

LOS ALAMOS NATIONAL LABORATORY
YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT

Monthly Activity Report

December 1992

WBS 1.2.1 Systems Engineering

Objective The objective of this task is to integrate systems with the Geologic Repository Program, to describe the Yucca Mountain Site Characterization Project Mined Geologic Disposal System, and to evaluate the performance of the natural, engineered barrier, and total systems for meeting regulatory standards.

Activities and Accomplishments No significant activity this month.

Planned Activities None

Problem Areas None

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**WBS 1.2.3.1.1 Site Investigation Coordination and Planning/
Site Management**

Objective The objective of this task is to manage and coordinate site characterization activities.

Activities and Accomplishments Staff developed PACs work agreements with Los Alamos work-performing groups and divisions and confirmed their commitments to costs, schedules, and deliverables defined in the PACs FY93.

Staff hosted a meeting with Lawrence Livermore National Laboratory (LLNL) to discuss mineral alteration studies and radionuclide transport processes. LLNL work scopes were discussed and they were integrated with Los Alamos work scopes. Plans were made for follow-up meeting.

Staff participated in the cost reduction exercise for testing and attended a meeting in Las Vegas on 11 December to review the report.

Staff attended the Technical Advisory Group meeting in Albuquerque on 16 December.

Staff participated in the GIT teleconference on 21 December.

S. Bolivar attended the December meeting of the Sample Overview Committee at the Sample Management Facility. Nine sample requests were discussed; of these, two from B. Carlos were approved.

Planned Activities No planned activities reported.

Problem Areas None

**WBS 1.2.3.1.2 Site Investigation Coordination and Planning/
Test Management and Integration**

Objective The objective of this task is to manage and integrate ESF and Los Alamos site characterization test activities and to provide coordination for Los Alamos surface-based test planning and package development.

Activities and Accomplishments **ESF Testing.** Staff continued efforts to develop and administrative database merged with the YMP GIS to identify and track Los Alamos interfaces with other participant and project site characterization surface-based testing activities.

Surfaced-based Test Coordination. Staff participated in the second workshop on requirements and prioritization of the YMP surfaced-based testing program. Staff supported several meetings to address the clarification of test planning and job packages.

Planned Activities Continue evolution and support of the Los Alamos surface-based site characterization activities in response to the Project program directives

Problem Areas None

Publications None

WBS 1.2.3.2.1.1.1 Mineralogy, Petrology, and Rock Chemistry of Transport Pathways

Objective

The purpose of this activity is to define the important mineralogical and geochemical variables along fracture and rock-matrix transport pathways at Yucca Mountain, in support of performance assessment and to evaluate the impact of repository construction on natural waste-transport barriers.

Activities and Accomplishments

The study plan for this task was being revised to address changes in ESF design, in procedures, and in requirements for study plans. Minor modifications were also made to reflect NRC and auditor comments.

To determine the nature and extent of intergrowth with other minerals, calcite fragments were studied using scanning electron microscopy and x-ray diffraction. Results of these studies were incorporated in a paper entitled "Calcite Deposits in Fractures at Yucca Mountain, Nevada," which will be presented at the 1993 International High Level Radioactive Waste Management Conference (Las Vegas, NV, April 26-30, 1993). This paper summarizes petrographic, major-element, and trace-element studies on fracture calcites in both unsaturated and saturated portions of drill cores USW G-1, USW G-2, USW GU-3/G-3, and USW G-4.

Planned Activities

Work planned within the next few months includes the following activities: (1) continue analysis of fracture-coating zeolites in existing drill core and begin analysis of fracture-coating minerals in UE-25 UZ-16; (2) continue analysis of calcites to understand transport and precipitation mechanisms; (3) sample UE-25 UZ-16 for studies of stratigraphic variability in bulk mineralogy.

Problem Areas

None

Milestone Progress

3120
30 June 1992
Calcite in Fractures
Approved by YMPO.

3130
15 December 1993
Fracture Mineralogy of the Paintbrush Tuff
Expanded scope.

3137
30 September 1992
Mineralogy of Calico Hills for Adit Development
Submitted to TPO.

Publications

- D. L. Bish
Thermal Behavior of Natural Zeolites
Conference paper, *Zeolites '93*
In preparation.
- D. L. Bish and D. T. Vaniman
The Importance of Zeolites in the Potential High-Level Radioactive Repository at Yucca Mountain
Conference paper, *Zeolites '93*
In preparation.
- D. Broxton
Geological Evaluation of Six nonweleded tuff sites in the vicinity of Yucca Mountain, Nevada, for a surface-based test facility for the Yucca Mountain Project.
LA-series report
Submitted to TPO.
- B. Carlos, D. Bish, S. Chipera, and S. Craven
Fracture-Lining Manganese Oxide Minerals in a Silicic Tuff
Journal article, *Chemical Geology*
Approved by YMPO; revised and resubmitted for publication.
- B. Carlos, S. Chipera, and D. Bish
Distribution of Fracture-Lining Zeolites at Yucca Mountain, Nevada
Conference paper, *Zeolite '93*
Approved by YMPO.
- S. J. Chipera, D. L. Bish, and B. A. Carlos
Equilibrium Modeling of the Formation of Zeolites in Fractures at Yucca Mountain, Nevada
Conference paper, *Zeolites '93*
In preparation.
- G. D. Guthrie, D. L. Bish, and B. T. Mossman
Quantitative Analysis of Zeolite-Bearing Dusts Using the Rietveld Method
Journal article, *Science*
Submitted.
- D. Vaniman
Calcite Deposits in Fractures at Yucca Mountain, Nevada
Conference paper, *International High-Level Waste Management Conference*
Approved by YMPO.
- D. Vaniman, D. Bish, D. Broxton, B. Carlos, S. Chipera, and S. Levy
Mineralogy as a Factor in Radioactive Waste Transport Through Pyroclastic Rocks at Yucca Mountain, Nevada
Journal article, submitted to *Bulletin of the Geological of Society of America*.
- D. T. Vaniman
Calcite Deposits in Drill Cores USW G-2 and USW GU-3/G-3 at Yucca Mountain, Nevada
LA-series report
Submitted to TPO.

WBS 1.2.3.2.1.1.2 Mineralogical and Geochemical Alteration

Objective

The objective of this task is to characterize past and present natural alteration processes that have affected the potential geologic repository and to predict future effects of natural and repository-induced alteration.

Activities and Accomplishments

D. Bish met with representatives of YMP and Lawrence Livermore National Laboratory (LLNL) to discuss thermal effects. This meeting was a first step to coordinate research on the mineralogical effects of a repository. For example, the results of Bish's heating experiments on low water-rock ratios could provide guidance for the design of hydrothermal experiments with a flow-through apparatus at LLNL. Bish made a formal presentation on this subject at the December TPO meeting in Las Vegas.

S. Levy presented a talk, "Surface-Discharging Hydrothermal Systems at Yucca Mountain—Examining the Evidence," at the Materials Research Society Symposium on the scientific basis for nuclear waste management. The presentation addressed the controversy about the existence of recent hydrothermal systems discharging at the ground surface. Levy also chaired the symposium poster session.

D. Vaniman and S. Levy submitted data for the draft paper on calcite-silica deposits to the technical data base.

Planned Activities

The steam-heating experiments will continue, and the samples will be examined periodically for mineralogical changes. Chemical and mineralogical characterization of samples of bedrock breccias and hydrothermal deposits exposed at the surface will continue, as will K/Ar and calcite-silica laminated-deposit studies. We will begin using the new electron microprobe in early January.

Further discussions with LLNL on repository thermal effects are planned for early next year.

Problem Areas

None

Milestone Progress

3138
30 September 1993
Chemical Transport in Zeolitic Alteration
60% complete.

3141
31 March 1992
Laminated Zone in Trench 14
Completed on 3 August 1992.

3142
31 January 1993
K/Ar Dating of Clays and Zeolites
In technical review.

**Milestone Progress
(cont.)**

3341
30 October 1992
Surface-discharging hydrothermal systems at Yucca Mountain -- examining the evidence
Completed on 3 August 1992.

3143
16 March 1992
Experimental Dehydration of Volcanic Glasses
Completed on 3 August 1992.

3150
15 April 1993
Final Report on Bedrock
37% complete.

Publications

D. Bish and J. Aronson
Paleothermal and Paleohydrologic Conditions in Silicic Tuff from Yucca Mountain, Nevada
Journal article, *Clay and Clay Minerals*
Approved by YMPO; submitted.

S. Levy
Surface-discharging hydrothermal systems at Yucca Mountain -- examining the evidence
Conference abstract, *Materials Research Society Fall Meeting Abstracts, p. 603 (1992)*
Published.

S. Levy
Surface-discharging hydrothermal systems at Yucca Mountain -- examining the evidence
Proceedings paper, *Materials Research Society Fall Meeting*
Approved by YMPO; submitted.

S. Levy and C. Naeser
Bedrock Breccias Along Fault Zones near Yucca Mountain, Nevada
Chapter in USGS Bulletin on Yucca Mountain studies
In USGS editorial review.

S. Reneau
Manganese Accumulation in Rock Varnish in a Desert Piedmont, Mojave Desert, California, and Application to Evaluating Varnish Development
Journal article, *Quaternary Research*
Approved by YMPO.

D. Vaniman, D. Bish, and S. Chipera
Dehydration and Rehydration of a Tuff Vitrophyre
Journal article, *Journal of Geophysical Research*
Approved by YMPO.

D. Vaniman, S. Chipera, and D. Bish
Pedogenesis of Siliceous Calcretes at Yucca Mountain, Nevada
Journal article, *Science*
Approved by YMPO.

WBS 1.2.3.2.1.2 Stability of Minerals and Glasses

Objective

The objective of this activity is to produce a model for past and future mineral alteration in Yucca Mountain. The model is intended to explain the natural mineral evolution resulting from the transformation of metastable mineral assemblages to more stable assemblages and the effects of a repository emplacement.

Activities and Accomplishments

This activity has been deferred.

WBS 1.2.3.2.5 Postclosure Tectonics

Objective The objective of these volcanism studies is to determine the hazards of future volcanic activities with respect to siting a high-level radioactive waste repository at Yucca Mountain.

Activities and Accomplishments We received a memorandum from the U. S. Geological Survey, which documented the formal naming of the Lathrop Wells volcanic center in 1987; therefore, we will not change the name to the Cind-R-Lite center, as previously reported.

We received isotopic data from the University of Colorado on Sr, Nd, and Pb for basalt samples from Black Cone, Hidden Cone, and Little Black Peak Cone volcanic centers and interpret them as follows: Isotopic and trace element data for three eruptive units of the Little Black Peak Cone show no significant variations and are consistent with previous interpretations, which state that this center is monogenetic (formed in a single eruptive cycle). Isotopic data for Hidden Cone show little variability, but there are large variations in the concentrations of Sr, Sm, and Nd. Isotopic and trace element data from the northern and southern flows at Black Cone are consistent with previously reported INAA data. Since Sr and Nd isotopic ratios are lower for the southern flow compared with the northern flow, and concentrations of Sr, Nd, and Sm are slightly higher for the south flow, this new data support the interpretation that the northern and southern flow were derived from separate magma batches.

Staff prepared figures using SYSTAT for the Volcanism Status Report.

Work in Progress. The Volcanism Status Report section on tectonic setting of basaltic volcanism in the Yucca Mountain region was completed. Multiple tectonic models, which will be used for revised calculations of E2, the probability of repository disruption, were designed.

Processing of the paleomagnetic samples from the Lathrop Wells center continued; data collection for all major lava units should be complete by January 1993.

QA reviews of older field and scientific notebooks for this task continued.

Planned Activities We will obtain digital data from aerial photos of the Sleeping Butte and Quaternary basalt centers of Crater Flat and use them for volume calculations.

Problem Areas Surveying of trench sites on the Quaternary basalt centers of Crater Flat was canceled because of uncertainty in the requirements for safety for field activities. The surveys may not be rescheduled until February or March.

Milestone Progress

3034
30 September 1992
Report on Magma System Dynamics
Complete

3109
30 September 1992
Report of Subsurface Effects
Complete

3111
30 April 1993
Preliminary Geologic Mapping of Volcanic Centers

3164
30 March 1993
Progress Report on Thermoluminescence

R482
30 October 1992
Volcanism status report
First draft complete; revised draft due 1 March 1993.

