Properties Data Base (Orzel)	2	
1.2.1.3.2	Interactive Graphics Information System (Jones)	3	
1.2.1.3.3	Reference Information Base (Schelling)	3	
1.2.1.3.4	Technical Data Base Management Computer Support (Jones)	4	
1.2.1.3.5	Technical Data Base Input (Sandoval) ...	4	
1.2.1.4.1	Total System Performance Assessment (Dockery)	5	
1.2.1.4.3.1	Postclosure Repository Design Analysis (Ryder)	6	
1.2.1.4.3.2	Pre-closure Radiological Safety Analyses (Schelling)	6	
1.2.1.4.3.4	Seal Performance Requirements and Analyses (Fernandez)	7	
1.2.1.4.4.1	Pre-Waste-Emplacement Ground-Water Travel Time (Dockery)	7	
1.2.1.4.6	Development and Validation of Flow and Transport Models (Tidwell)	8	
1.2.1.4.7	Supporting Calculations for Postclosure Performance Analyses (Fewell)	11	
1.2.1.4.9	Development and Verification of Flow and Transport Codes (Dockery)	12	
1.2.3	Site Investigations	13	
1.2.3.1	Site Management and Integration (Rautman)	13	
1.2.3.2.2.2.1	Systematic Acquisition of Site-Specific Subsurface Information (Rautman)	14	
1.2.3.2.2.2.2	Three-Dimensional Rock Characteristics Models (Rautman)	14	
1.2.3.2.7.1.1	Laboratory Thermal Properties (Chocas)	15	
1.2.3.2.7.1.2	Laboratory Thermal Expansion Testing (Chocas)	16	
1.2.3.2.7.1.3	Laboratory Determination of Mechanical Properties of Intact Rock (Price)	16	
1.2.3.2.7.1.4	Laboratory Determination of the Mechanical Properties of Fractures (Price)	17	
1.2.3.2.8.3.3	Ground Motion from Regional Earthquakes and Underground Nuclear Explosions (Gibson)	18	
1.2.3.2.8.4.6	Quaternary Faulting Within the Site Area (Gibson)	18	
1.2.3.6.2.1.6	Future Regional Climate/Environments (Behl)	19	
1.2.4	Repository Investigations	20	
1.2.4.1.1	Repository Management and Integration (Costin)	20	
1.2.4.2.1.1.1	Excavation Investigations (Pott)	20	
1.2.4.2.1.1.2	In Situ Thermomechanical Properties (Pott)	21	
1.2.4.2.1.1.3	In Situ Mechanical Properties (Pott)	21	
1.2.4.2.1.2	Rock Mass Analysis (Jung)	22	
1.2.4.2.3.1	Certification of Design Methods	23	
1.2.4.2.3.2	Design Analysis (Ryder)	23	
1.2.4.6.1	Seal Design and Design Requirements (Fernandez)	24	
1.2.4.6.2	Seal Testing (Fernandez)	24	
1.2.5	Regulatory and Institutional	25	
1.2.5.1	Management and Integration (Sandoval)	25	
1.2.5.2.2	Site Characterization Program (Dennis)	25	
1.2.5.2.5	Study Plan Coordination (Price)	26	
1.2.5.2.6	Semi-Annual Progress Reports (Cheek-Martin)	26	
1.2.6	Exploratory Shaft Investigations	27	
1.2.6.1.1	Exploratory Shaft Management, Planning, and Technical Assessment (Pott)	27	
1.2.9	Project Management	28	
1.2.9.1.1	Management (Sharpton)	28	
1.2.9.1.4	Record Management (Hotchkiss)	28	
1.2.9.1.5	Yucca Mountain Site Characterization Project (YMP) Support for the Training Mission (Cheek-Martin)	29	
1.2.9.2	Project Control (Sharpton)	29	
1.2.9.3	Quality Assurance Program (Richards) ..	30	
APPENDIX A: Reference Information Base (Schelling)			31
APPENDIX B: Technical Data Base Input (Orzel)			31

1.2.1 SYSTEMS

The objective of the Systems element is to provide the focal point for the Yucca Mountain Site Characterization Project (YMP) activities concerned with the integrated perspective of the entire radioactive waste disposal system. The Systems element is comprised of four individual tasks: Systems Management and Integration (1.2.1.1), Systems Engineering (1.2.1.2), Technical Data Base Management (1.2.1.3), and Total System Performance Assessment (1.2.1.4).

1.2.1.1 MANAGEMENT AND INTEGRATION

Significant Meetings Attended

On June 3, representatives of the SNL performance assessment group met with representatives of the Management and Operations (M&O), R. Nelson and B. Andrews in Albuquerque, NM. The M&O representatives presented their recent work in defining tasks for performance assessment. W. Chambers of Sandia National Laboratories (SNL) staff presented the results of the recent SNL efforts to produce a performance-assessment roadmap. The meeting produced some agreement and some insights into the near-term future course of performance assessment.

1.2.1.2.5 CONFIGURATION MANAGEMENT PLANS AND PROCEDURES CONTROL

Status Report on Ongoing Activities

Affected document notices for three Yucca Mountain Site Characterization Project (YMP) Change Directives (CR92/093, 094, and 095) were submitted. Twelve Open Interface Memoranda of Understanding that involve SNL were evaluated and a request to close or cancel ten of them was made to the M&O on June 17, 1992 because the work had been completed or was no longer needed.

Work continues on development and implementation of an internal configuration management system.



**1.2.1.3.1 SITE AND ENGINEERING
PROPERTIES DATA BASE**

Significant Meetings Attended

SNL staff attended a meeting of the Technical Data Base (TDB) Administrators' Working Group on June 30, 1992, in Las Vegas, NV.

Status Report on Ongoing Activities

The transition of the SEPDB to GENESIS has begun. In a letter from R. Sandoval, SNL, to C. Newbury, U.S. Department of Energy (DOE), dated June 3, 1992, a transition plan was recommended that would have the SEPDB officially transferred by September 30, 1992. The basis for prioritizing the data being transferred is found in a letter from J. Beckett, Edgerton, Germeshausen, and Grier Corporation (EG&G), to R. Orzel, SNL, dated March 19, 1992. A data cartridge containing the primary priority tables as defined in that letter was sent to EG&G on June 5 and was successfully loaded into the GENESIS data base. Those tables contain porosity, pore saturation, natural-state pore-water content percentages, rock and mineral constituents, grain density and hydraulic conductivity data. On June 17, 1992, a second data cartridge containing the secondary priority tables was sent to EG&G. The second cartridge contained thermal

conductivity, transmissivity data and pumping conditions, well test hydraulic conductivity measurements, water chemical constituents, and relative hydraulic conductivity data. Once SNL receives verification reports from EG&G that compare identically to those generated by SNL, they will be added to the job file at SNL and the job file will be closed out. It is anticipated that a data cartridge containing the remaining tables (~50) will be sent to EG&G by July 15, 1992.

Now that the transition of the Site Engineering Properties Data Base (SEPDB) to the GENESIS has begun, the emphasis on data entry of old submittals has diminished. Only new submittals that are considered critical will have data entry priority.

Major Activities Upcoming Next Three Months

Data entry will be completed for any new submittals that are considered critical.

Technical Data Information Forms (TDIFs) will be developed for all old data submittals that existed prior to the conception of the Automated Technical Data Tracking (ATDT) system.

The transition of the SEPDB to the GENESIS data base will be completed on schedule.



1.2.1.3.2 INTERACTIVE GRAPHICS INFORMATION SYSTEM

Status Report on Ongoing Activities

One individual received training on ARC/INFO, a graphics software package. Further development of ARC/INFO can now proceed as required to establish the user interface for both workstation and personal computer (PC) users.

The following CALMA thermal/mechanical model job has been completed:

- Job 392 for M. Fewell - Locate Neutron Boreholes

Major Activities Upcoming Next Three Months

System setups and user interface for ARC/INFO software will be developed and training will be obtained for additional personnel. A technique to create three-dimensional solids model of thermal/mechanical stratigraphy using visualization software will be developed.

Staff will continue working with Project Graphics Information System (GIS) to obtain additional data such as contours at a higher resolution and files containing graphics to display symbols similar to the maps produced at the GIS.

The following CALMA jobs are in progress:

- Job 385 for W. Chambers - FEM of Yucca Mountain
- Job 386 for H. Dockery - Drill Holes/Section
- Job 391 for M. Esp - Section Through Ramps/Drifts
- Job 393 for T. Robey - Profile Through USW N54-N55

Staff will continue to develop video graphics and animation techniques.

1.2.1.3.3 REFERENCE INFORMATION BASE

Major Accomplishments

Three Reference Information Base (RIB) changes submitted April 17, 1992 were approved for release by the YMP Change Control Board. Copies were transmitted to the M&O for distribution as a controlled document.