Publications

B. M. Crowe, *et al.*
Volcanism Status Report
First draft complete; revised draft due 1 March 1993.

J. Poths and B.M. Crowe
Conference abstract, *Surface Exposure Ages and Noble Gas Components of Volcanic Units at the Lathrop Wells Volcanic Center, Nevada*
EOS 1992 73, p. 610.
Published.

WBS 1.2.3.2.8.1 Potential for Ash Fall

Objective	This activity will provide rock-varnish dating support for in various areas of surface site characterization activities including erosion, neotectonics, and paleoclimate.
Activities and Accomplishments	Staff met to plan FY93 rock-varnish dating support and field activities to identify potential sites for rock-varnish dating.
Planned Activities	As soon as the Erosion topical report is complete, we will begin field work.
Problem Areas	None
Milestone Progress	None
Publications	None

WBS 1.2.3.3.1.2.2 Water-Movement Tracer Tests

Objective	The objective of the water-movement tracer tests is to obtain measurements of chlorine isotope distributions to help quantify the percolation of precipitation in the unsaturated zone.
Activities and Accomplishments	<p>The revised study plan for the Water Movement Test was returned to the YMPO for verification of comment resolution. A comment resolution meeting is scheduled for January.</p> <p>Processing of nine additional cuttings samples from USW UZ-N-54 and N-55 began. These samples will be submitted to Lawrence Livermore National Laboratory for chlorine-36 analysis in January. Collection of cutting samples for ³⁶Cl analysis from UZ16 continued this month. Collection from USW UZ-N61, one of the Phase 2 neutron boreholes, also began this month.</p> <p>The Dionex AI-450 chromatography package was installed, and as a result we expect chloride and bromide analytical sensitivity to be greatly improved.</p> <p>One deficiency report was issued as a result of a LATA audit.</p>
Planned Activities	Address study plan review comments; revise existing DPs; prepare new DPs; process soil samples for Cl/Br and chlorine-36/Cl ratios; process cuttings samples from UZ-16 and neutron-access boreholes; collect additional soil samples from Yucca Mountain area as opportunities arise.
Problem Areas	None
Milestone Progress	3191 <i>Procedure for Chlorine-36 Analysis of Unsaturated Zone Samples</i> 30 September 1992 97% complete
Publications	None

WBS 1.2.3.3.1.2.5 Diffusion Tests in the ESF

Objective

The objective of this task is to determine *in situ* the extent to which the nonsorbing tracers diffuse into the water-filled pores of the Topopah Spring welded unit.

Activities and Accomplishments

This task has been deferred because of lack of funding.

WBS 1.2.3.3.1.3.1 Site Saturated Zone Ground-water Flow System (Reactive Tracer Testing)

Objective	Experiments will be conducted at the C-Well complex (holes UE-25c #1, UE-25c #2, and UE-25c #3) and other wells in the vicinity of Yucca Mountain using reactive tracers to characterize retardation and transport properties at a larger scale than currently used in laboratory experiments.
Activities and Accomplishments	<p>A paper on flow and transport through fractures prepared for the 1993 International High-Level Radioactive Waste Management Conference was completed. The authors used surface-profile data taken with a noncontact laser profilometer to determine the aperture distribution within a natural fracture and found the surfaces and apertures to be isotropic. They also found that the aperture spatial correlation varied over different areas of the fracture, with some areas being much more correlated than others. The fracture surfaces did not have a single fractal dimension over all length scales, which implied that they were not self-similar. Resolution aperture data (0.5- and 0.05-mm spacing between points, respectively) over the same subset of the fracture domain suggests that the spacing between the aperture data points must be less than the correlation length to obtain accurate predictions of fluid flow and tracer transport.</p> <p>This suite of experiments described above will continue, and detailed technical procedures will be written for transport experiments using both dissolved species and polystyrene microspheres as tracers.</p> <p>This task was the subject of an internal audit by LATA. A few minor deficiencies were noted and corrected during the audit.</p> <p>Staff continued to analyze the latest suite of lithium batch sorption tests.</p>
Planned Activities	<p>B. Robinson will continue to contribute to the SQA effort by serving as acting CCB chair.</p> <p>Staff will complete documentation of batch sorption experiments with lithium bromide, continue modeling studies using FEHMIN to support the design of field tests, and begin lithium column-transport studies.</p>
Problem Areas	None
Milestone Progress	<p>3188 30 September 1992 <i>Documentation for SORBEQ</i> Rescheduled to March 1993 because of personnel reassignment.</p> <p>3194 30 September 1992 <i>Batch Sorption Experiments with Lithium</i> Rescheduled to March 1993 because of personnel reassignment.</p> <p>T112 22 June 1992 <i>Final Documentation for FEHM</i> Rescheduled to June 1993 because of personnel reassignment.</p>

**Milestone Progress
(cont.)**

3196
27 July 1992
FRACNET Documentation
Rescheduled to August 1993 because of personnel reassignment.

Publications

B. A. Robinson
FRACNET—Fracture Network Model for Water Flow and Solute Transport
LA-series report
In preparation.

B. A. Robinson
SORBEQ—A One-Dimensional Model for Simulating Column Transport Experiments
LA-series report
In preparation.

B. A. Robinson
A Strategy for Validating a Conceptual Model for Radionuclide Migration in the Saturated Zone Beneath Yucca Mountain
Journal article, *Radioactive Waste Management and the Nuclear Fuel Cycle - Special issue on the Yucca Mountain Project*
Submitted to YMPO.

W. L. Polzer and E. H. Essington
The Use of Selectivity Coefficients to Estimate Modified Langmuir Isotherm Parameters as a Function of Experimental Conditions
Journal article, *Radioactive Waste Management and the Nuclear Fuel Cycle - Special issue on the Yucca Mountain Project*
Submitted to YMPO.

P. Reimus, R. Glass, and B. Robinson
Aperture Characteristics, Saturated Fluid Flow, and Tracer Transport Calculations for a Natural Fracture
Conference paper, *1993 High-Level Radioactive Waste Management Conference*
Approved by YMPO.

WBS 1.2.3.4.1.1 Ground-water Chemistry Model

Objective

The goal of this investigation is to provide conceptual and mathematical models of the ground-water chemistry at Yucca Mountain. These models will explain the present ground-water composition in relation to interactions of minerals and ground-water and will be used to predict ground-water compositions as a result of anticipated and unanticipated environments.

Activities and Accomplishments

Study Plan. Staff continued to review comments and revise the study plan for this task.

Other Activities. Staff continued modeling related to "most active ground-waters." Our goal is categorize ground-waters using the compositional variables that affect radionuclide solubility and/or sorption properties. The letter report on this subject due 30 September 1992 has been delayed until after a 2 March meeting with task members from Sorption, WBS 1.2.3.4.1.2.1, and Solubility, WBS 1.2.3.4.1.3.

Modeling of pH and Eh stability is underway.

Planned Activities

Continue resolution of comments on study plan.

Continue "most active ground-water" modeling with radionuclide and sorption input. Staff continued to collaborate with the USGS on water chemistry, stable isotopes, constraints on water composition, and the ground-water chemistry model.

Continue support of QA efforts and tracking of IMOU with Lawrence Livermore National Laboratory.

Problem Areas

None

Milestone Progress

3006
30 October 1993
Eh and pH Buffering Capacity

3415
30 May 1993
Letter report on Most-Active Ground-water Chemistry

Publications

None

WBS 1.2.3.4.1.2.1 Batch Sorption Studies

Objective	The objective of this task is to provide sorption coefficients for elements of interest to predict radionuclide movements from the repository to the accessible environment.
Activities and Accomplishments	<p>Staff developed a plan to study the effects of organic coatings on radionuclide sorption using batch sorption experiments; K. Kung, a clay organic chemist, is leading this research. Our objective is to determine the interfacial geochemical reactions that dominate the transport of radionuclides when organic materials are sorbed onto mineral surfaces. These experiments will also generate new data to improve the current sorption models that predict the mobility of radionuclides in the presence of organics.</p> <p>This research will be conducted in two phases. During the first phase, we will quantify the sorption of organics onto the surfaces of minerals such as Fe, Al, and Si oxides; clays; zeolites; and tuffs from Yucca Mountain. Magnetic and vibrational spectroscopy will be used to explain <i>how</i> organic sorption takes place. In the second phase, we will quantify the sorption of radionuclides onto organically coated mineral phases to determine the effect of organic coatings on the sorption of radionuclides.</p> <p>When the second phase is complete, we will begin studying sorption in systems containing multiple species, organics, and radionuclides. The experiments will address the competitive effect on sorption of mineral phase, organics, and radionuclides.</p> <p>We generated 1 kilogram of each of the following solid phases (intended for sorption experiments) in the size range of 75–500 μm: quartz, purified clinoptilolite, montmorillonite, and tuffs from G4-270 and 1508.</p>
Planned Activities	Next month we will begin experiments involving the sorption of a positively charged organic compounds onto quartz as a function of organic concentration at near-neutral pH.
Problem Areas	None
Milestone Progress	<p>3218 30 September 1993 <i>Effects of Water-Rock Ratios on Sorption Coefficients</i></p> <p>3345 30 June 1993 <i>Neptunium Sorption onto Feldspar</i></p> <p>3346 30 September 1993 <i>Sorption as a Function of Temperature</i></p>
Publications	None

WBS 1.2.3.4.1.2.3 Sorption Models

Objective

The objective of this task is to provide sorption models for elements of interest to predict radionuclide movements from the repository to the accessible environment.

Activities and Accomplishments

A paper for presentation at the International High-Level Radioactive Waste Management conference was completed. The author presented results of experiments to determine the dependence of sorption on sample grinding and on pre-conditioning with water of various compositions. The major conclusions were (1) Sorption R_d 's for representative Yucca Mountain tuffs, determined from batch measurements, do not depend on sample grinding for size fractions larger than about 65 μm . Thus, previous batch measurements, which for the most part used 63-500 μm or 75-500 μm size ranges for the crushed samples, should not contain (non-conservative) errors caused by sample grinding. (2) Water composition influenced the sorption behavior of the studied radionuclides, particularly Sr, Cs, and Np. Np sorption onto zeolitized tuff decreased by over a factor of three when the tuff was pretreated with J-13 water containing added Ca and Mg.

Although optical-microscopy examination of a natural surface (not freshly cleaved) revealed a number of pits in the surface, atomic-force microscopy of the same sample (conducted in air) showed a uniformly smooth surface. We believe that the explanation for this is that the natural surface was covered by a thin layer of another mineral that filled the pits and led to the detection of a smooth surface, and the mineral, which we think may be calcite, then dissolved in water to expose the pitted surface. Our results emphasize the fact that natural surfaces of the minerals in Yucca Mountain tuffs may be coated with other materials, and they may have very different sorptive properties. We believe it is important to develop ways to identify these surface coatings.

C. Ong of Stanford University began preparing silica and albite samples to be used in adsorption experiments with uranyl ion. The protocol for analyzing ^{232}U using liquid-scintillation counting is being customized, and the possible interference of chemiluminescence with the scintillation results is being investigated.

Planned Activities

Next month we will obtain images of freshly cleaved goethite surfaces under water, before and after reaction with acid etching agents, to determine the possible effects of adsorbed gases on previous scans, and to prepare and characterize surface samples for further reaction with adsorbates in solution.

Problem Areas

None

Milestone Progress

None

Publications

P. S. Z. Rogers
Dependence of Radionuclide Sorption on Sample Grinding, Surface Area, and Water Composition

Conference paper, 1993 International High-level Waste Management Conference
In internal review.

P. S. Z. Rogers, A.M. Meijer, and K. H. Kung
Sorption Characteristics of Yucca Mountain Tuffs as a Function of Particle Size
Conference abstract, *Materials Research Society Fall Meeting Abstracts*, p. 162 (1992)
Published.

WBS 1.2.3.4.1.2.2 Biological Sorption and Transport

Objective	The purpose of this research is to determine whether microbial activity can influence the movement of plutonium in tuff. Because fluids are used extensively in the exploration of locations for a nuclear repository, those micro-organisms capable of utilizing drilling fluids as growth substrates are of special interest.
Activities and Accomplishments	<p>Los Alamos. Work continued on crushed-tuff columns.</p> <p>UC Berkeley. Work on microbially mediated mineral dissolution continued, and experiments were conducted to develop an assay technique. Iron chloride or hematite (iron oxide) was added to nutrient plates void of iron, and bacterial growth was compared between the two, and to an iron-deficient control. The results of these experiments will be compared to experiments using broth cultures. We anticipate that the results will provide us with information regarding the importance of cell contact for mineral dissolution.</p>
Planned Activities	Complete milestones 3186, 3080, 3177, and 3092.
Problem Areas	None
Milestone Progress	<p>3080 30 September 1992 <i>Report on Chelation</i> Delayed.</p> <p>3092 30 September 1992 <i>Report on Colloidal Agglomeration</i> Delayed.</p> <p>3176 30 September 1992 <i>Procedure for Determination of Formation Constants</i> Delayed.</p> <p>3177 30 September 1992 <i>Procedure for Determination of Effects on Colloidal Agglomeration</i> Delayed.</p>
Publications	None

WBS 1.2.3.4.1.3 Radionuclide Retardation by Precipitation Processes

Objective

The objective of the solubility determination task is to determine the solubilities and speciation of important waste elements under conditions characteristic of the repository and along flow paths from the repository into the accessible environment.

Activities and Accomplishments

Speciation Studies. We determined the oxidation state of 250-nM Pu solutions at pH 8.5–9 as a function of bicarbonate concentration. As reported previously, we have already characterized three regions of Pu speciation by their optical signatures. We associated one Pu(IV) species with high NaHCO_3 ; however, we have not established the Pu oxidation state of the other two. We used PAS to test for the presence of the two other species: We prepared two 250-nM Pu solutions in 1.0 M bicarbonate, one with Pu(IV) and one with Pu(VI). (Previous NMR experiments with the Pu(VI) bicarbonate indicated that the oxidation state of this solution does not change, at least over the course of several weeks.) Whereas the absorbance of the Pu(IV) solution increased by only 0.08 units from 480 to 450 nm, the Pu(VI) solution increased by 0.30 units; therefore, we believe the results of this control experiment indicate that we can indeed observe the oxidation state for an unknown solution.

Two 250-nM unknown Pu solutions were made in 0.10-M NaHCO_3 and 0.003-M NaHCO_3 (which is very close to that found in J-13 water). The absorbance of the 0.10 M NaHCO_3 solution increased only 0.05, whereas that for the 0.003 M solution increased only 0.006 units. We believe the oxidation state for these solutions is 4+, and we found no evidence of a significant redox change.

Work continued on the Milestone 3330 entitled "Evaluation of Alternative Detection Schemes for Actinide Speciation using Photoacoustic Spectroscopy" by Tait et al, which describes the development phase of our PAS system. Staff continued to incorporate review comments on Milestone 3031, "Actinide(IV) and Actinide(VI) Carbonate Speciation Studies by PAS and NMR Spectroscopies," by Clark et al.

Solubility Studies. Work continued on the current undersaturation experiments in UE-25p #1 water. Staff prepared to determine the oxidation states of the three Pu undersaturation experiments. Following the determinations, Eh measurements will be made, the solid phases will be isolated and analyzed, and the experiment will be halted. In February, we will complete the americium/neodymium undersaturation experiments.

Milestone 3010 is in YMPO review. Staff submitted scientific records from 1986-1988 to the Los Alamos RPC. The following DPs were submitted: "X-ray Powder Diffraction by the Debye-Scherrer Method," LANL-LBL-DP-03, R1; "Operating and Calibrating a Low-energy Gamma-ray Counting System," LANL-LBL-DP-02, R1, "Operating and Calibrating the Mettler H6T Analytical Balance," LANL-LBL-DP-14, R0; and "Concentration Determination of Soluble Radionuclides from Data Provided by a Low-energy Gamma-ray Counting System," LANL-LBL-DP-01, R0.

Planned Activities

Efforts in all above mentioned areas will continue.

Problem Areas

None

Milestone Progress

3010

30 June 1991

Report on Measured Solubilities of Pu, Am, and Np in J-13 Ground-water from Oversaturation Conditions

Submitted 7/29/91

In YMPO review process; YMPO comments being addressed.

3031

30 September 1992

Actinide(IV) and Actinide(VI) Carbonate Speciation Studies by NMR and PAS Spectroscopies

Submitted for technical review.

3329

30 September 1992

Measured Solubilities and Speciations from Oversaturation Experiments of Neptunium, Plutonium, and Americium in UE25p #1 Well Water from the Yucca Mountain Region

Technical review completed; reviewer comments returned to LBL.

3330

30 January 1993

Evaluation of Alternative Detection Schemes in Photoacoustic Spectroscopy

In preparation.

3344

30 September 1993

Report on Comparison of Solubilities of Np, Am, and Pu Between J-13 and UE-25p #1 Waters

3350

30 September 1993

PAS Analysis of Pu(IV) Carbonate Systems

3351

30 September 1993

NMR Analysis of Np(V) and Pu(IV) Carbonate Systems

Letter Report

Spectroscopic Studies of the Hydrolysis of UCl_4 : Spectral Effects of Ligand Exchange

In preparation.

Publications

D. L. Clark, D. E. Hobart, P. D. Palmer, J. C. Sullivan, and B. E. Stout

*Carbon-13 NMR Characterization of Plutonyl(VI) Aqueous Carbonate Complexes*Journal article, *Journal of the American Chemical Society*

In preparation.

D. L. Clark, C. D. Tait, D. E. Morris, D. E. Hobart, S. A. Ekberg, and P. D. Palmer

Actinide(IV) and Actinide(VI) Carbonate Speciation Studies by NMR and PAS Spectroscopies

LA-series report

In preparation.

Publications (cont.)

D. L. Clark, J. G. Watkin, D. E. Morris, and J. M. Berg
Molecular Models for Actinide Speciation
LA-series report
In preparation.

L. E. Hersman, P. D. Palmer, and D. E. Hobart,
Preliminary Evidence of a Siderophore/Plutonium Complex
Journal article, *Journal of Applied and Environmental Microbiology*
In preparation.

D. E. Hobart, D. L. Clark, P. D. Palmer, J. C. Sullivan, and B. E. Stout
Carbon-13 NMR Characterization of Americyl(VI) Aqueous Carbonate Complexes
Journal article, *Inorganic Chemistry*
In preparation.

D. E. Morris and D. L. Clark
Spectroscopic Studies of the Hydrolysis of UCl_4 : Spectral Effects of Ligand Exchange
LA-series report
In preparation.

H. Nitsche, R. C. Gatti, E. M. Standifer, S. C. Lee A. Miller, T. Prussin,
R. S. Deinhammer, H. Maurer, K. Becraft, S. Leung, and S. A. Carpenter
*Measured Solubilities and Speciations of Neptunium, Plutonium, and Americium in a
Typical Ground-water (J-13) from the Yucca Mountain Region*
LA-series report
In YMPO review.

C. D. Tait, D. E. Morris, J. M. Berg and W. H. Woodruff
Evaluation of Alternative Detection Schemes in Photoacoustic Spectroscopy
Journal article, *Analytical Chemistry or Reviews of Scientific Instrumentation*
In preparation.

C. D. Tait, S. A. Ekberg, and P. D. Palmer, and D. E. Morris
Plutonium (IV) Carbonate Speciation Changes
Journal article, *Inorganic Chemistry*
In internal technical review.

WBS 1.2.3.4.1.4 Radionuclide Retardation by Dispersive, Diffusive, and Advective Processes

Objective

The objectives of this task are to determine the rate of radionuclide movement along the potential flow paths to the accessible environment and to examine the effect of diffusion, adsorption, dispersion, anion exclusion, sorption kinetics, and colloid movements in the flow geometries and hydrologic conditions expected to exist along the flow path to the accessible environment in the scenarios used for perform assessment.

Activities and Accomplishments

Staff continued investigating Np transport through Yucca Mountain tuffs and compared the results of batch sorption experiments with those obtained using crushed-tuff columns. Using a one-dimensional transport model within the code SORBEQ, the Np elutions through three crushed-tuff columns were fitted. The transport model incorporated advection, dispersion, and equilibrium sorption in a porous medium.

In the general case, the transport equation describing the migration of a solute in a saturated porous medium is given by Equation 1.

$$\nabla \cdot (D \nabla C - C U) = \varepsilon \frac{\partial C}{\partial t} + Q, \quad (1)$$

where

D = dispersion tensor,
C = concentration of solute in solution phase,
U = Darcy's velocity,
 ε = porosity of medium,
t = time,
Q = 0 for a non-reactive solute,
Q = $\rho_b \frac{\partial F}{\partial t}$ for a sorbing solute,
 ρ_b = bulk rock density, and
F = amount of solute sorbed per unit mass of solid.

Dispersion has three components: D_L , the longitudinal dispersion coefficient in the direction of the flow and D_T , the transverse dispersion coefficient in the two directions at right angles to the velocity of the flow. The longitudinal and transverse dispersion coefficients are given by Equations 2 and 3, respectively.

$$D_L = \varepsilon d + \alpha_L |U|, \quad (2)$$

$$D_T = \varepsilon d + \alpha_T |U|, \quad (3)$$

where

d = effective diffusion coefficient in medium, and
 α = dispersivity.

**Activities and
Accomplishments
(cont.)**

The mechanism of sorption determines the relationship between F and C. When sorption is linear, reversible, and instantaneous, the relationship between F and C is given by Equation 4, where K_d is the sorption coefficient.

$$\frac{F}{C} = K_d \quad (4)$$

Substitution of Equation 4 into Equation 1 yields Equation 5. The expression in brackets in Equation 6 is the retardation factor, R_f . Equation 6 provides a means of comparing results for sorption coefficients obtained under advective and diffusive conditions with the sorption coefficients obtained using batch sorption experiments. The expression for R_f (given in Equation 6) is only valid if sorption is linear, reversible and instantaneous. The code SORBEQ is capable of fitting elution data using Langmuir and the Freundlich isotherms, which are examples of non-linear relationships between F and C. In the case of Np reasonable fits were obtained using the linear relationship, given in Equation 4.

$$\nabla \cdot (D \nabla C - CU) = \epsilon \left[1 + \frac{\rho_b}{\epsilon} K_d \right] \frac{\partial C}{\partial t} \quad (5)$$

$$R_f = 1 + \frac{\rho_b}{\epsilon} K_d \quad (6)$$

The hydrologic parameters, mean residence time and the Peclet number (Pe), were determined for each column using the tritiated water elution data. They were then used to fit the elution of Np through the columns to obtain a value for the sorption coefficient. The same fit was obtained (as shown in Fig. 1) when the analytic solution to the one-dimensional version of Equation 1 was used to predict the elution data using the parameters listed in Table I.

Last month, we reported that the batch sorption coefficient (K_d) for Np in tuff G4-1530 using J-13 water was 2.4 ml/g. There is a good agreement between this result and the K_d we obtained this month by modeling (fitting the Np elution data). Consequently, we found no differences between Np retardation determined under flowing conditions and Np sorption determined via batch techniques.

Activities and
Accomplishments
(cont.)