Status Report on Ongoing Activities

Interactions with the M&O have been initiated for a transition of responsibility for the RIB to the M&O in FY93. The RIB Topic Index is being revised to correct editorial errors and further simplify maintenance.



**1.2.1.3.4 TECHNICAL DATA BASE
MANAGEMENT COMPUTER
SUPPORT**

Status Report on Ongoing Activities

Staff continued to load Personal Computer Network File Server (PCNFS) software on personal computers (PCs), to install communications boards, and to set up network files to get all PCs operational on the local area network (LAN).

A typeset quality printer and a network grade printer have been installed on the LAN and are operational.

E-mail connections are now possible for those connected to the LAN. Addressing schemes and mail system management will be developed.

Major Activities Upcoming Next Three Months

Staff will continue to set up new and existing workstations and PCs. Staff will also begin setting up machines for automatic backups on the Excabyte/Legato system.

1.2.1.3.5 TECHNICAL DATA BASE INPUT

Major Activities Upcoming Next Three Months

A Technical Data Workshop organized by the YMP is scheduled to be held at SNL on August 4, 1992 to inform SNL staff of the operations of the Project Technical Data Management System.



1.2.1.4.1 TOTAL SYSTEM PERFORMANCE ASSESSMENT

Major Accomplishments

The TSPA-91 document (SAND91-2795) was completed and sent to the printer. The final document is substantially the same as preliminary versions released in April 1992 prior to the Nuclear Waste Technology Review Board (NWTRB) presentations; however, a number of editorial revisions resulting from YMP review have been incorporated into the final version. The expected date for distribution of the document is the third week of July 1992.

Significant Meetings Attended

SNL staff attended the American Nuclear Society annual meeting in Boston, MA on June 10, 1992 to present three papers, including "A Six-Step Method for Systematic Performance Assessment" (R. Barnard), "Approach to Geologic Repository Postclosure System Performance Assessment" (F. Bingham), and "Total-System Performance Assessment for the Yucca Mountain Project" (M. Wilson). A summary of the latter presentation was published in Transactions of the American Nuclear Society, Vol. 65, pp. 53-54.

On June 25 1992 SNL hosted a meeting requested by the Electric Power Research Institute (EPRI) to provide input on the development of enhancements to

the source-term/near-field component of the EPRI Total-System model. Representatives from EPRI, Intera, DOE, Risk Engineering Inc. (REI), Disposal Safety Inc. (DSI), TRW and SNL were present. The list of items recommended for inclusion into EPRI's model in the near term included modeling the distribution of container failures (by various processes), thermal effects (such as thermally accelerated geochemical processes), and hydrologic effects (such as near-field flow process). Although the meeting was mainly concerned with discussions of waste-package and near-field issues, some far-field flow and transport issues were discussed as well.

Status Report on Ongoing Activities

Sandia letter report (SLTR) 90-2002 on construction of the event tree for tectonics has now entered internal technical review. In addition, the Basaltic Igneous Activity Scenario report (SAND91-1653) was also submitted for SNL technical review. Work has resumed on the SAND document on the construction of scenarios for nominal flow.

The cross-sectional model for the saturated flow model has been completed. Results from the first analyses showed several inconsistencies that were resolved. Analyses are proceeding and the results will be presented at the Hydrology Integration Working Group meeting scheduled for late July in Albuquerque, NM.



**1.2.1.4.3.1 POSTCLOSURE REPOSITORY
DESIGN ANALYSIS**

Status Report on Ongoing Activities

SAND91-1493, "Equivalent Energy Density Concept: A Preliminary Reexamination of a Technique for Equating Thermal Loads," by E. Ryder, is being prepared for printing. SAND91-1493 documents the results of a study that addresses the thermal design problem of bounding induced thermomechanical response over expected ranges of waste stream characteristics (age and burnup).

**1.2.1.4.3.2 PRECLOSURE RADIOLOGICAL
SAFETY ANALYSES**

Significant Meetings Attended

A presentation on the methodology developed to determine natural barrier characteristics important to waste isolation and the application of the methodology to unconsolidated surficial deposits was made to DOE and M&O personnel in Las Vegas, NV on June 10, 1992 by SNL staff.

Status Report on Ongoing Activities

A report on the assessment of unconsolidated surficial deposits as an item potentially important to waste isolation is being prepared and should be completed in July 1992. The evaluation of the impacts of Exploratory Studies Facility (ESF) design changes on the evaluation of repository items important to safety is being performed.



1.2.1.4.3.4 SEAL PERFORMANCE REQUIREMENTS AND ANALYSES

Major Accomplishments

The final version of the conference paper, SAND92-1317C, "Seismic Considerations in Sealing a Potential High-Level Radioactive Waste Repository," by J. Fernandez, A. Richardson, and M. Lin, was completed and sent to the American Society of Civil Engineers (ASCE) for publication. Prior to this submittal, additional activities associated with completion of this paper included response to technical peer review and management reviews and completion of additional analyses that supported the paper. These analyses included the evaluation of a soft seal in rock. Specifically, the principal stress, velocity, and displacement vectors, and the maximum compressive stress contours for the soft seal dynamic analysis of both the 1- and 10-Hz cases were postprocessed to understand the mechanism causing dynamic amplification. The results from the stiff seal, 10-Hz case were also postprocessed to compare with the soft seal results. Finally, it was observed from the strain gradient along the deformational field for the soft seal, 10-Hz case that stress amplification did occur in the soft seal.

1.2.1.4.4.1 PRE-WASTE-EMPLACEMENT GROUND-WATER TRAVEL TIME

Major Accomplishments

A copy of a Ph.D. dissertation entitled "Uncertainty Modeling of Many Correlated and Skewed Random Variables" by G. Panchalingam was received. This document is the major deliverable under the SNL contract with Purdue Research Foundation (PRF).

Significant Meetings Attended

SNL staff attended the joint meeting of the Geochemistry and Hydrology Integration Teams in Denver, CO on June 9 and 10, 1992.

A presentation entitled "Uncertainty and Sensitivity Results for Pre-Waste-Emplacement Ground-Water Travel Time" was given at June's TPO meeting.

Status Report on Ongoing Activities

Preliminary numerical simulations have been conducted under the boundary-condition study ongoing at Lawrence Berkeley Laboratory (LBL) to test grid problems. Only minor potential distortions were noted.

Preparation and coordination activities associated with a short course entitled "Reliability Based Design in Civil Engineering" were begun. The course will be conducted by Dr. M. Harr of Purdue and P. Kaplan of SNL. Course description and registration materials were distributed to potentially interested parties, including YMP participants, the NWTRB, the NRC, and the state of Nevada.

The geometry was set up for two cross-sections, one perpendicular and one parallel to the wash where drill holes N54 and N55 are located. The data received from the INTRAVAL study will be incorporated into the cross sections for analyses that will be run in the next few months. An adaptive mesh generator was written to accept output from a geostatistical program. It was also designed to generate a grid for flow codes which allows each individual block to be as homogeneous as possible. Future work will be done to formulate the interfaces for all the programs.



1.2.1.4.6 DEVELOPMENT AND VALIDATION OF FLOW AND TRANSPORT MODELS

All activities addressed in this monthly status report support SCP Section 8.3.5.12.2.1.1. Activities supporting SCP Section 8.3.5.12.2.2.2 are not scheduled for FY92 and hence are not addressed.

Status Report on Ongoing Activities

Flow and transport in single fractures

SNL is continuing to reduce and analyze data from our systematic study of full-field instability in initially dry fractures. In this study, we used a large 30- x 60-cm fracture simulated by two roughened glass plates forced into close contact through application of a confining pressure to each side (20 psi). The effects of gravity on wetting front structure were investigated by inclining the fracture at four angles between vertical and horizontal, corresponding to gravitational gradients of 1.00, 0.75, 0.50, and 0.25. Experiments were initiated by sudden injection of a fixed quantity of water at the upper boundary of the fracture. The injection rate was designed to be greater than the characteristic imbibition rate of the fracture; the excess fluid was allowed to pond along the fracture prior to imbibition. This boundary condition simulates the effects of a sudden rain storm in an arid region. The volume of fluid applied to the fracture was varied between 6 and 23 ml, a range found to be appropriate for this particular set of experimental conditions. On the cessation of imbibition, the initially stable wetting front was observed to become unstable resulting in the development of fingers. Movement of the wetting front within the fracture was recorded at predetermined intervals using a digital camera. Subsequent analysis of the digital images provides a means of calculating the width, velocity, and dynamic behavior of individual fingers in the unstable front. This data has been collected and collated and is currently ready for analysis. M. Nicholl (Ph.D. Co-op student from the University of Nevada, Reno) will be returning to our group in July 1992 to conduct this analysis.

SNL has begun a series of preliminary scoping experiments to investigate the effects of initial moisture content on the behavior of gravity-driven fingers. The initial moisture field is created by saturating the analog fracture and then rotating it from horizontal to the appropriate inclination for use in the experiment. By

allowing free drainage to steady state and then performing a capillary evacuation of excess fluid along the lower boundary, a uniform moisture field at approximately field capacity of the fracture is created. Because analysis is performed using optical methods, it is necessary to develop a means of discerning the advancing finger from the initial moisture field. Current experimentation is investigating the use of different dye formulations as a means of defining the domain of the advancing finger. Work is also underway to refine our techniques to provide an improved characterization of the initial moisture field. From preliminary experiments, we have determined that a detailed wetted structure analysis would be enhanced through development of a more stable light source. Prospects for doing so were explored and it was concluded that the current light box would be modified through use of an outboard voltage regulator controlled from a photoelectric sensor mounted within the existing light box. These modifications are expected to be completed during July 1992.

Plans were made to extend the current experimental work with analog fractures to include casts of natural fractures. To facilitate experimentation, large, rough-walled (but nearly planar) fractures are desirable. A suitable field site, containing relatively large planar fractures in welded to partially welded tuff was located nearby in the Jemez mountains. Acquisition of suitable samples will be performed in July 1992. Plans are also being formulated to extend prototype validation experiments of the Reynolds equation in saturated analog fractures with near-zero contact area to include geometrically complicated air-entrapped regions as found in many of our unsaturated fracture flow experiments.

Fracture matrix interaction

We have initiated systematic studies of fracture/matrix interaction in the plane normal to the fracture. A scoping study was designed and performed this month to evaluate the feasibility of using an angiographic x-ray system to image transient moisture content fields in fractured-porous media. The advantage of using this equipment, which is owned by the UNM Medical Center, is its real-time imaging capabilities. To make use of this equipment, efforts have been made to develop an algorithm for translating the digitized images collected by the angiographic x-ray equipment to a format compatible with our own imaging software. Efforts are also being made to identify x-ray techniques that will allow the imaging of both flow and solute transport fields simultaneously.



To develop physically based models for interblock connectivity and the onset of fracture flow, SNL has continued the effort to define the wetted area structure in horizontal fractures within a porous matrix as a function of pressure. Most analyses and experiments conducted by others to date have assumed a uniform wetted structure in the fracture plane. The initial proof of concept experiment in this area, conducted in August 1991, showed this to be far from the case (presented by R. Glass and D. Norton at the International High-Level Radioactive Waste Management Conference, Las Vegas, NV in April 1992). DOE/OCRWM fellow D. Burns (University of Texas at Austin), who joined our group this past month, will be continuing this research as part of his fellowship practicum this summer and will be extending the work into his M.S. thesis this fall. The wetted structure experiment is designed to study how water spans fractures as a function of pressure. A planar fracture matrix system is simulated with a roughened glass plate that is forced against a flat porous plate. The wetted structure is recorded with a digital camera through the glass plate as the suction is raised and lowered in the porous plate. This past month SNL ran several scoping experiments to assess the present state of the experimental system (which had not been used since last August 1991), to incorporate the high-resolution imaging system (2048 x 2048 pixels) into the experiment, and to analyze several methods for differentiating between wet and dry regions in the digital images. During the experiment, the human eye can distinguish wet and dry regions easily. The experimental data, however, is captured in digital form and, on a pixel scale, the transition between wet and dry is less pronounced.

Gravity-driven fingering in porous media

After a halt of nearly two years, experiments were resumed to finish the study of Miller scaling of gravity-driven finger properties in unsaturated porous media. This work is being completed after discussions this Spring with B. Nelson of the M&O and is supported by a DOE summer undergraduate fellow from NM Tech, Socorro, NM. The completion of this research will aid in delineating the bounds of occurrence of gravity-driven fingering in unsaturated porous media and is required to determine whether the flow mechanism is expected to occur in the nonwelded, nonzeolitized units at Yucca Mountain, NV. Efforts this summer will be aimed at measuring the properties of the seven scale similar media used in experiments conducted two years ago and determining what further experiments and analysis are required to lay this issue to rest.

Field, lab, and numerical experimentation to determine scaling laws for effective-media properties in heterogeneous media

Automation of the gas permeameter test system was initiated. A computer-driven positioning system has been designed. Current efforts are focused on evaluating various commercially available components which can be utilized in the fabrication of the unit. Various software packages are also being evaluated which will facilitate the integration of the positioning system and the data acquisition system.

In support of the research in effective-media properties for heterogeneous media and the LANL Caisson experiment where small-scale (.001 to 1 m) heterogeneity is expected, three slab (30 x 60 x .63 cm) experiments were conducted using our full-field moisture content technique (light transmission). The slabs were packed with Wedron 510 sand (to be used in the caisson) using standard methods for generating homogeneous slabs. A series of automated filling and drainage cycles were conducted followed by a sequence of constant flux infiltration events (increasing flux with each subsequent event). During the infiltration events, dye pulses were followed in the steady-state flow field for use in development of SNL's full-field concentration-sensing ability. Data from these experiments will be analyzed in the next month to obtain hysteretic saturation pressure relations and the relative permeability for the Wedron 510 sand. The transient system response will also be numerically simulated and evaluated as a prototype validation experiment. Additional support to the LANL Caisson experiment included design of the bottom suction boundary condition. Suction will be applied through a series of distributed porous high-flow cups mounted on plates at the bottom of the caisson. A prototype cup suction device was designed, fabricated, and tested.

An exhaustive literature review was also initiated this month to help identify theoretical and experimental work conducted relative to the modeling of property scaling.

Development of laboratory capabilities to support all activities

Efforts have continued relative to the selection of a small industrial x-ray unit for dedicated use in the flow and transport laboratory. The schedule was set back by a month due to uncertainties related to health and safety considerations that must be addressed prior to the installation of such equipment in the laboratory.



The general-purpose image acquisition/data acquisition/flow control program was expanded to include peristaltic pump speed control within an experimental sequence. This provides the capability of momentarily flushing the flow manifold and changing flow rates in different sequences. Also, program flexibility was improved to permit scale acquisition without image acquisition, simplified format versions of data output added, and the provision to control a midsequence draining of a reservoir when its scale indicates maximum weight has been reached. Future improvements to this program will include the ability to monitor a scale for a steady-state flow condition and the addition of printing the sequence name and elapsed time on the image.

An effort is underway to develop an inexpensive pressure sensor/tensiometer to monitor pressure (or suction) in chambers and columns with PC-based data acquisition systems. A Motorola pressure sensor is connected to an interface control (IC) instrumentation amplifier, the output of which can be monitored by one of two different makes of A/D data acquisition boards. The pressure transducers have been characterized using a water column over a range of ± 1 m. Hysteresis and linearity have been found to be small and after fitting the data to a calibration curve, the standard deviation of the deviations from that curve are found to be <1% of the range.

SNL is also developing a dye concentration sensor utilizing photodiode excitation fiber optically connected to a photospectrometer source. The components of this system have been purchased and fabrication and testing of prototypes is to be undertaken in July 1992. These sensors are also to be monitored by the same acquisition system as the pressure sensors. An interface box will be fabricated to house multiplexors and termination boards, and, if required, the instrumentation amplifiers and an external power supply. This box will be fitted with input and output connectors to the various sensors and acquisition boards.

Scoping sorption studies

No activity to report this period.

Reactive transport model development

A series of experiments are being carried out to determine the effect that trace surface coatings and admixed grains have on the surface properties of natural materials. Changes in the composition of a 0.01M NaCl solution in contact with Wedron 510 sand under CO₂-free conditions over a range of initial pH

have been monitored by periodic measurements on batch systems over a span of 34 days. The readings at low pH (less than ~4) stabilized after less than three days; the difference between the initial pH and that at three days provides a means of assessing the total buffering capacity of the raw sand. The readings at high pH decreased slowly with time, and may be explained by uptake of CO₂, either diffusing through the plastic or perhaps introduced each time the containers were opened for measurement.

An aliquot of Wedron 510 sand was treated with 6 N HCl and then the acid was analyzed by flame AAS for possible soluble components. Substantial Fe was detected, along with minor amounts of Ca, Mg, and Si.

Data has been collected for the titration of a reference silica (untreated Min-U-Sil) in batch experiments under CO₂-free conditions. The batch systems contained a Min-U-Sil surface area similar to that of the Wedron 510 sand systems. Preliminary indications show much less buffering capacity than the sand, but still a small increase in pH when only Min-U-Sil is added to water.

More detailed surface potentiometric measurements will be made on raw and treated samples of sand and limonite when the autotitrator has been brought on line. During the last month, a new Orion 720A meter was installed and its remote control abilities verified. A new version of the operating software that supports the 720A will be ready shortly.

Caisson test

Collaboration with Los Alamos National Laboratories YMP staff (E. Springer) in an intermediate-scale (caisson) flow and transport validation experiment continued. Design of bench-scale column experiments to estimate the pH in the caisson under unsaturated-flow conditions continued during June 1992. A moisture characteristic (saturation vs. suction) curve was measured on the Wedron 510 sand. Tensiometer readings for a 4-cm-thick plug of sand were correlated with the degree of water saturation. The relationship between saturation and tensiometer readings was then used to give an indication of the saturation state of the column for several different steady-state flow conditions. It is hoped that the saturation measurements can then be correlated to the effluent pH.