Table I. Column Experiments for Np Elution

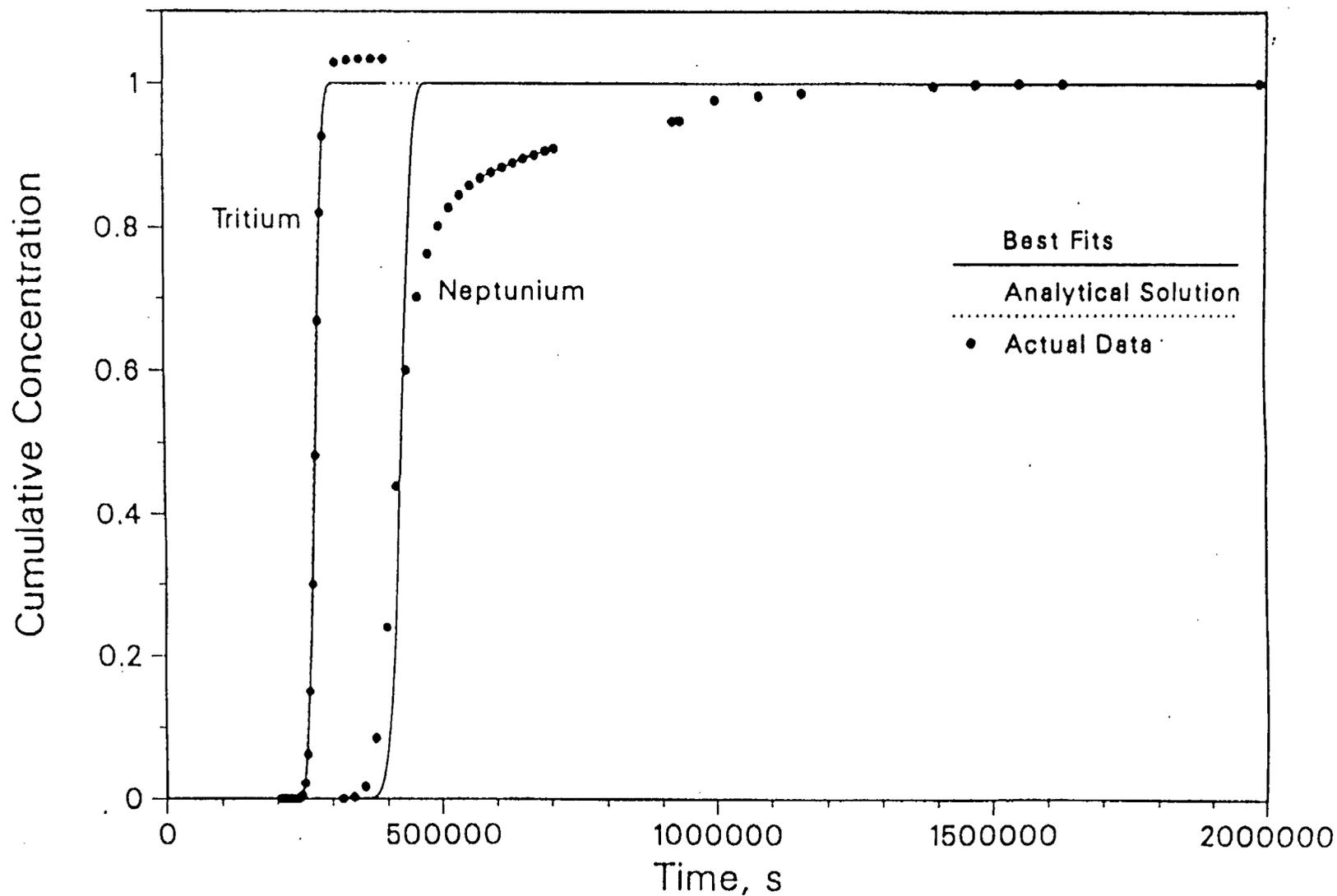
Solid: Tuff G4-1530
Particle Size: 75-500 μ m
Water: J-13
pH range: 8.1 - 8.4
Np Batch K_d = 2.4 ml/g

Column Parameters	Column #1	Column #2	Column #3
Length, cm	182	182	183
Diameter, cm	0.5	0.5	0.6
Volume, cm ³	32	32	58
Grams of Tuff	32	33	56
Density, g/ml	1.0	1.0	1.0
Porosity	0.4	0.4	0.4
Volumetric Flow	0.3 for tritiated water	1	1
Rate, ml/hr	1 for Np		
Interstitial Velocity	400 for tritiated water	1000	700
m/y	1000 for Np		
Mean Residence	75 for tritiated water	22	36
Time, hr	23 for Np		
P_c	1300	970	1500
Dispersivity, cm	0.14	0.19	0.12
Np K_d from fit, ml/g	1.6	1.7	1.9

Breakthrough Curves Through G4-1530

December 1992

Run 1



Planned Activities Work in all the above mentioned areas will continue.

Problem Areas None

Milestone Progress

3040
30 January 1993
Kinetics of Sorption on Columns of Pure Minerals
In internal review.

3044
30 January 1993
Measurement of Unsaturated Hydraulic Conductivity in Yucca Mountain Tuff
In internal technical review.

3065
Techniques to Study Diffusion in Saturated Tuffs
30 October 1992
In internal review.

3348
Colloid Workshop Report
30 September 1993

3349
Summary Report on Np Transport through Yucca Mountain Tuffs
30 September 1993

Publications

I. R. Triay, M. A. Ott, A. J. Mitchell, and C. M. Overly
Transport of Np through Yucca Mountain Tuffs
Conference abstract, *Materials Research Society Fall Meeting Abstracts, p.163 (1992)*
Published.

I. R. Triay, M. A. Ott, A. J. Mitchell, and C. M. Overly
Transport of Np through Yucca Mountain Tuffs
Conference paper, *Proceedings of the fall meeting of the Materials Research Society, November 30 - December 4, 1992 .*
In preparation.

A. Meijer
Far-Field Transport of Carbon Dioxide: Retardation Mechanisms and Possible Validation Experiments
Los Alamos letter report
In internal review.

J. Conca
Measurement of Unsaturated Hydraulic Conductivity in Yucca Mountain Tuff
LA-series report
In internal review.

WBS 1.2.3.4.1.5.1 Retardation Sensitivity Analysis

Objective

The objectives of this task are to construct a geochemical/geophysical model of Yucca Mountain and to use this model to examine the physical and chemical controls on radionuclide transport along flow paths to the assessable environment.

Activities and Accomplishments

Using FEHM, we continued work on three-dimensional grid generation techniques. The problem of ensuring positive transmission from the grid is being addressed.

Work on the three degree-of-freedom double porosity/double permeability model continued. This work is in the debug stage, and results are expected soon. A solution algorithm has been designed and implemented, and tests are continuing.

Fracture/Matrix coupling. FEHM: We continued investigating the equivalent continuum model for unsaturated flow. We are studying the relative flow through the fracture and matrix portions of the media under differing conditions as found at Yucca Mountain.

QA and Programmatic. The final package for the certification of TRACRN has been submitted and we are anticipating final approval.

Planned Activities

Begin calculations for ^{36}Cl transport.

Perform near-field double-permeability calculations to test the performance of various thermal-load designs.

Implement air/water diffusion for thermal calculations.

Complete certification of TRACRN.

Problem Areas

We have had problems designing strategies for tetrahedral generation from hexahedral data sets and assigning the appropriate properties to the tetrahedrals.

Milestone Progress

3052
30 January 1993
Baseline Documentation for TRACRN

Publications

None

WBS 1.2.3.4.1.5.2 Demonstration of Applicability of Laboratory Data

Objective

The purpose of this study is to design and conduct experiments to evaluate the applicability of laboratory data and to test models used in the radionuclide transport program to determine far field radionuclide transport. Both intermediate- and field-scale experiments and natural analogs will be assessed for their potential to provide the required data.

Activities and Accomplishments

This task has been deferred because of lack of funds.

Publications

C. Loeven
A Summary and Discussion of Hydrologic Data from the Calico Hills Nonwelded Hydrogeologic Unit at Yucca Mountain, Nevada (LA-12376-MS, 1992)
LA-series report
Published.

WBS 1.2.5.2.2 Site Characterization Program

Objective

The purpose of this task is to coordinate the regulatory Project requirements within the Los Alamos programmatic structure. The focus of this coordination effort is on the integration of the technical work within the regulatory framework.

Management and Integration

Staff supported cost reduction exercise meetings in Las Vegas on 1 and 10 of December. A review of the preliminary report was conducted.

Staff continue to support the Erosion and Calcite-Silica topical reports and the Volcanism status report.

Study Plans

Water Movement Test, R1 (8.3.1.2.2.2). Review comments on Rev. 1 of the Study Plan were received from the YMPO in May 1992; they were addressed and returned to YMPO in December 1992.

Diffusion Test in the Exploratory Studies Facility, R0 (8.3.1.2.2.5). In April 1992, this study plan was accepted by DOE. In June 1992 it was submitted to the NRC for review.

Testing of the C-Hole Sites With Reactive Tracers, R0 (8.3.1.2.3.1.7). In February 1992, DOE/HQ issued the study plan as a controlled document; it was then sent to the NRC for comments. In January 1992, we were requested by DOE to review revised NRC comments addressed by the USGS. The revision was completed and all comments were accepted by Los Alamos.

Ground Water Chemistry Modeling, R0 (8.3.1.3.1.1). This study plan was returned in May 1992 from YMPO review; comments are now being addressed.

Mineralogy, Petrology, and Chemistry of Transport Pathways, R0 (8.3.1.3.2.1). In January 1992, we submitted revised NRC comments to T. Bjerstedt. In August 1992, YMPO requested that we word process the changes to be incorporated in the revision; that revision is in progress.

History of Mineralogy and Geochemical Alteration at Yucca Mountain, R0 (8.3.1.3.2.2). The YMPO approved the study plan on 18 December 1991 and submitted it to the NRC on 31 January 1992.

Natural Analog Hydrothermal System in Tuff (8.3.1.3.3.1). This is an out-year activity.

Kinetics and Thermodynamics of Mineral Evolution and Conceptual Model of Mineral Evolution, R0 (8.3.1.3.3.2; 8.3.1.3.3.3). No progress during the recording period because of funding.

Sorption Studies and Sorption Modeling, R0 (8.3.1.3.4.1; 8.3.1.3.4.3). A new draft of the study plan was submitted to DOE for review in October 1992.

Biological Sorption and Transport, R0 (8.3.1.3.4.2). A revision addressing the Exploratory Shaft Design was submitted in September 1992.

Dissolved Species Concentration Limits, and Colloid Formation and Stability, R0 (8.3.1.3.5.1; 8.3.1.3.5.2). All YMPO comments on the study plan were resolved by the principal investigator in September 1992. Rev. 0 was submitted to YMPO for comment resolution, verification, and approval on 9 October 1992.

Study Plans (cont.)

Dynamic Transport Column Experiments, R0 (8.3.1.3.6.1). All YMPO comments on the study plan were resolved by the principal investigator in September 1992. Rev. 0 will be submitted to YMPO for comment resolution, verification, and approval.

Diffusion, R0 (8.3.1.3.6.2). All YMPO comments on the study plan were resolved by the principal investigator in September 1992. Rev. 0 was submitted to YMPO on 30 November 1992.

Retardation Sensitivity Analysis, R0 (8.3.1.3.7.1). This study plan was approved by the DOE and sent to the NRC for review in July 1992.

Demonstration of the Applicability of Laboratory Data to Repository Transport Calculations, R0 (8.3.1.3.7.2). This study plan is deferred because no funds were allocated.

Gaseous Radionuclide Transport Calculations and Measurements, (8.3.1.3.8.1). This study plan is deferred because no funds were allocated.

Probability of Magmatic Disruption of the Repository, R0 (8.3.1.8.1.1). A detailed technical review was complete in July 1992 by the NRC. In August 1992, a one-day video conference was held with the NRC to discuss their technical review comments. These comments are now being addressed.

Physical Processes of Magmatism and the Effects on the Repository, R0 (8.3.1.8.1.2). A draft study plan was submitted to DOE for review in October 1992.

Characterization of Volcanic Features, R0 (8.3.1.8.5.1). This study plan was accepted by NRC on 4 September 1990.

WBS 1.2.5.3.5 Technical Database Input

Objective The objective of this task is to coordinate input of technical data to the Project Technical Database (TDB) and the Automatic Technical Data Tracking System (ATDT).

Activities and Accomplishments Staff attended the Technical Data Advisory Group meeting on 3 December in Las Vegas, Nevada.

Staff submitted data from Activities 8.3.1.3.2.2.1, 8.3.1.3.2.1.2, and 8.3.1.6.1.1.3 to the ATDT.

Planned Activities Submit data from Activities 8.3.1.3.2.2.1, 8.3.1.3.2.1.2, and 8.3.1.6.1.1.3 to the TDB.

Submit calcite data to the TDB.

Submit erosion data to the TDB.

Problem Areas None

WBS 1.2.5.4.6 Development and Validation of Flow and Transport Models

Objective Model testing is necessary to assess performance at Yucca Mountain. This task will conduct an experiment in a caisson facility to provide a baseline of confidence in models for transport.

Activities and Accomplishments Testing of the 264 cups, which will be part of the lower-boundary condition apparatus, was completed. A special work permit was prepared so that instrumentation can be installed in the caisson. This permit is required for to ensure a safe work environment.

A paper entitled "Testing Models of Flow and Transport in Unsaturated Porous Media" is being prepared for the International High-Level Waste Management Conference.

Planned Activities Install lower-boundary condition apparatus as soon as special work permit is approved and weather conditions permit. Complete fabrication of manifold for soil solution sampling system, and construct soil solution samplers. Complete filling of the caisson.

Problem Areas None

Milestone Progress No FY93 milestones.

Publicatlons E. P. Springer, M.D. Siegel, P. L. Hopkins, and R. J. Glass
Testing models of flow and transport in unsaturated porous media
Conference paper, 1993 High-Level Radioactive Waste Management Conference
In preparation.

WBS 1.2.5.4.7 Supporting Calculations for Postclosure Performance Analyses

Objective

This task will provide documentation and results of calculations used in analyses of postclosure performance that supports design of repository, seals, and waste package and perform calculations of postclosure performance needed to support activities carried out under other performance assessment WBS elements.

Activities and Accomplishments

Staff met with Golder Associates on 17 December to discuss FRACMAN-FEHM interface. Topics discussed included (1) the common element types (two-dimensional elements in three-dimensional space) necessary for data exchange and (2) guidelines for completing intermediate tasks.

Planned Activities

No planned activities reported this month.

Problem Areas

None

Milestone Progress

None

Publications

None

WBS 1.2.6**Exploratory Studies Facility****Objective**

These Exploratory Studies Facility (ESF) tasks address the issues and information needs associated with the ES-based characterization of Yucca Mountain to determine the suitability of permanently isolating high-level nuclear waste from biosphere in a geologic repository.

Activities and Accomplishments

Staff continued to gather information on the use of tracers, fluids, and materials (TFM) at Yucca Mountain with emphasis on FY 1993 ESF-related activities. Waste isolation impact and test interference analysis for the TFMs were requested from the M&O. Staff prepared briefings and attended weekly ESF management meetings.

Staff also prepared papers on TFM and on ESF test prioritization and coordination, which will be presented at the 1993 High-Level Radioactive Waste Management Conference.

Staff prepared briefings and attended weekly ESF management meetings and participated in weekly Field Engineering/PA/QA meetings.

Staff prepared agenda for meeting with Lawrence Livermore National Laboratory (LLNL) on heater test to be performed in the ESF; it will be held at LLNL on 6 January.

Planned Activities

We will continue to develop definitive design-related information for tests to be performed in the launch chamber and to support integration meetings such as ESF design, TIG, SMF, and surface-based testing and its interface with ESF testing. We are developing ESF testing networks integrated with test planning, ESF design, and ESF construction. We are coordinating the approval, funding, and implementation of a design verification testing and monitoring plan submitted by SNL for implementation in the starter tunnel. Requested CRWMS M&O to provide information on IDS requirements for ESF construction monitoring.

Staff will participate in ED&D weekly ESF management review meetings.

Staff will participate in weekly Field Engineering/PA/QA meetings.

Publications

N. Elkins

Prioritization of ESF Testing and Integration with Design and Construction
Conference paper, *International High-Level Waste Management Conference*
Approved by YMPO.

H. Kalia

Control of Tracers, Fluids, and Materials for the Yucca Mountain Site Characterization Project
Conference paper, *1993 High-Level Radioactive Waste Management Conference*
Approved by YMPO.

H. Kalia

Test Facilities for High-Level Radioactive Waste Management
Conference paper, *34th US Symposium on Rock Mechanics*
Approved by YMPO.

Problem Areas

None

WBS 1.2.6.8.4 Integrated Data System

Objective

The integrated data system (IDS) supports the Exploratory Studies Facility (ESF) test program by providing a central facility to automatically measure and control aspects of the ESF tests. The primary purposes of the IDS are to assist the principal investigators (PI's) in acquiring high-quality test data in a uniform, controlled fashion and to transfer those data to the PI's organizations for data management and analysis.

Activities and Accomplishments

Staff transmitted a paper on the Integrated Data System for ESF to the Second International Symposium on Mine Mechanization and Automation in Sweden.

Staff attended IDS briefings to Project Office by CRWMS M&O, and visited N-Tunnel at NTS to assess underground monitoring equipment used at the NTS.

Planned Activities

No planned activities reported.

Publications

H. Kalia

Acquisition of Test Data from the Exploratory Studies Facility for the Yucca Mountain Site Characterization Project

Conference paper, *Second International Symposium on Mine Mechanization and Automation*

Approved by YMPO.

Problem Areas

None

WBS 1.2.9.1.2 Technical Project Office Management

Objective

The objective of this task is to manage the Los Alamos Yucca Mountain Project Site Characterization Program.

Activities and Accomplishments

Management staff attended the TPO and TAG meetings, participated in cost reduction exercises, and finalized FY93 commitments.

The TPO determined that ES&H assistance was needed, and even though DOE provides no funds for this purpose in WBS 1.2.3 or 1.2.5, ES&H staff was identified through Los Alamos Technical Associates. The TPO will only support ES&H work that is legally required and discourage participation in Project committees such as ALARA.

WBS 1.2.9.2.2 Project Control

Objective

The objective of this task is to support management's efforts in planning, scheduling, and controlling the technical work. This task will develop, implement, and maintain computerized cost, schedule, and technical milestone data bases and develop strategies to meet management information requirements.

Activities and Accomplishments

Staff attended a Project Control Steering Committee meeting in Las Vegas 3 December.
The PACS status report was submitted on 9 December.

Planned Activities

FY 1995 DOE Unicall budget submission.

Problem Areas

We are concerned because B&R reclassification appears to be very disorganized, and we have received very little guidance about how to identify the new B&Rs. When we did finally receive guidance, only a small amount of time was devoted to bringing Los Alamos accounts in line with the DOE. We are also concerned because we see no communication between DOE/YMP and DOE/ALO.

WBS 1.2.11.2/3**Quality Assurance Program Development, Verification, and Engineering****Objective**

The Quality Assurance (QA) Program supports Los Alamos Yucca Mountain Site Characterization Project participants and ensures that their efforts provide data and evidence admissible for the repository-licensing process.

**WBS 1.2.11.2
Program
Development**

Program Development. One Q meeting was held. Activities for 1992 were examined and outstanding 1992 action items were discussed. New Project personnel were identified, and QAL assignments were issued. Tentative goals for 1993 were identified, the major one being to implement the QARD as soon as possible. The internal quality assurance contract for FY93 effort was reviewed and approved.

Procedure Revisions. Twenty-three quality administrative procedures (QPs) are in various stages of revision. Procedure QP-2.9 (Personnel Proficiency Evaluations) will be combined with QP-02.7 (Personnel Training). Procedures QP-03.5, R1 (Documenting Scientific Investigations) and QP-06.1, R5 (Document Control) were issued. Detailed Technical procedures LANL-INC-DP-94, R0 (Using Ion Chromatography to Determine Chloride and Bromide Concentrations) and LANL-EES-DP-119, R2 (Moisture Evolution Analyzer Procedure) were also issued.

**WBS 1.2.11.3
Audits and Surveys**

Audit plans LANL-AR-92-13 (EES-4 and EES-15), LANL-AR-92-08 (INC Division), and LANL-AR-92-17 (EES-13 software) were approved and the audits conducted. The 1992 audit schedule was revised and issued. Internal stop work order SWO-LA-06 was lifted. The QAPL completed his evaluation of the 1992 Management Assessment Report.

**WBS 1.2.11.5
Quality Engineering**

One CCB meeting was held. A Software Management Status Report was compiled and issued.

Planned Activities

The training coordinator will continue development of training classes for QPs-17.4 and -17.5. Outstanding 1992 audit reports will be completed. QP revisions will continue; procedures QP-06.2 (Preparation of QPs) and QP-06.3 (Preparation of DPs) will be completed. Corrective actions for CARs YM 93-018 and YM 93-019 will be completed. Completion of corrective actions for Los Alamos stop work order SWO-03 will be verified and the stop work order lifted. Efforts to close out all 'old' notebooks will continue. Compilation of the 1992 Quality Assurance Status Report and development of a schedule to implement the new QARD will begin.

Problem Areas

None

Publications

S. Bolivar and J. Day

The Quality Assurance Liaison—Combined Technical and Quality Assurance Support
Conference abstract

Approved by YMPO.

**WBS 1.2.12.2/2.5
1.2.13**

Local Records Center Operations/Records Management and Document Control

Objective

The objective of this task is to satisfy the records management requirements of the YMP and NQA-1.

Activities and Accomplishments

Forty-seven records and/or records packages were received by the RPC; eight of these were rejected and sent back to the originators for corrections.

Te CRF did not reject any records and/or records packages. The RPC resubmitted 8 records to the CRF that had been previously returned for corrections.

Planned Activities

A Minolta 607Z microfilm reader/printers will be purchased for the RPC.

The records procedure should be ready for review by 22 January.

Problem Areas

None

WBS 1.2.15.2 Administrative Support

Objective The objective of this task is to provide administrative support for Group EES-13 and the YMPO.

Activities and Accomplishments Editor reviewed and edited five technical information products (TIPS) and following TPO review and approval, forwarded them to YMPO.

Editor prepared YMP weekly updates for December and highlights for November and transmitted them to the M&O and YMPO. Editorial staff completed the YMP Monthly Activity Report for October.

Planned Activities S. Klein will design a customized database to track TIPS in January.

Problem Areas None

WBS 1.2.15.3 Training

Objective The objective of this task is to fulfill the training requirements of the Yucca Mountain Project and maintain appropriate training records.

Activities and Accomplishments No activities reported this month.

Planned Activities No planned activities reported this month.

Problem Areas None

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February 1993

Highlights from Los Alamos

WBS 1.2.3.2.1.1.1 (Mineralogy/Petrology)

D. Vaniman visited the Sample Management Facility on 2/23-2/24 to describe portions of drill core UE-25 UZ-16 for sampling. The samples will be used for two studies important to the mineralogy of transport pathways: (1) systematic samples at spacings less than 20 ft. will be used to define vertical variations in mineralogy, and (2) distributed bulk samples of the lower Topopah Spring Member and of the tuff of Calico Hills will be used to concentrate trace minerals for sorption studies. In contrast to previous sampling of other drill cores for XRD mineralogy, sample spacing for new core is closer and is particularly focused on the critical barriers between the welded Tiva and Topopah units and between the potential repository horizon and the water table. About half of UZ-16 was described; the remainder will be described for sampling after drilling is completed.

D. Vaniman continued to work on the review of the Erosion topical report.

B. Carlos examined fractures in core from UE-25 UZ-16 at the SMF and selected samples for further analysis.

D. Bish S. Chipera, and G. Guthrie continued to prepare the LAMS report on the distribution of hazardous minerals at Yucca Mountain (Milestone 3352). R. Raymond and G. Guthrie collected several dust samples in the vicinity of UZ-16 in order to assess the background levels of dust and the changes to the background that may have resulted from operations at UZ-16. Arrangements were also made to have air-filter samples collected by D. Chapman of SAIC.

G. Guthrie responded to inquiries by TRW about the potential hazards associated with mordenite at Yucca Mountain. The TRW data banks suggested that mordenite was carcinogenic. However, Guthrie prepared a memo discussing the available data on mordenite, none of which indicate that the mineral is carcinogenic.

WBS 1.2.3.2.1.1.2 (Mineralogic and Geochemical Alteration)

D. Bish and S. Levy attended a workshop to discuss thermal loading concerns with LLNL personnel. In particular, we discussed the assumptions inherent in the calculations performed by T. Buscheck and J. Nitao and how mineralogical and petrological features are important in the modeling. Bish presented data on the mineralogic effects of short- and long-term heating of zeolites, smectite, and glass and emphasized that these phases can be affected simply by changing the water vapor pressure. Levy talked about natural hydrothermal alteration that occurred during the cooling of Topopah Spring pyroclastic deposit as a self-analog for repository effects. The workshop identified numerous experimental and modeling needs that are important in understanding the behavior of a "hot repository."

WBS 1.2.3.2.3.1.A (Volcanism)

Revised probability calculations of the recurrence rate of volcanic events (E1), the disruption ratio (E2) and the probability of magmatic disruption of the repository, the controlled area, and the Yucca Mountain region ($\text{Pr}(E2 \text{ given } E1)\text{Pr}(E1)$) have been completed. The emphasis of the revised calculations is to assess the most likely, the minimum and the maximum values of the probability attributes in preparation for simulation modeling to establish probability distributions. This is different from previous work where the calculations were designed to establish probability bounds. The most likely value of the probability of magmatic disruption of the repository is < 1 in 10,000 in 10,000 years. The most likely values of the probability of magmatic disruption of the controlled area and the Yucca Mountain region are > 1 in 10,000 in 10,000 years. Three samples were analyzed for cosmogenic helium during the month. The measured cosmogenic He age of the sample is 3 ± 5 ka.