Sorption studies of I, Li, Ni, and B by the candidate materials for the caisson continued during this month. Kd values for iodide uptake by limonite under CO₂-free conditions ranged from 10 ml/g to 0.4 ml/g for a pH range of 2 to 12. Under moderate pH, the Kd values



were about 1.5 ml/g. Kd values for iodide uptake by the Wedron 510 sand ranged from 0.3 to 0.01 ml/g over the same pH range; however, no correlation between Kd and pH was observed. At moderate pH, the Kd was approximately 0.02 to 0.2 ml/g. Preliminary results for Li and B will be reported next month.

Other activities

Work continued on the development of budgets, work scopes, and networks for FY93 through FY01.

Dr. M. Taniguchi from Fara University in Japan visited R. Glass (SNL) on June 22 and 23, 1992 to discuss gravity-driven fingering as relevant to high-level nuclear waste disposal. Dr. Taniguchi is on sabbatical leave this year and has spent the past six months at the University of Arizona working with Dr. S. Newman. He and Dr. Newman are in the process of preparing a review paper on gravity-driven fingering in porous media and fractures.

Major Activities Upcoming Next Three Months

To expedite effective media property-scaling studies, an automated data acquisition system for measuring gas permeabilities on meter-scale slabs of rock will be designed and built. Testing of the electronic gas permeameter will also be conducted. Studies will also continue relative to the design of a dual-ring air-injection permeameter/rock seal in an effort to better define the geometry of the flow field that develops during rock slab testing.

Purchase and installation of an industrial x-ray unit dedicated to the flow and transport laboratory will be pursued.

Detailed studies of sorption of B, I, and Ni by mixtures of sand and goethite and by materials (samplers and plastic laboratory ware) to be used in caisson or in supporting laboratory studies will continue. Design calculations for caisson experiment will continue. The caisson will be filled and instrumented.

Surface potentiometric titration of sand, goethite, and zeolite will continue.

Two papers will be completed for the special issue of Radioactive Waste Management and Nuclear Fuel Cycle on the YMP.

1.2.1.4.7 SUPPORTING CALCULATIONS FOR POSTCLOSURE PERFORMANCE ANALYSES

Status Report on Ongoing Activities

The calculations to estimate the effects on repository performance of surficial water use in the controlled zone but outside the repository, Exploratory Studies Facility (ESF) Performance Assessment (PA) Analysis No. 12 and the Problem Definition Memo (PDM) describing these calculations, PDM 72-32, were completed. The analysis is now undergoing technical review. The results of the analyses were presented at the ESF status meeting and at the Technical Integration Group (TIG). Exploratory Studies Facility Design Requirements (ESF DR) Appendix I will be revised to include the results of ESF PA Analysis No. 12.

Preliminary efforts for a model validation exercise in collaboration with WBS 1.2.1.4.6 have been initiated. Preliminary calculations are being performed and a PDM describing calculations to be made in conjunction with the caisson sand experiments is being written.

Reviews of controls on the Phase II Neutron Boreholes and on the U.S. Geological Survey (USGS) Activities in the Quaternary Fault site area were completed.

Major Activities Upcoming Next Three Months

The documents describing the performance assessment plan for the ESF Title II design support will be completed. The plan described in the document will be developed and implemented.



**1.2.1.4.9 DEVELOPMENT AND
VERIFICATION OF FLOW AND
TRANSPORT CODES**

Status Report on Ongoing Activities

Code development (Subactivity 1.6.2.1.2)

A large (~20,000 unknowns) three-dimensional problem of flow through an unsaturated, heterogeneous domain was defined to test the applicability of JACQ3D and COYOTE-II to this class of problem. The performance results for JACQ3D indicate a fairly efficient algorithm for large problems. However, experience indicated that the solver loses efficiency or even fails to converge when the conductivity varies over more than 5 to 6 orders of magnitude; this condition can occur when applying infiltration into an initially very dry medium. The solver in COYOTE-II is very efficient and capable of handling drier problems than JACQ3D, but the matrix assembly requires substantial central processing unit (CPU) time. These results were documented in a memorandum and distributed.

A Picard solver was added to the DUAL code. This direct solver provides an initial guess for the Newton solver. For the test case run, it appears to eliminate the large number of iterations in the Newton solver and results in much faster execution times.

Software QA (no SCP activity)

All codes were transferred to the software configuration management Sun workstation. Approximately 25 percent of the codes have been put under source code control system (SCCS) control.

Some problems running the BLOT code under the new version of the Sun operating system (4.1.2) have surfaced and are being looked into for a solution. The design information needed for the BLOT evaluation report is being developed. The software documentation for BLOT and LEHGC and in preparation.

The NORIA-SP installation report should be done by July 2, 1992 and a checkout report will follow shortly thereafter.

A number of additional tasks were completed, including preparation of responses to internal audit filing/ observations, preparation of revisions to QAIP 3-2 (Rev. 2), drafting several sample QA memoranda, updating the master log to include additional tracking fields, and beginning the evaluation review of the climatology codes.

Staff are serving on a YMP Analysis Review Team. In accordance with requirements set forth in DOP 2-4, the PDM and resulting analysis are being reviewed.



1.2.3 SITE INVESTIGATIONS

The objective of the Site Investigation element is to determine repository site suitability in terms of DOE siting guidelines (10 CFR 960), Nuclear Regulatory Commission (NRC) criteria (10 CFR 60), and Environmental Protection Agency (EPA) standards (40 CFR 191).

1.2.3.1 **SITE MANAGEMENT AND INTEGRATION**

Major Accomplishments

Sample Overview Committee

The Sample Overview Committee (SOC) met on June 3, 1992 in Area 25 to consider various specimen removal requests. One request from an outside party (a university professor) was deferred until July because the request was received too late to meet procedural requirements. A request from the USGS for transfer of core samples from several neutron holes was disapproved. The samples in question had already been assigned to another principal investigator (PI) for essentially identical tests.

The discussion begun at the May SOC meeting regarding "permanent" archiving of some fraction of core to provide samples for retesting at the request of intervenors during licensing was renewed. C. Rautman (SNL SOC representative) presented geostatistical data suggesting that the various tuff units at Yucca Mountain are sufficiently different in their spatial correlation character that achieving "representativeness" of archived samples would be difficult and would require the preservation of a variable fraction of material depending upon the geologic unit. Capturing and archiving certain thin, yet potentially significant "deterministic" features of the stratigraphic section might make it impossible to perform site characterization testing of these same features. SOC representatives reported on the results of polling PIs in their organizations regarding such archives; the opinions were uniformly negative. The consensus among the technical community is that it is a better use of Project resources to do a thorough and credible scientific job now, than potentially to cripple the scientific effort in an attempt to anticipate undetermined issues that might arise 10 to 20 years in the future. The acting SOC chairman was to report the SOC stance to Project management.

The acting Los Alamos National Laboratory (LANL) SOC representative proposed expanding the scope of

the preliminary, non-quality-affecting geologic log created at the rig site by Sample Management Facility (SMF) personnel. SMF personnel will consult with the LANL representative and propose an expanded log format for use on drill hole UZ-16 at the next SOC meeting, July 7, 1992.

Selection of Preferred Initial ESF Access (SPIA) Task Force

The SPIA Task Force report was completed and entered Project review. SNL staff involvement in the task force is essentially complete, pending review comments on the report.