WBS 1.2.3.4.1.2.1 (Batch Sorption Studies)

This month we performed batch sorption experiments to study the effect of organic coatings on metal sorption onto minerals available in the tuff at Yucca Mountain.

The results indicate that the sorption of Cd onto Fe oxide is enhanced by the presence of the organic coating; however, Cd sorption onto Al oxide decreases as the amount of organic coating increases. The enhancement or decrease of Cd sorption was not very large (20%).

WBS 1.2.3.4.1.3 (Radionuclide Retardation by Precipitation Process)

P. Palmer, a technician working on the Los Alamos YMP Radionuclide Solubility Task team for the past 9 years, has recently received the American Chemical Society's National Technician of the Year Award for his outstanding work. Palmer received recognition by the New Mexico regional ACS in 1991.

We have obtained results for our UV/Vis absorption study on NpO_2^+ species in (bi)carbonate media. At least three species have been observed (consistently) for 0.4 mM Np at 0.9 M (bi)carbonate concentrations from pH 8.4 to 13. This information will serve as a starting point for parallel NMR studies as well as bicarbonate concentration and temperature dependent UV/VIS experiments.

The neptunium undersaturation experiment at pH 8.5 was concluded by examining the last of the supernatant by adsorption spectroscopy. All of the Np(V) in the pH 8.5 solution was complexed by carbonate.

Most task members will be attending the 205th National Meeting of the American Chemical Society to be held in Denver, CO, March 28 - April 2, 1993. Palmer will receive his National Technician of the Year Award at this meeting.

WBS 1.2.3.4.1.4.1/2 (Radionuclide Retardation by Dispersive, Diffusive, and Advective Process)

This month we initiated two sets of experiments to further study the transport of Np through Yucca Mountain tuffs. The first set consists of studying the kinetics of sorption of Np using

wafers made of intact tuff which are placed in contact with a Np solution in water from the well J-13 or UE-25 p#1. Aliquots from the Np solution in contact with the tuff wafer are taken as a function of time so that the uptake of Np by the wafer can be determined. The wafers were made of tuffs: G4-270 and G4-1532. Next month we will report the results of these studies.

The second set of experiments involves eluting a Np solution through crushed tuff columns in order to determine whether Np sorption onto tuff is reversible, linear, and instantaneous in waters from the wells J-13 and UE-25 p#1. Four crushed tuff columns are in preparation from tuffs: G4-270 and G4-1506. This month we are establishing flow rates through the columns with waters from the well J-13 and UE-25 p#1.

WBS 1.2.5.3.5 (Technical Database Input)

Submitted Erosion Data to the technical database.



Reynolds Electrical & Engineering Co., Inc.

Post Office Box 98521 • Las Vegas, NV 89193-8521

MAR 8 9 12 AM '93

I-338426-7

IN REPLY REFER TO:
580-01-293

WBS 1.2.9.1
QA: N/A

March 4, 1993

Carl P. Gertz, Project Manager
Yucca Mountain Site Characterization
Project Office
U.S. Department of Energy
Post Office Box 98608
Las Vegas, NV 89193-8608

YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT (YMP) STATUS REPORT (SCP: N/A)

Attached is the February YMP Status Report for Reynolds Electrical & Engineering Co., Inc.'s participation in the YMP.

If further information is required, please contact Rene' R. Knott at 794-7193.

Bruce Scudella For R.F.P.

R. F. Pritchett, Manager
Yucca Mountain Project Division
YMP Technical Project Officer

RFP:RRK:mab

Enclosure
Status Report (3 pages)

cy: See page 2

Gertz
Sampton / Petrus
Blanchard / Simecka
 CC: *Deaton / Williams*
 CC: *Dyer / Wilson*
 CC: *Harrison / Bekkop*
 CC: *Hutchinson / Brodsky*
 CC: *Lasin / H. Kay*
 CC: *Jones, S. / Stucker-2020*

REC'D IN YMP
3/5/93

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ENCLOSURE 43

Carl P. Gertz
580-01-293
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March 4, 1993

cy w/encl.

Information Services Center, M/S 408
C. E. Hampton, DOE/NV, M/S 505
L. M. Smith, DOE/NV, M/S 505
M. B. Blanchard, DOE/YMP, M/S 523
W. R. Dixon, DOE/YMP, M/S 523
J. R. Dyer, DOE/YMP, M/S 523
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B. D. Hutchinson, DOE/YMP, M/S 523
V. F. Iorii, DOE/YMP, M/S 523
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E. H. Petrie, DOE/YMP, M/S 523
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L. D. Foust, M&O, M/S 423
M. M. Martin, M&O, M/S 423
R. L. Robertson, M&O/Fairfax, VA
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W. J. Glasser, REECo, M/S 408
J. L. Henze, REECo, M/S 751
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R. B. Land, REECo, M/S 585
T. M. Leonard, REECo, M/S 408
K. L. Limon, REECo, M/S 408
C. J. Mason, REECo, M/S 751
M. L. Pochowski, REECo, M/S 706
S. O. Straub, REECo, M/S 408
J. R. Trujillo, REECo, M/S 590
M. Brodeur, SAIC, M/S 517/T-23
R. D. Hutton, SAIC, M/S 517
P. L. Osborne, SAIC, M/S 517/T-12
S. C. Smith, SAIC, M/S 517/T-10
J. W. Teak, SAIC, M/S 517
J. E. Therien, SAIC, M/S 517



**REYNOLDS ELECTRICAL & ENGINEERING CO., INC.
(REECO)**

YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT (YMP)

FEBRUARY 1993 - STATUS REPORT

Reeco has no reportable Level 0 or Level 1 Milestones.

SITE (1.2.3)

WBS 1.2.3.2

Task: USGS Integrated Data Acquisition System (IDAS)

Continued support of IDAS to include technical support, equipment testing, maintenance and repairs.

WBS 1.2.3.5

Task: Capital Equipment to support Drilling Programs

Procurement is in progress for the following drilling support equipment: Cuttings/handling system, bag house, and data recorder and monitors. The Class XIII drill was accepted and should be put into service during March 1993 on the NRG-5 North Portal Ramp Borehole.

Task: UZ-16 Drilling and Testing (Job Package 92-3)

Depth of the 4.380-inch core hole was 1620.22 feet at period end. Reached the water table at approximately 1614 feet. The 12 1/4-inch reamed hole depth was 1598.94 feet at period end. Anticipated total depth of this hole is approximately 1689 feet.

Task: NRG-6 Drilling and Testing (Job Package 92-11)

The 6 5/8-inch casing landed at 317 feet from the surface. The 5 1/2-inch core hole depth was 1047.96 feet. Anticipated total depth to be cored is approximately 1100 feet. Double shift terminated on February 26, 1993; single shift to begin March 1, 1993.

Task: NRG-2 North Portal Ramp Borehole (Job Package 92-19)

Completed drilling/coring; awaiting geophysical logging program.

Task: Borehole Security Program

Borehole Security Program Nos. 1, 2, 3, 5, and 6 are complete. Program No. 4 has not been issued.

REGULATORY (1.2.5)

WBS 1.2.5.2.4

Task: Site Characterization Plan (SCP) Reference Library and Database

Continued distribution and database maintenance for the SCP and Progress Reports. Distributed four SCP sets and thirty copies of Progress Report #6 during this reporting period. Two hundred twenty



copies of Progress Report #7 were provided to the Technical Information Section for distribution at professional conferences.

EXPLORATORY STUDIES (1.2.6)

WBS 1.2.6.1

Task: Exploratory Studies Facility (ESF)

Continued administrative support for ESF activities to include; planning, scheduling and management. Prepared one Technical Control Procedure and three Construction Inspection Plans during this period.

Request for Proposal (RFP) for the Tunnel Boring Machine closed February 9, 1993 and the Technical Evaluation Team commenced proposal evaluation.

Received DOE approval of the Source Selection on the RFP for Technical Support and Underground Excavation for the ESF on February 23, 1993. Preaward audit requested through REEC's internal audit on February 24, 1993.

Awarded purchase order for resin and grouted rockbolts on February 1, 1993. The RFP for Tunnel Arch Structure was approved by the Procurement Review Team on February 26, 1993.

Task: ESF North Portal Pad & Facilities (Job Package 92-20)

Continued cut and fill at the North Portal Pad area; continued excavation of north and south drainage channels; completed tortoise fencing and separation fencing at Borrow Pit No. 1; began discing vegetation at Borrow Pit No. 1; began and completed construction of haul road from Borrow Pit No. 1 to the North ESF Pad; supported mapper and photographers for first cut; completed rockbolt and wire cut at north ESF boxcut; began hauling common fill from Borrow Pit No. 1 to the North ESF Pad; continued removal and storage of topsoil at Borrow Pit No. 1; completed installation of split set rockbolts at second phase of north ESF boxcut (125 bolts to date); washed high walls and wing walls for second mapping exercise; pinned wire mesh to split set rockbolts with insert bolts; and drilled and installed 10-foot split sets above portal area for personnel safety.

TEST FACILITIES (1.2.7)

Task: Field Operations Support

Continued logistical and tour support for DOE Yucca Mountain Site (YMSO) staff. Eleven tours were held during this period with 561 people attending. Support included but was not limited to arrangements for buses, registration of guests, coordination of lunches/beverages, medical service, furniture, and mechanical service. Continued preparations for upcoming tours.

Continued support services to participants, and maintenance of YMP utilized facilities, utilities, equipment and roads in Area 25. The vendor returned to perform repairs to the membrane roof of Building 4015 in Area 25.



PROJECT MANAGEMENT (1.2.9)

WBS 1.2.9

Task: Technical Project Office Management/Project Control

Continued normal administrative level of effort support. Continued status and update of Planning and Control System (PACS); supported ESF Construction activities, drilling activities and completed cost estimates as required.

QUALITY ASSURANCE (1.2.11)

WBS 1.2.11

Task: Quality Assurance

Continued normal administrative level of effort support. DOE/YMP QA completed Audit No. YMP-93-06 of the REECo/YMP QA Program. The audit evaluated the following criteria: Organization; QA Program, Instructions, Procedures and Drawings; Document Control; Control of Measuring & Test Equipment (MT&E); Handling, Storage & Shipping; Corrective Action; QA Records; and Audits. All areas were satisfactory with the exception of M&TE, which had one finding identified on a DOE Corrective Action Request.

ENVIRONMENT, SAFETY & HEALTH (1.2.13)

WBS 1.2.13

Task: Safety & Occupational Health

Provided medical, occupational safety, industrial hygiene, and fire protection support. Continued participation in the update of the Five-Year Safety and Health Plan.

Per Project Office direction, initiated development of underground safety and health training program. This training will be provided to any persons accessing the underground facility, including experienced and inexperienced workers, and visitors. Program development will be completed in early March, 1993.

Held a postaward conference for Environmental Technologies (ET) to review subcontract requirements and policies prior to their start of work on February 22, 1993. The Subcontract is for the removal of approximately 1,224 tons of oil stain from Area 25 and transportation to their facility in Las Vegas for remediation. As of February 26, 1993, the Subcontractor had removed approximately 1,100 tons of soil for remediation. The Subcontract will require modification to remove an additional amount of approximately 1,200 tons.

SUPPORT SERVICES (1.2.15)

WBS 1.2.15

Task: Administrative Support and Training

Continued to provide procurement, logistical, and information management administrative level of effort support; continued support services to various YMP participants.



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CHARACTERIZATION
PROJECT**

Monthly Status Report

January 1993

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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CHARACTERIZATION
PROJECT

Monthly Status Report

January 1993

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Highlights

SNL staff digitizes the cross sections associated with the geologic map of Yucca Mountain (Scott and Bonk, USGS Open-File Report 84-494); the welded and nonwelded lithologies are coded into indicators with geographic coordinates.

See **1.2.3.2.2.2 Three-Dimensional Rock Characteristics** on page 4

SNL staff completes initial planning for geotechnical monitoring associated with proposed north portal and starter tunnel construction and works with USGS staff to define and conduct thermal and mechanical tests on core from the north ramp holes.

See **1.2.4.1.1 Repository Coordination and Planning** on page 9

Highlights, Continued

SNL staff develops, implements, and tests a new data reduction scheme for the ongoing laboratory Hilbert Transform-based experiments involving small polycarbonate models.

See **1.2.4.2.1.2 Rock Mass Analysis** on page 12

SNL staff meets with members of the Management and Operations Exploratory Studies Facility (ESF) design group to identify and define analyses to support the north ramp design.

See **1.2.4.2.3.2 Design Analysis** on page 13

SNL staff completes SLTR92-0005, the document describing the performance assessment plan for the ESF Title II design support. SNL staff also submits recommendations for controls on surficial water usage and locations of surficial ponds for inclusion in Appendix I of the ESF Design Requirements document and the Surface-Based Testing Field Requirements document.

See **1.2.5.4.7 Supporting Calculations for Postclosure Performance Analyses** on page 23

SNL staff completes the first four major steps in the Transition Plan of the Office of Civilian Radioactive Waste Management Office of Quality Assurance.

See **1.2.11 Quality Assurance** on page 27

WBS Elements Without Reportable Activity This Period

1.2.1.2.1	Program Level Requirements Document Development
1.2.1.2.2	Project Level Requirements Documents Development and Maintenance
1.2.2.4.3	Container/WP Interface Analysis
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YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT

EXECUTIVE SUMMARY JANUARY 1993

WBS 1.2.3.2.2.2 Three-Dimensional Rock Characteristics

- The cross sections associated with the Scott and Bonk geologic map of Yucca Mountain (USGS Open-File Report 84-494) have been digitized and the welded versus nonwelded lithologies coded into indicators with associated geographic coordinates. This information will be used to construct indicator variograms and to develop a model of spatial continuity for use in simulations of equivalent lithology as part of the 1993 total-systems performance-assessment (TSPA) activity. This modeling is intended to investigate the performance implications of uncertainty in the location of stratigraphic contacts. Undulatory contacts between materials of significantly different hydrologic character might serve to focus groundwater flow, thus leading to fast flow in fractures to the water table. (SCP Activity 8.3.1.4.3.2.1)

WBS 1.2.4.1.1 Repository Coordination and Planning

- SNL staff completed initial planning for geotechnical monitoring activities to be conducted as part of the north portal and starter tunnel construction. These activities are associated with the implementation of Study Plan 8.3.1.15.1.8 that was submitted to the Project Office for approval.
- SNL staff has been working with principal investigators (PIs) from the USGS to define and conduct a series of thermal and mechanical tests on the core from the NRG holes. The testing will be done under WBS 1.2.3, but significant effort from WBS 1.2.4 is required to ensure that the testing is coordinated with ESF design needs.

WBS 1.2.4.2.1.2 Rock Mass Analysis

- Laboratory work continued on the experiments involving small polycarbonate models. SNL staff developed and implemented a new data reduction scheme based on a Hilbert Transform. SNL staff tested the data reduction scheme on a simple test case using a solid sample of polycarbonate, which is geometrically similar to the jointed samples. This sample was loaded in uniaxial compression. Two sets of simple uniaxial loading tests were performed at each of four different stress levels. One set of tests was performed for displacements parallel to the loading direction, and one set was performed perpendicular to the loading direction. The data was compared to the analytical solution of a uniaxially loaded thin plate containing a circular hole. Considering the different boundary conditions between the theory and experiment, the agreement is quite good. A report describing the method is in preparation.



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YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT

WBS 1.2.4.2.3.2 Design Analysis

- SNL staff met with members of the M&O ESF design group to identify and define analyses needed to support the design of the ESF north ramp. Three analyses were defined for SNL to complete before the 90% design review. These include far-field thermal analyses to assess the potential for thermal loading of the north ramp, analyses of ramp cross sections to assess long-term stability and support requirements, and a three-dimensional analysis of the intersections of the north ramp with the ramp to the Calico Hills. Thermal as well as structural calculations will be carried out to assist in the completion of the 90% review package due in August 1993.

WBS 1.2.5.4.7 Supporting Calculations for Postclosure Performance Analyses

- SLTR92-0005, the document describing the performance assessment plan for the ESF Title II design support has been completed. The plan described in the document will be developed and implemented.
- Recommendations for controls on surficial water usage and locations of surficial ponds have been submitted for inclusion in Appendix I of the ESF Design Requirements Document and the Surface-Based Testing Field Requirements Document. Recommendations were based on the calculations described in PDM 72-32 that were used to estimate the performance impacts of surficial water use in the controlled zone outside the repository.

WBS 1.2.11 Quality Assurance

- Staff have completed the first four major steps of the Transition Plan specified by the OCRWM Office of QA.

1.2.1 SYSTEMS ENGINEERING

The objective of the Systems Engineering element is to apply the systems engineering discipline to transform the regulatory requirements into functional needs of the MGDS design, system configuration, and site characterization activities. The Systems Engineering element is comprised of four tasks: Systems Engineering Coordination and Planning (1.2.1.1), Program-Level Requirements Document Development (1.2.1.2.1), Project-Level Requirements Documents Development and Maintenance (1.2.1.2.2), and Special Studies (1.2.1.5), which includes development of items important to safety/waste isolation.

1.2.1.1 SYSTEMS ENGINEERING COORDINATION AND PLANNING

Status Report on Ongoing Activities

Comment resolution on five draft subsystem requirements documents continued and is nearing completion.

Major Activities Upcoming Next Three Months

New drafts of the project-level requirements documents will be issued by the Management and Operations (M&O) contractor for review by Sandia National Laboratories (SNL) and other reviewers.

1.2.1.5 SPECIAL STUDIES

Status Report on Ongoing Activities

Assessment Team comments on draft SAND92-2334, "Preclosure Radiological Safety Evaluation-Exploratory Studies Facility," were resolved. Minor text changes were made as a result and the document is being resubmitted for the Project Office policy review. With the release of the two deliverables, SLTR92-0004 and SAND92-2334, SNL's actions under the "Determination of Importance and Grading Enhancement (DIGE) Management Plan" (YMP/92-1) are completed and final records will be submitted to the Problem Definition Memo (PDM) 71-46 file.



1.2.3 SITE INVESTIGATIONS

The objective of the Site Investigations element includes work scope related to site data collection and analysis to support site suitability evaluation, design, licensing, performance assessment requirements, and the natural barrier system component of the multiple barrier system described in the physical system. The Site Investigations element is comprised of eight tasks: Site Investigations Coordination and Planning (1.2.3.1), Systematic Acquisition of Site-Specific Subsurface Information (1.2.3.2.2.1), Three-Dimensional Rock Characteristics Models (1.2.3.2.2.2), Laboratory Thermal Properties (1.2.3.2.7.1.1), Laboratory Thermal Expansion Testing (1.2.3.2.7.1.2), Laboratory Determination of Mechanical Properties of Intact Rock (1.2.3.2.7.1.3), Laboratory Determination of the Mechanical Properties of Fractures (1.2.3.2.7.1.4), and Future Regional Climate and Environments (1.2.3.6.2.1.6).

1.2.3.1 SITE INVESTIGATIONS COORDINATION AND PLANNING

Significant Meetings Attended

SNL staff participated in the Sample Overview Committee (SOC) meeting on January 19, 1993, in Area 25 at the Nevada Test Site (NTS). Various core requests, principally involving the north ramp (NRG) series of holes, were acted upon. The sample request submitted by SNL and subsequently rejected last month by the SOC after it was erroneously reported that no approved study plan was in place for the requesting study was resubmitted and approved. The original study plan describing the testing process is an approved Project document. Confusion on the study plan status occurred because the study plan is being reissued to incorporate the redesigned Exploratory Studies Facility (ESF) as a series of ramps and drifts rather than as a vertical shaft. The revision is in review.

1.2.3.2.2.1 SYSTEMATIC ACQUISITION OF SITE-SPECIFIC SUBSURFACE INFORMATION

Major Accomplishments

"Influence of Deterministic Geologic Trends on Spatial Variability of Hydrologic Properties in Volcanic Tuff," by C. A. Rautman (SNL), J. D. Istok (Oregon State University), A. L. Flint [United States Geological Survey (USGS)], L. E. Flint [Raytheon Services of Nevada (RSN)], and M. P. Chornack (USGS), received Project Office approval and was submitted to the American Nuclear Society (ANS) for publication in April 1993 as part of the *Proceedings of the 4th International High-Level Radioactive Waste Management Conference*. (SCP Activities 8.3.1.4.3.1.1 and 8.3.1.2.2.3.1)

Significant Meetings Attended

SNL staff met with other Project personnel and University of Nevada-Las Vegas (UNLV) computing center faculty on January 29, 1993, to discuss the use of statistics and computer graphics for modeling natural phenomena, including the design of sampling for *spatially correlated* phenomena. The study plan for the Systematic Drilling Program incorporates many of the sampling concepts advocated by UNLV's Dr. Yfantis in its design. The possibility for involvement of the UNLV group in evaluating the adequacy of the drilling and sampling program at Yucca Mountain will be explored further. See Work Breakdown Structure (WBS) 1.2.3.2.2.2 for further detail. (SCP Activity 8.3.1.4.3.1.1)

Status Report on Ongoing Activities

Two data reports in preparation will contain the results of the outcrop sampling studies conducted at Yucca Mountain over the past several years. One report will focus on the two-dimensional set of transects covering



the shardy base microstratigraphic unit of the Tiva Canyon Member, whereas the other will contain the results of more areally and stratigraphically diverse sampling throughout the Yucca Mountain area. The reports will probably be prepared as USGS open-file reports because the laboratory measurements of hydrologic properties were performed at the USGS Hydrologic Research Facility. (SCP Activities 8.3.1.4.3.1.1 and 8.3.1.2.2.3.1)

The paper submitted to the International High-Level Radioactive Waste Management Conference is being rewritten for journal publication. (SCP Activities 8.3.1.4.3.1.1 and 8.3.1.2.2.3.1)

Technical procedures for the Systematic Drilling Program are being drafted in close cooperation with SNL Quality Assurance (QA) personnel. Several SNL QA implementing procedures (QAIPs) will be rewritten in accord with the recently revised Project-level Quality Assurance Requirements and Description (QARD) document and the Systematic Drilling Program interfaces with other Project participants. For example, SNL QAIP 8-1 mandates the use of an SNL sample-numbering system, yet samples for the SD series of drill holes will be processed through the Sample Management Facility (SMF) and assigned a unique sample designator. To retain this Project-level sample identifier requires that the current SNL procedure be modified. (SCP Activity 8.3.1.4.3.1.1)

Geostatistical analysis of hydrologic properties data from outcrop studies of the Bandelier Tuff, a natural analog for some of the nonwelded tuffs at Yucca Mountain, was deferred due to limited staff resources and higher-priority work. (SCP Activity 8.3.1.4.3.1.1)

Major Activities Upcoming Next Three Months

Field sampling to complete the outcrop sampling effort will be conducted in early February 1993, weather permitting. This sampling will emphasize the shardy base of the Topopah Spring Member, which appears to be lithologically similar (and perhaps hydrologically similar) to the shardy base microstratigraphic unit of the stratigraphically higher Tiva Canyon Member. Sampling will also be conducted at other geographic and stratigraphic locations where additional data appear necessary. The data reports for the outcrop sampling work will be drafted and submitted for review as soon as feasible. (SCP Activities 8.3.1.4.3.1.1 and 8.3.1.2.2.3.1)

The technical procedures and modifications to SNL QAIPs that are necessary for the field and laboratory activities of the Systematic Drilling Program will be finalized and issued as controlled documents.

Presentation materials will be prepared for the International High-Level Radioactive Waste Management Conference on April 26 through 30, 1993.