1.2.3.2.2.1 **SYSTEMATIC ACQUISITION OF SITE-SPECIFIC SUBSURFACE INFORMATION**

Status Report on Ongoing Activities

Staff have been invited to contribute a section on hydrologic rock properties to a LANL report in preparation. The report will compare several potential sites for a "surface-based test facility" or "prototype Exploratory Studies Facility." LANL has prepared information regarding the general geology, mineralogy/petrology, and geochemistry of several sites in "bedded" and other nonwelded tuffs. Information on hydrologic properties obtained as part of the outcrop sampling studies conducted by this WBS element may be of significance to the evaluation of the various sites. Appropriate data are being compiled and text will be prepared. (SCP 8.3.1.4.3.1.1)

A small rock-properties laboratory has been established at SNL to support the outcrop scoping studies, the Systematic Drilling Program, and activities in the unsaturated flow and transport laboratory operated under the Development and Validation of Flow and Transport Models activity (SCP 8.3.1.4.3.1.1 and WBS Element 1.2.1.4.6)

Major Activities Upcoming Next Three Months

Evaluation of data from the surface transects will continue intermittently to obtain samples needed to resolve questions or to confirm existing findings as appropriate. The air permeameter will be tested upon completion of repairs and used to collect permeability data from several promising locations as feasible. Emphasis will be placed on attempting to obtain field measurements from rock types that could not be cored for laboratory analysis because of their excessively friable nature. (SCP 8.3.1.4.3.1.1)

1.2.3.2.2.2 **THREE-DIMENSIONAL ROCK CHARACTERISTICS MODELS**

Significant Meetings Attended

Staff participated in the Hydrology/Geochemistry Integration Teams joint workshop in Denver, CO, on June 9 and 10, 1992. C. Rautman presented an informal talk entitled "Geostatistical Methods to Locate (and Evaluate) Fast Paths." The talk focused on potential uses of descriptive geostatistical techniques to better understand the geology of Yucca Mountain as it relates to the identification of potential fast flow and transport pathways to the accessible environment. Modeling uses of geostatistics were also described as a means of approximately quantifying how significant (i.e., large) a potential fast path might need to be before it affected performance. (SCP 8.3.1.4.3.2.1)

Status Report on Ongoing Activities

Staff have been told informally that the issue of a study plan for this modeling (analysis) activity (and for a similar modeling activity conducted by the USGS [8.3.1.4.2.3.1, Three-Dimensional Geologic Model]) has been resolved. Apparently a study plan will not be required and no provision has been made for writing a study plan in the current draft Planning and Control System (PACS) planning exercise. No formal, written documentation of this reported Project decision has been received as yet. (SCP 8.3.1.4.3.2.1)

Tapes containing the remaining geophysical well log data from the USGS have been received at SNL for use in the Lynx Geotechnical Modeling System (GMS). Other commitments have prevented significant Lynx-type modeling during the month. Separately, a new digitizer compatible with the Lynx GMS has been received and installed. Incompatibility of the old CALMA digitizer with the Lynx software system has stymied some data entry activities for several months. (SCP 8.3.1.4.3.2.1)

Staff has begun to work on adapting geostatistical simulation subroutines into work being performed under the Ground-Water Travel Time Activity for an INTRAVAL exercise. (SCP 8.3.1.4.3.2.1 and WBS Element 1.2.1.4.1)

Major Activities Upcoming Next Three Months

Modeling activities using the Lynx GMS will continue. Staff and USGS personnel will meet in mid-July to



define some of the parameters that will constitute the basic underpinnings of a jointly developed geologic model for the site. Agreement on conventions for creating and naming three-dimensional model components is essential if the two participants are to continue working on a joint geologic/rock characteristics model of the site. (SCP 8.3.1.4.3.2.1 and 8.3.1.4.2.3.1)

Completion of the geostatistical description of material properties obtained for the two-dimensional surface transect of the shardy base microstratigraphic unit of the Tiva Canyon Member (see WBS 1.2.3.2.2.2.1) will allow two-dimensional modeling and simulation of this important hydrologic unit. Efforts will be made to merge geologic modeling with flow modeling to produce a better understanding of hydrologic behavior at Yucca Mountain. (SCP 8.3.1.4.3.2.1)

1.2.3.2.7.1.1 LABORATORY THERMAL PROPERTIES

Status Report on Ongoing Activities

SAND92-0119, "An Experimental Comparison of Laboratory Techniques in Determining Bulk Properties of Tuffaceous Rocks," is undergoing technical review. (SCP 8.3.1.15.1.1.1)

The Thermal Conductivity Analyzer (TCA) has been successfully calibrated and verified per Technical Procedure (TP)-202, Rev. 00. The successful calibration of the instrument using reference materials of known values satisfies the requirement for verification of the data acquisition software.

Tests were run to verify that previous calibration failures at lower temperatures were due to variances in sample-plate interfaces caused by inadequate application of a heat sink compound. These tests confirmed that the TCA is well within the $\pm 2\%$ repeatability limit claimed for the instrument when heat sink compound is adequately applied. The TCA will be used for thermal conductivity measurements made at or above 110°C. (SCP 8.3.1.15.1.1.3)

The C-Matic LT Instrument is undergoing an overhaul because of erratic output from the heat flux transducers. Other components will be replaced or reworked as necessary. The LT instruments will be used for measuring thermal conductivity at temperatures from 20 to 100°C. (SCP 8.3.1.15.1.1.3)

Changes to TP-201, "Calibration of Mechanical and Electrical Measuring Equipment Used for Thermal Properties Testing" (Interim Change Notices [ICNs] 02 and 03), and TP-207, "Calibration of Temperature Sensors Used for Thermal Properties Testing" (ICNs 01 and 02), are in the process of being issued. (SCP 8.3.1.15.1.1.3)

Major Activities Upcoming Next Three Months

The scoping study on the effects of saturation on thermal conductivity will begin after the LT instrument is overhauled and recalibrated. (SCP 8.3.1.15.1.1.3)



1.2.3.2.7.1.2 LABORATORY THERMAL EXPANSION TESTING

Status Report on Ongoing Activities

SAND88-1581, "Linear-Thermal-Expansion Data for Tuffs from the Unsaturated Zone at Yucca Mountain, Nevada," has been submitted to the Project Office for review. (SCP 8.3.1.15.1.2.1)

The power supplies and controllers to control the temperature of the linear variable differential transformer (LVDT) chamber and environmental tube are being incorporated into the dilatometer instrumentation. (SCP 8.3.1.15.1.2.1)

Major Activities Upcoming Next Three Months

Once the accuracy and reproducibility of test data is established, and the relevant procedures approved, a scoping study on the effects of sample size on thermal expansion will be initiated. (SCP 8.3.1.15.1.2.1)

Other Items to Report

A presentation was made to the Rock Mechanics Review Panel on June 11, 1992 by C. Chocas (SNL). Issues regarding the scoping studies specified in the Study Plans for Laboratory Thermal Properties (SCP 8.3.1.15.1.1) and Laboratory Thermal Expansion Testing (SCP 8.3.1.14.1.2) were discussed.

1.2.3.2.7.1.3 LABORATORY DETERMINATION OF MECHANICAL PROPERTIES OF INTACT ROCK

Major Accomplishments

SAND91-1926C, entitled "Modulus Dispersion and Attenuation in Tuff and Granite," by R. Haupt, R. Martin, X. Tang, W. Dupree (New England Research, Inc. [NER]), and R. Price (SNL), was presented at the 33rd U.S. Symposium on Rock Mechanics in Santa FE, NM, on June 9, 1992. (SCP 8.3.1.15.1.3.2)

Status Report on Ongoing Activities

NER is conducting a study involving high-temperature experiments at creep and low strain rate conditions. The results from six experiments run at a nominal axial strain rate of 10^{-8} s⁻¹ are being compiled and prepared for inclusion in a data report. Preparations for the series of six constant stress (creep) experiments are ongoing. The experiments will be starting in July 1992 after a delay resulting from minor problems with the internal furnace. Six samples of TSw2 will be tested at a pore pressure of 4.5 MPa, a confining pressure of 5 MPa, and a constant differential stress of 80 MPa. Initially, the experiments will be performed at room temperature and then at 250°C. Each test will each take about four months to complete. Also, R. Martin and R. Price presented the status of the testing to the SNL YMP Rock Mechanics Review Panel in Albuquerque, NM on June 11, 1992. (SCP 8.3.1.15.1.3.2)

R. Price is a member of the American Society for Testing and Materials/Institute for Standards Research (ASTM/ISR) Steering Committee for the Interlaboratory Testing Program for Rock Properties. The testing portion of Phase I has been completed, with a total of nine government, private, and academic laboratories participating. The committee met on June 17, 1992 in Louisville, KY and completed the review of the draft report of the Phase I data and finalized plans for Phase II. (No SCP Activity)

Staff attended a meeting of ASTM Subcommittee D-18.12 on Rock Mechanics on June 16, 1992 in Louisville, KY. Several Standard Methods are being revised by members of the committee and the review of these documents was discussed. In addition, staff volunteered to begin drafting a standard for running rotary friction experiments. (No SCP Activity)

SAND92-0119, entitled "Experimental Comparison of Laboratory Techniques in Determining Bulk Properties



of Tuffaceous Rocks," is being technically and editorially reviewed. (SCP 8.3.1.15.1.3.2)

Major Activities Upcoming Next Three Months

SAND92-0847, entitled "Modulus Dispersion and Attenuation in Tuff," is being drafted and will begin the review process in the next two months. (SCP 8.3.1.15.1.3.2)

1.2.3.2.7.1.4 LABORATORY DETERMINATION OF THE MECHANICAL PROPERTIES OF FRACTURES

Significant Meetings Attended

S. Brown (SNL) was cochairman and major presenter at a Short Course on Fractals at the 33rd U.S. Symposium on Rock Mechanics in Santa Fe, NM, on June 10, 1992.

Status Report on Ongoing Activities

Study Plan 8.3.1.15.1.4, "Laboratory Determination of the Mechanical Properties of Fractures," has been reviewed by other Project participant, Project Office, and Headquarters personnel and the review comments were received in May. The comments have been read and considered. The responses to the comments are being formulated by the authors and a revision of the study plan will be written in the next two to three months. (SCP 8.3.1.15.1.4.1 and 8.3.1.15.1.4.2)

W. Olsson, S. Brown, and R. Price presented the status of the mechanical fracture properties work on the SNL YMP Rock Mechanics Review Panel in Albuquerque, NM on June 11, 1992. (SCP 8.3.1.15.1.4.1 and 8.3.1.15.1.4.2)

The time-dependent mechanical properties of fractures are being investigated to address long-term stability issues within the potential repository. This month the results from experiments on artificial fractures in samples of welded, devitrified Tonopah Spring Member tuff to study the effect of water in rate-stepping experiments have been analyzed. While preliminary analysis of the data has indicated that there is very little, if any, difference in the shear behavior at these two saturation conditions, the analysis is continuing. (SCP 8.3.1.15.1.4.2)

Major Activities Upcoming Next Three Months

A revised version of Study Plan 8.3.1.15.1.4, "Laboratory Determination of the Mechanical Properties of Fractures," will be submitted to the Project Office within the next three months. (SCP 8.3.1.15.1.4.1 and 8.3.1.15.1.4.2)

A journal article summarizing the topography data collected on seventeen natural joints and the analysis of the data using the simple mathematical model is being drafted and will be submitted for internal review in the next three months. (SCP 8.3.1.15.1.4.1 and 8.3.1.15.1.4.2)



1.2.3.2.8.3.3 GROUND MOTION FROM REGIONAL EARTHQUAKES AND UNDERGROUND NUCLEAR EXPLOSIONS

Status Report on Ongoing Activities

SAND92-0956, "A Statistical Analysis of Ground Motion Resulting From Underground Nuclear Explosions in the Yucca Mountain Region," by B. Rutherford, was submitted for internal SNL technical and managerial review.

1.2.3.2.8.4.2 LOCATION AND REGENCY OF FAULTING NEAR PROSPECTIVE SURFACE FACILITIES

Status Report on Ongoing Activities

Work continues by Geomatrix Consultants on logging soil pits and trenches in Midway Valley. Delays have been encountered because of safety concerns regarding the trenches. Entry into the trenches will occur once the safety requirements have been satisfied. Shoring may need to be used in the trenches or the trench configuration changed.

1.2.3.2.8.4.6 QUATERNARY FAULTING WITHIN THE SITE AREA

Status Report on Ongoing Activities

A draft progress report, "Geologic Mapping Within the Yucca Wash and Northwestern Fortymile Wash Drainage Basins, Nye County, Nevada," by J. Gibson (SNL) was submitted to the USGS in Denver, CO for informal review. This report includes a description of mapping units, faults that transect this area, and copies of preliminary maps at a scale of 1:12,000.



1.2.3.6.2.1.6 FUTURE REGIONAL CLIMATE/ ENVIRONMENTS

Significant Meetings Attended

Staff attended the 26th Annual Congress of the Canadian Meteorological and Oceanographic Society, which was held June 8 through 12, 1992 in Quebec City, Canada to give a key address on regional climate modeling.

Status Report on Ongoing Activities

The overall evaluation of the surface climatology of the 3-1/2 year present-day run with MM4 driven by GENESIS is essentially complete. This evaluation was limited to spatial and seasonal characteristics of the model climatology and was conducted for the whole United States. It showed that the model reproduced temperature well over most of the domain, except the Great Lakes region, and also reproduced most features of the averaged precipitation field. Over the West, precipitation was somewhat overpredicted but the orographically forced regional precipitation patterns were well simulated, especially during the cold season. Overall, seasonal precipitation patterns were also realistic in the model, although the model performance varied widely from region to region. The analysis also showed that over the western United States, the use of the nested model considerably improved the simulation of surface climate compared to the use of the Global Climate Modeling (GCM) alone.

Additional analyses are being planned to: (1) look at the model variability by analyzing higher-order statistics of the precipitation and temperature fields (variability in simulated precipitation and temperature is important for the effect that it has on the surface hydrology); and (2) examine the simulated hydrologic fields (soil moisture, evaporation, infiltration, and

runoff). The analysis will first be conducted for various basins in the United States to understand the general behavior of the model hydrologic component. After the overall model evaluation is complete, a detailed validation analysis for a smaller region encompassing Yucca Mountain, NV will be performed.

All reviewers' comments on the Phase I report, "Simulation of Arid Climate of the Southern Great Basin Using a Regional Climate Model," have now been addressed.

QA software evaluation of the Regional Climate Model (RCM) computer model is ongoing.

Major Activities Upcoming Next Three Months

The review of the Phase I report, "Toward the Simulation of Possible Future Climate Scenarios over the Southern Great Basin," will be completed.

A multiyear regional climate run for the western United States using boundary conditions provided by CCM1, a modeling program, at finer resolution (T420) will be completed.

The software evaluation reports for computer codes associated with the regional climate modeling will be completed.

Issues/Potential Problems Needing Resolution and Potential Impacts

QA-certified inputs from the global circulation model, to be provided by Pacific Northwest Laboratory (PNL), have been delayed. SNL has proposed an alternative plan to Dr. R. Dyer, YMPO, to prevent any further delays. This alternative plan is not yet finalized.



1.2.4 REPOSITORY INVESTIGATIONS

The objectives of the Repository element are to design a repository compatible with the host rock that meets the engineered barrier performance objectives of 10 CFR 60 and 40 CFR 191; to develop the required instrumentation and equipment for the repository; to obtain the necessary geoenvironmental data through laboratory and field tests; and to identify repository operation, closure, and decommissioning requirements.

1.2.4.1.1 REPOSITORY MANAGEMENT AND INTEGRATION

Status Report on Ongoing Activities

Several integration efforts are ongoing. A plan has been developed in cooperation with Lawrence Livermore National Laboratory (LLNL) and LANL to address the issue of consolidation of Thermal Tests in the ESF. A list of tests that could be consolidated has been developed and initial discussions between LLNL, SNL, and LANL have been completed. A thermal design working group has been formed with key staff from SNL, LLNL, and the M&O. The initial focus of this group will be to revise the current Site Characterization Plan (SCP) thermal design goals for the repository. Once this is completed, issues such as the range of thermal loading to be studied during Advanced Conceptual Design (ACD) can be addressed.

Initial design analyses to address a range of thermal loading for both in-drift and in-borehole emplacement schemes have been completed and will be consolidated with the M&O waste-stream studies. SNL and the M&O will review these results and designate several cases for further study.

Input for all SNL activities in 1.2.4 for the mission 2001 exercise was completed and transmitted to the Project Office. SNL is working with LANL and the M&O to provide input into the decision process for a possible prototype test facility for the long-term thermal/hydrological and thermal/structural tests.

Major Activities Upcoming Next Three Months

Thermal structural calculations of near-drift response for a range of thermal loadings will be completed by late July 1992. These analyses support the M&O waste-stream systems studies.

1.2.4.2.1.1 EXCAVATION INVESTIGATIONS

Significant Meetings Attended

Staff hosted a meeting of the Rock Mechanics Review Panel on June 11 and 12, 1992. The Rock Mechanics Review Panel consists of six independent, objective, highly qualified experts in rock mechanics whose purpose is to provide advice and technical recommendations to SNL's rock mechanics investigators. SNL's current plans for the ESF were presented to the panel and discussions with the panel followed that helped advance the design of the ESF tests. These design enhancements should result in better test measurements when the experiments are fielded.



**1.2.4.2.1.1.2 IN SITU THERMOMECHANICAL
PROPERTIES**

Status Report on Ongoing Activities

A rough draft on a study of thermal effects on instrumentation, produced to make recommendations for the ESF thermal tests, was written. The study lists what instrumentation is needed and why it is needed, matches this list with available off-the-shelf instrumentation, and details new technologies that may be able to fill the gaps where no commercial instrumentation is available.

**1.2.4.2.1.1.3 IN SITU MECHANICAL
PROPERTIES**

Status Report on Ongoing Activities

Clarification was provided to the Independent Cost Estimating (ICE) Team to explain differences between SNL's PACS estimates and the ICE Team's estimates.



1.2.4.2.1.2 ROCK MASS ANALYSIS**Significant Meetings Attended**

On June 11-12, 1992, SNL convened a meeting of the Rock Mechanics Review Panel. This panel consists of Z. Bieniawski, Penn State; S. Crouch, University of Minnesota; H. Pincus, Consultant; J. Russel, Texas A&M; C. Scholz, Columbia; and H. Swolfs, USGS. A number of topics were discussed during the meeting including laboratory testing of intact rock, laboratory testing of fractures, laboratory joint model testing, thermal analyses, field testing, and analyses. SNL's work in these areas was presented to the panel for comment. The most significant comments received were associated with the instrumentation to be used for the field testing. These recommendations are being considered during the writing of the final test plans.

Status Report on Ongoing Activities

Work on the laboratory experiments involving loading layered polycarbonate plate models continued. SNL has been working on improving the technique for interpreting Moiré fringes. SNL expects to automate and improve the accuracy of the method. To do this, SNL has been developing software that allows for the performance of digital bandpass filtering of the data and to mask out certain areas of the model such as a hole. When these techniques are fully implemented next month and SNL receives a new monochromatic light source, the layered model will be retested. SNL has also ordered some new diffraction gratings that will significantly increase resolution. (The current method uses 1000 line/in. while the new gratings are

13,000 lines/in.) Experimentation with these gratings will begin next month.

Substantial progress was made in completing the software QA requirements so that the ESF support analyses can be performed. It is anticipated that the final QA approvals will be obtained in July 1992 and the analyses will be performed soon thereafter.

A series of experiments designed to study the effects of nonstandard loading conditions on frictional properties is being conducted at the University of Colorado. Four rock samples with fractures and five to seven replicates of each fracture have been tested for normal stiffness properties and then tested in shear with constant normal load or constant normal stiffness conditions. This month, the final three samples were tested and the data is being reduced and analyzed. The data and analysis will be reported in SAND documents that will be drafted in the next three months. Some of this work was presented in a paper, "Shear Response of a Rock Joint Under Different Boundary Conditions: An Experimental Study," J. Wibowo, B. Amadei, S. Sture, A. Robertson, and R. Price, at the Fractured and Jointed Rock Masses Conference, June 3-5, 1992.

The report "Fracture Analysis and RQD Estimation for the Yucca Mountain Site Characterization Project," by M. Lin and M. Hardy (Agapito & Associates) and S. Bauer (SNL), SAND92-0449, has completed Project Office review. Peer review comments have been resolved for SAND92-0450, "Rock Mass Mechanical Property Estimates for the Yucca Mountain Site Characterization Project," by M. Lin and M. Hardy (Agapito & Associates) and S. Bauer (SNL).



1.2.4.2.3.1 CERTIFICATION OF DESIGN METHODS

Status Report on Ongoing Activities

While updating the jointed rock continuum model to be more efficient and to be compatible with a newer version of SNL's main finite element, JAC2D, staff found that the new material model in the new version of the JAC code produced results that were inconsistent with those obtained in the past (in terms of robustness, convergence rate, and displacements). Further complicating the situation, the new material model is a complete rewrite (to obtain more efficiency) and the old JAC and old material model will not run on the current CRAY operating system. To sort out the problems, staff began an effort to carefully examine and test the material models. Initially, a simple conversion of the old material model to work in the new JAC was performed. Both material models agree for a number of small test cases run this month. Next month, some larger problems where discrepancies were first detected will be run.

Testing of combined finite-element and boundary-element technologies continued. Another test problem was attempted and the equation solver failed to obtain a solution. Next month, consideration will be given to using a direct solver to determine if the problem is with the method or the equation solver. Some work with "infinite" elements has been performed and the elements have been formulated. These elements may have better numerical characteristics than the boundary elements. SNL expects to implement and test these elements in the next few months. This work has resulted in a paper, "A Combined Finite Element - Boundary Element Formulation for Iterative Solution Methods," by J. Koterak to be presented at the CUBE 92 Symposium, October 27-30, 1992.

A paper covering some of SNL's discrete-element work, "A Study of Discrete and Continuum Joint Modeling Techniques," by J. Jung and S. Brown, SAND91-1730C, was presented at the Fractured and Jointed Rock Masses Conference, June 3-5, 1992.

1.2.4.2.3.2 DESIGN ANALYSIS

Status Report on Ongoing Activities

Work on PDM 75-25, "New 3-D Far-Field Repository Thermomechanical Calculations," continued. The defined analyses are intended to determine the temperatures, stresses, and strains expected in the vicinity of ESF openings that may become part of the repository. The "new repository design" is being used in the analysis, with thermal loadings of 57 and 80 kW/acre. Results from the first phase (thermal calculations) have been completed and are being documented. The definition of mechanical calculations examining the performance of drift intersections has been initiated and work should begin within the next month.

Based on requests from the M&O, a work agreement was developed that outlines a series of thermal analyses to be run in support of TRW's systems study on the thermal management of the potential repository. The ongoing analyses are examining the near-field thermal effects of two emplacement options, two waste package concepts, two drift shapes and sizes, and six local areal power densities (LAPDs) in limited combination. Phase I of these calculations, examining the near-field thermal response to LAPDs of 20, 24.2, 57, 69.1, 114, and 138.2 kW/acre for an SCP-type vertical emplacement layout, and 57 and 114 kW/acre for an in-drift emplacement scheme, has been completed. Selected results of these analyses will be used in future mechanical calculations.

A study comparing the predictions of near-field thermal response using approximations of smeared two-dimensional heat sources and discrete three-dimensional representations was initiated. Near-field thermal and thermal-mechanical analyses are often run as two-dimensional approximations. For the reference emplacement options published in the SCP, this requires the smearing of the power outputs of discrete canister heat sources into a rectangular region that is assumed to be infinitely extensive perpendicular to the modeled plane. Such a "smearing" results in a diffusion of the source and may result in an underprediction of near-field thermal response. The purpose of this study is to provide a preliminary evaluation of this aspect of two-dimensional thermal modeling.



1.2.4.6.1 SEAL DESIGN AND DESIGN REQUIREMENTS**Status of Ongoing Activities**

Development of the report, entitled "A Strategy for Sealing Exploratory Boreholes for the Yucca Mountain Project," continued. The primary activities involved the preparation of many figures to be used in the report. Portions of Chapter 3 were completed dealing with the rock strength and the in situ conditions.

Work continued on the review of available technologies to seal underground openings. The following were accomplished during this month:

- Completion of a rough draft of the chapter dealing with backfilling technologies.
- Documentation of the material handling process for backfill materials from when the rock is excavated to when it is emplaced.
- Development of potential gradations of mined materials using different mining techniques.
- Preparation of an annotated outline for the grouting technology.

1.2.4.6.2 SEALING TESTING**Status of Ongoing Activities**

Draft report SAND92-0960, "Field Testing Definition of Subsurface Sealing and Backfilling Tests in Unsaturated Tuff," by J. Fernandez, J. Case, and J. Tyburski is still undergoing internal technical peer review. The report has been in technical review for two months. As a result of this long review time, the completion of this report may continue into FY93.



1.2.5 REGULATORY AND INSTITUTIONAL

The objective of the Regulatory and Institutional element is to (1) conduct all activities involving licensing, environmental compliance, communication, and liaison with the State of Nevada, affected Indian tribes, and the public and (2) administer the grants mandated by the Nuclear Waste Policy Act (NWPA) of 1982.

1.2.5.1 MANAGEMENT AND INTEGRATION

Status Report on Ongoing Activities

Staff represented SNL on the public tour conducted at Yucca Mountain, NV on June 27, 1992. These tours are conducted monthly as part of the DOE public outreach program. A representative from each of the YMP participants is requested to staff the exhibits at the Field Operation Center (FOC) and answer questions that the public might have about the displays.

1.2.5.2 SITE CHARACTERIZATION PROGRAM

Status Report on Ongoing Activities

Support for the weekly meetings of the Integrated Test Evaluation effort continued.



1.2.5.2.5 STUDY PLAN COORDINATION

Major Accomplishments

Study Plan 8.3.1.12.2.1, Rev. 1, "Meteorological Data Collection at the Yucca Mountain Site," written by Science Applications International Corp. (SAIC) staff, was reviewed by staff in response to a Project Office request. The Review Checklist with no comments was submitted to the Yucca Mountain Site Characterization Project Office (YMPO) on June 3, 1992. (No SCP Activity)

Major Activities Upcoming Next Three Months

A joint YMP/HQ meeting has been set up for July 1, 1992 at SNL to address and resolve comments on Study Plan 8.3.1.4.3.1.1, "Systematic Acquisition of Site-Specific Subsurface Deformation-Systematic Drilling Program," by C. Rautman (SNL).

1.2.5.2.6 SEMI-ANNUAL PROGRESS REPORTS

Status Report on Ongoing Activities

The review draft of the Progress Report was received, reviewed, and approved.



1.2.6 EXPLORATORY SHAFT INVESTIGATIONS

The objective of the Exploratory Shaft element is to develop, design, construct, operate, maintain, and decommission the exploratory shafts required for site characterization and to plan and implement the in situ testing program.

1.2.6.1.1 **EXPLORATORY SHAFT MANAGEMENT, PLANNING, AND TECHNICAL ASSESSMENT**

Status Report on Ongoing Activities

Staff participated in a number of meetings to formulate a decision process for determining the need for a prototype facility. SNL provided input to several sections of the decision report, which will be finished in mid-July.



1.2.9 PROJECT MANAGEMENT

The objective of the Project Management element is to schedule, budget, perform, control, coordinate, and report Project management, Project control, and quality assurance work. This includes identifying and defining interfaces among Project elements and integrating those elements.

1.2.9.1.1 MANAGEMENT

Major Accomplishments

Four SAND reports were printed and distributed in June 1992:

- SAND87-2778, "G-Tunnel Pressurized Slot-Testing Evaluations," by R. Zimmerman (SNL), K. Mann, R. Bellman, and S. Luker (SAIC), D. Dodds (North Pacific Research), and C. Sifre-Soto (SNL);
- SAND89-7007, "Transportation Cask Decontamination and Maintenance at the Yucca Mountain Repository," by D. Hartman and D. Miller (Bechtel National, Inc.);
- SAND90-2491, "Summary and Evaluation of Existing Geological and Geophysical Data Near Prospective Surface Facilities in Midway Valley, Yucca Mountain Project, Nye County, Nevada," by J. Gibson (SNL), F. Swan, J. Wesling, T. Bullard, R. Perman, M. Angell, and L. DiSilvestro (Geomatrix); and
- SAND91-0607, "Preliminary Mapping of Surficial Geology of Midway Valley, Yucca Mountain Project, Nye County, Nevada," by J. Wesling, T. Bullard, F. Swan, R. Perman, and M. Angell (Geomatrix) and J. Gibson (SNL).

1.2.9.1.4 RECORDS MANAGEMENT

Major Accomplishments

Local Records Center (LRC) staff implementing procedure QAIP 17-3, "Processing, Storing, and Protecting YMP QA Records," was approved and is scheduled for distribution.

Significant Meetings Attended

LRC staff attended the DOE Records Management Conference in Englewood, CO from June 23-25, 1992.

Status Report on Ongoing Activities

Cross-training of LRC staff in the Data Records Management System (DRMS) function was completed. Development of supplemental modules for the On-the-Job Training (OJT) program for LRC staff continued. Work to revise the Master List of File Codes continued. Sorting of backlog records related to PDMs, Design Investigation Memos (DIMs), and Interaction Task Memos (ITMs) continued. Sorting of backlog records related to the SCP continued. Indexing of photographic negatives for the Nevada Test Site (NTS) photographic data base was completed. Slides, maps, and videos remain to be inventoried. A draft desk guidance for LRC statistics was completed.

Major Activities Upcoming Next Three Months

A revision to the Master List of File Codes will be issued.



**1.2.9.1.5 YUCCA MOUNTAIN SITE
CHARACTERIZATION PROJECT
(YMP) SUPPORT FOR THE
TRAINING MISSION**

Major Accomplishments

The recommendations of the Job Effectiveness Training (JET) Quality Action Team (QAT) were presented to the Technical Project Officer (TPO) by the training staff. The TPO accepted the recommendations which will be incorporated into the revision JET program.

Significant Meetings Attended

Staff attended the Annual American Society for Training Development (ASTD) Conference in New Orleans, LA, May 31 through June 4, 1992. Staff attended the quarterly Training Coordinator Meeting hosted by the Project Office Training Staff in June 17-19, 1992 in Las Vegas, NV.

Status Report on Ongoing Activities

The "Pulling It Together" technical orientation video module was filmed June 2, 1992 at Yucca Mountain. This video will be used to give new technical staff a cohesive overview of the issues and concerns of the site characterization process.

Two summer staff were added to the training function to support the implementation of the JET program and to complete the orientation module.

Major Activities Upcoming Next Three Months

Project Office training staff will perform an on-site evaluation of the SNL YMP training program on July 16, 1992. Their visit to SNL will also include a meeting with the TPO.

1.2.9.2 PROJECT CONTROL

Major Accomplishments

Major efforts of staff were focused on support of the YMP Mission 2001 schedule and resource planning activities. These efforts included setting up a workstation, establishing backup and restore procedures, developing and testing programs to import data automatically, and supporting the transfer of data to Las Vegas, NV from the workstation.

The 2001 Planning Exercise was completed June 22, 1992 with the successful electronic transfer of the SNL planning networks, work scopes, and budget data to the YMPO. Retransmissions of corrections to the initial data transfer have been completed during subsequent weeks. The May project status and cost data were successfully transmitted electronically during the second week of June 1992.

A procedure was developed and tested to support the electronic transfer of Monthly Status Reports to Las Vegas, NV using Internet and the VAX ALL-IN-ONE program.

Development of the Controlled Document System (CDS) data base for implementation on the Administrative Information Management System (AIMS) is under development. Design of the "Person" data table was reevaluated.

Status Report on Ongoing Activities

Code development for the AIMS Controlled Document System (CDS) element will be completed and installed in July 1992.

Major Activities Upcoming Next Three Months

The installation of the upgrade to the NOVELL server computer and software, used to support the Project Control processing, is scheduled to be performed during July 1992, based upon the arrival of the hardware and software upgrades.

Staff will attend Primavera training sessions in Las Vegas, NV in July and will assist with integration of schedules in Mission 2001.

The Project Control Steering Committee and advisors will meet in Albuquerque, NM to elect a new chair and co-chair.



1.2.9.3 QUALITY ASSURANCE PROGRAM

Major Accomplishments

One external audit was conducted during this month; activities being conducted by J. F. T. Agapito & Assoc. were examined. The audit report is being prepared and the audit resulted in two findings and two observations. Staff performed a review of the OCRWM Quality Assurance Requirements Document (QARD) "Draft" Rev. 0B and submitted comments to the OCRWM.

Status Report on Ongoing Activities

The procedure streamlining process continues. The following procedure revisions were issued or are in process:

<u>Procedure</u>	<u>Title</u>	<u>Status</u>
QAIP 1-2 QAIP 2-8	Organization Conduct and Reporting of Management Assessments	Issued (Rev. 03)
QAIP 5-1	QA Implementing Procedures	Issued
QAIP 5-4 QAIP 8-1	Use of AP-Qs Sample Identification and Handling Requirements	In review In review
QAIP 10-1	Surveillances	Prepare draft Issued
QAIP 16-3 QAIP 17-1	QA Program Report Preparing and Submitting YMP Records	In review Issued
QAIP 17-3	Processing YMP Records	Issued

One surveillance was performed during June 1992; QA criteria elements 3, 5, 6, and 17 were examined. The surveillance results are being prepared. YMP DOE QA staff accompanied the surveillance team as an observer.

Major Activities Upcoming Next Three Months

The YMP DOE QA Audit of SNL YMP Criteria elements 3, 5, 6, 17, 19, and 20 is scheduled to begin August 25, 1992.

An audit of a subcontractor, the National Center for Atmospheric Research (NCAR), is scheduled for August 1992.

Three surveillances are scheduled for the next quarter. Areas to be reviewed include QA program elements 20 and WBS activities 124512, 121441, and 1232222.

The improvement and simplification of SNL Quality Assurance Implementing Procedures (QAIPs) will continue, as will activity on the development of a new computer-network-based QA matrix.

Other Items to Report

Four Work Agreements were processed this month; two were placed with subcontractors and two were issued to internal SNL organizations.

APPENDIX A: REFERENCE INFORMATION BASE

APPENDIX B: TECHNICAL DATA BASE INPUT

1. REFERENCE INFORMATION BASE (RIB) CHANGE REQUESTS SUBMITTED

<u>RIBCR</u>	<u>Subject</u>	<u>Participant</u>	<u>Status</u>
None.			

1. CANDIDATE DATA FOR THE TECHNICAL DATA BASE

<u>Participant</u>	<u>Description of Data</u>
None.	

2. INFORMATION BEING PROCESSED AS RIB CHANGE DEVELOPMENT FILES FOR CONSIDERATION AS INPUT TO THE RIB

<u>RIBCR</u>	<u>Subject</u>	<u>Status</u>
CR58	Volcanic Features	Under Development
CR63	Estimated Water Usage	Review Complete
CR71	Potential Transportation Routes	Approved for Release 4/28
CR80	Water Application Movement	Under Development
CR81	Thermal/Mechanical Surfaces	Approved for Release 4/28
CR82	Topographic Maps	Approved for Release 4/28
CR83	Radiological Monitoring	Initiated

2. DATA FORMALLY SUBMITTED TO THE TECHNICAL DATA BASE

<u>Participant</u>	<u>Description of Data</u>	<u>SNL Data Auth. No.</u>
None.		

3. DATA FORMALLY ENTERED INTO THE TECHNICAL DATA BASE

<u>Participant</u>	<u>Description of Data</u>	<u>SNL Data Auth. No.</u>
	DA0158 - Thermal Expansion Data for Unsaturated Tuffs from Yucca Mountain, Nevada from SNL report SAND88-1581.	

3. INFORMATION ENTERED INTO THE RIB

None.

*Candidate information is identified by RIB Change Requests, which are prepared in accordance with Revision 0 of Yucca Mountain Project Administrative Procedure AP-5.3Q, "Information Flow Into the Reference Information Base," which is implemented at SNL as Department Operating Procedure (DOP) DOP 3-8.