1.2.3.2.2.2 **THREE-DIMENSIONAL ROCK CHARACTERISTICS MODELS**

Major Accomplishments

"Recent Developments in Stochastic Modeling and Upscaling of Hydrologic Properties in Tuff," by C. A. Rautman (SNL) and T. H. Robey (Spectra Research Institute), received Project Office approval and has been sent to the ANS for publication in the *Proceedings of the 4th International High-Level Radioactive Waste Management Conference*. (SCP Activity 8.3.1.4.3.2.1)

Significant Meetings Attended

SNL staff presented the results of several simulation exercises and other developments in simulation technology to investigators from the USGS, Unsaturated Zone Section, in an informal technical information exchange on January 20, 1993, in Las Vegas, NV. These informal meetings, sponsored by the USGS and held at irregular intervals, are particularly valuable in that they bring together modelers, data-gatherers, and field and laboratory personnel investigating the unsaturated zone to discuss activities, needs, problems, and breakthroughs. (SCP Activity 8.3.1.4.3.2.1)

SNL staff met with other Project personnel and UNLV computing center faculty on January 29, 1993, to discuss the use of statistics and computer graphics for modeling natural phenomena. The UNLV computer sciences group has considerable experience in surface estimation and visualization, sampling design, compression of computer-generated images for use in animation sequences, and implementation of parallel processing for complex computer codes. The modified fractal surface-generation algorithms being developed by UNLV students and faculty could provide the basis for an alternative/confirmatory modeling technique to complement the more geostatistical approaches currently in development. Parallel implementation of the simulation algorithm selected to model Yucca Mountain may be mandatory, given the large number of simulations anticipated. (SCP Activity 8.3.1.4.3.2.1)

SNL staff also met with personnel working on the SNL environmental restoration activities in Albuquerque, NM. These personnel are developing a computerized decision-support system for evaluating, monitoring, and remediating various low-level radioactive, hazardous, and mixed waste sites at the SNL plant. The discussions have identified a common need for a user-friendly graphical user interface to more

sophisticated modeling algorithms for hydrologic properties, such as those contained in the GSLIB package of subroutines. The environmental restoration group is implementing the prototype decision-support system on a SUN workstation running under Open Windows, which is completely compatible with SNL YMP computing facilities. Additional discussions will explore jointly funded development of an integrated geostatistical package. Further interest in such a system has been expressed by SNL staff involved in the integrated demonstration project at the Fernald, OH, U.S. Department of Energy (DOE) site. (SCP Activity 8.3.1.4.3.2.1)

Status Report on Ongoing Activities

The cross sections associated with the Scott and Bonk geologic map of Yucca Mountain (USGS Open-File Report 84-494) have been digitized and the welded versus nonwelded lithologies coded into indicators with associated geographic coordinates. This information will be used to construct indicator variograms and to develop a model of spatial continuity for use in simulations of equivalent lithology as part of the 1993 total-systems performance-assessment (TSPA) activity. This modeling is intended to investigate the performance implications of uncertainty in the location of stratigraphic contacts. Undulatory contacts between materials of significantly different hydrologic character might serve to focus groundwater flow, thus leading to fast flow in fractures to the water table. (SCP Activity 8.3.1.4.3.2.1)

The simulations of the N-54/N-55 cross sections produced for the recently completed International High-Level Radioactive Waste Management Conference paper have not yet been rerun using the two-step simulation process identified as a work-around to the simulation artifacts identified last month. Work will continue in this area. (SCP Activity 8.3.1.4.3.2.1)

Major Activities Upcoming Next Three Months

The study plan for the three-dimensional rock characteristics models study will be initiated. The requirements for study plan descriptions of experiments and test work do not fit this activity well. Therefore, content of this study plan will by necessity focus on the geostatistical tools used for analysis. The many one-of-a-kind modeling exercises of this activity and the necessity to guide ongoing modeling activities by the results of the immediately preceding analysis step render the scientific notebook method a very reasonable approach to controlling the three-



dimensional rock characteristics study. SNL QA procedures are currently being revised to facilitate the use of scientific notebooks as described in the QARD. (SCP Activity 8.3.1.4.3.2.1)

Work will also commence on attempting to modify the simulation codes to accommodate the soft information provided by the known microstratigraphic units at Yucca Mountain. SNL staff will discuss with USGS personnel the required interfaces to the geometric model being developed by the USGS. The initial Lynx model of the Topopah Spring Member of the Paintbrush Tuff, including its internal microstratigraphic zonation, will be completed by the USGS in April 1993. (SCP Activity 8.3.1.4.3.2.1)

Presentation materials will be prepared for the International High-Level Radioactive Waste Management Conference, which will be held in Las Vegas, NV, on April 26 through 30, 1993. (SCP Activity 8.3.1.4.3.2.1)

Discussions will continue with UNLV and M&O staff regarding technical support investigations at UNLV. Interactions with SNL environmental restoration personnel will continue as well. (SCP Activity 8.3.1.4.3.2.1)

Issues/Potential Problems Needing Resolution and Potential Impacts

As described above, SNL QAIPs must be revised to accommodate the new Project-level requirements. This will involve and is receiving a significant effort by SNL QA and technical staff, but these revisions are required to initiate modeling that is subject to the QA program. (SCP Activity 8.3.1.4.3.2.1)

1.2.3.2.7.1.1 LABORATORY THERMAL PROPERTIES

Status Report on Ongoing Activities

Reproducibility studies for the C-Matic low temperature (LT) instrument using the moisture containment cell are in process. Five runs using a Pyrex standard have been completed, yielding the differences between the highest and lowest measurements of 4.0%, 5.4%, and 4.9% at 80°C, 50°C, and 30°C, respectively. These test were made using Parafilm M as the interface medium between the sample and moisture containment cell. The higher temperatures were measured first to allow the Parafilm to soften and form a better interface. Repeatability of the instrument without the moisture containment cell is within $\pm 3\%$. The C-Matic LT will be used for measuring thermal conductivity at temperatures from 20°C to 100°C. (SCP Activity 8.3.1.15.1.1.3)

After a calibration and verification is performed on C-Matic LT with the moisture containment cell, additional measurements will be made to determine the accuracy of the instrument when using Parafilm as the interface medium. Technical Procedure (TP) 202, "Measurement of Thermal Conductivity of Geologic Samples by the Guarded-Heat-Flow-Meter Method," will be revised, if necessary, to correct the calibration and verification criteria for measurements made with the moisture containment cell.

Major Activities Upcoming Next Three Months

The scoping study on the effects of saturation on thermal conductivity will begin after the C-Matic LT instrument is calibrated, the data acquisition software is verified and approved, and the relevant procedures are revised. (SCP Activity 8.3.1.15.1.1.3)



1.2.3.2.7.1.2 LABORATORY THERMAL EXPANSION TESTING

Status Report on Ongoing Activities

A 1-inch sample from Busted Butte Unit TSw2 was run at the 0.25°C/min ramp rate as a baseline sample for determining when tridymite and cristobalite undergo polymorphic transformations. As with the 4-inch TSw2 sample that was previously run, there were no sudden increases in the coefficient of thermal expansion (CTE) over the tested range.

A 1-inch sample from thermal/mechanical Unit TSw1 from drill hole USW G1, which contains significant amounts of both tridymite and cristobalite, was tested from ambient temperature to 325°C using a ramp rate of 0.25°C/min. Two significant increases in the instantaneous CTE at approximately 165°C (from ~1.3 to ~3.3 ppm/°C) and 250°C (from ~2.5 to ~5.3 ppm/°C) were measured. These temperatures correspond to those at which α to β polymorphic transformations occur for tridymite and cristobalite, respectively. The sample was then allowed to cool at a rate of less than 1°C/min while the CTE was measured. The significant change in the instantaneous CTE was measured at approximately 120°C, which is assumed to be a temperature hysteresis caused by the silica polymorphs reverting to their initial form. The mineralogy of the sample is being assessed to confirm the presence of tridymite and cristobalite. Tests to establish the appropriate heating rate are continuing using 4-inch samples and a 1°C/min. (SCP Activity 8.3.1.15.1.2.1)

Review comments for TP-203, "Measurement of Thermal Expansion of Geologic Samples Using a Push Rod Dilatometer," are being resolved.

Review comments for TP-215, "Calibration of Lawson Board System," is being reviewed. These systems are used in the Thermal Conductivity Analyzer (TCA), Qualitative Thermal Analyzer (QTA), and dilatometer to reference cold junction temperatures and to convert thermocouple emf to a digital signal.

Major Activities Upcoming Next Three Months

A scoping study on the effects of sample size on thermal expansion will be initiated after the heat-up rates are established and the relevant procedures are issued. (SCP Activity 8.3.1.15.1.2.1)

1.2.3.2.7.1.3 LABORATORY DETERMINATION OF MECHANICAL PROPERTIES OF INTACT ROCK

Major Accomplishments

"Characterization of Porosity in Support of Mechanical Property Analysis" has been accepted for presentation and publication at the 1993 International High-Level Radioactive Waste Management Conference on April 26 through 30, 1993, at Las Vegas, NV. The paper was prepared, approved, and submitted in January 1993 to the conference. (SCP Activity 8.3.1.15.1.3.2)

Status Report on Ongoing Activities

New England Research, Inc. (NER) is conducting a study of time-dependent deformation involving high-temperature experiments at creep and low strain rate conditions. The series of experiments consists of a least six samples of Topopah Spring welded tuff (TSw2) to be tested at a pore pressure of 4.5 MPa, a confining pressure of 5 MPa, and a maximum constant differential stress of 80 MPa. The experiments are initially performed at room temperature and then at 250°C. The furnace has been rebuilt; however, the high-temperature calibration of the system has taken longer than expected. The second experiment should begin in February. (SCP Activity 8.3.1.15.1.3.2)

R. Price visited NER on January 11 through 13, 1993, to discuss progress on and plans for the time-dependent property experiments. A number of reports in process were discussed also. (SCP Activity 8.3.1.15.1.3.2)

SAND92-1810, "Unconfined Compression Experiments on Topopah Spring Member Tuff at 22°C and a Strain Rate of 10^{-3} s $^{-1}$: Data Report," has been put into technical and editorial review. (SCP Activity 8.3.1.15.1.3.2)

"The Influence of Strain Rate and Sample Inhomogeneity on the Moduli and Strength of Welded Tuff" has been accepted for presentation and publication at the 34th U.S. Symposium on Rock Mechanics on June 27 through 30, 1993, at the University of Wisconsin-Madison. (SCP Activity 8.3.1.15.1.3.2)

Major Activities Upcoming Next Three Months

NER staff R. Martin and P. Boyd will be in Albuquerque, NM, in February 1993 to discuss results from the testing of samples of Topopah Spring



Member tuff in the investigation of time-dependent mechanical properties and plans for testing NRG samples.

SAND92-0119, "Experimental Comparison of Laboratory Techniques in Determining Bulk Properties of Tuffaceous Rocks," and SAND92-0847, "The Effect of Frequency on Young's Modulus and Seismic Wave Attenuation in Tuff," have been technically and editorially reviewed. The document revisions in response to the resulting comments will be completed in February 1993. (SCP Activity 8.3.1.15.1.3.2)

1.2.3.2.7.1.4. LABORATORY DETERMINATION OF THE MECHANICAL PROPERTIES OF FRACTURES

Status Report on Ongoing Activities

The technique for making gypsum cement replicas of rough fractures in the welded Topopah Spring Member tuff is being refined. Achieving maximum surface hardness and strength and the problem of entrainment of bubbles are being addressed. A set of replicas are being cast to study the effect of topographic correlation. (SCP 8.3.1.15.1.4.2)

Study Plan 8.3.1.15.1.4, "Laboratory Determination of the Mechanical Properties of Fractures," has been reviewed by other Project participants, the Project Office, and Headquarters personnel. Review comments were received in May 1992; the study plan is being revised. (SCP Activities 8.3.1.15.1.4.1 and 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 in the next two months. (SCP Activities 8.3.1.15.1.4.1 and 8.3.1.15.1.4.2)

SAND92-2216J, a journal article entitled "Simple Mathematical Model of a Rough Fracture" is being drafted and will be submitted for review in the next two months. (SCP Activities 8.3.1.15.1.4.1 and 8.3.1.15.1.4.2)

SAND92-2333, "The Effect of Sliding Velocity on the Mechanical Response of Artificial Joints in Topopah Spring Member Tuff," has been drafted and will begin technical and editorial review in the next two months. (SCP Activity 8.3.1.15.1.3.2)



1.2.3.6.2.1.6 FUTURE REGIONAL CLIMATE AND ENVIRONMENTS

Status Report on Ongoing Activities

Funding for this WBS element was allocated for FY93 to complete the Study Plan and prepare a transition plan for SNL's acceptance of this work. A new Task Leader was assigned and is evaluating program status prior to initiating work on these deliverables.

Major Activities Upcoming Next Three Months

The program status will be ascertained and transition actions defined.



1.2.4 REPOSITORY

The objective of the Repository element includes work scope related to the repository component of the physical system including the repository operations system, the underground facility component of the engineered barrier system, the access/borehole seals, and the monitoring system component of the performance evaluation system. The Repository element is comprised of nine tasks: Repository Coordination and Planning (1.2.4.1.1), Excavation Investigations (1.2.4.2.1.1.1), In Situ Thermomechanical Properties (1.2.4.2.1.1.2), In Situ Mechanical Properties (1.2.4.2.1.1.3), In Situ Design Verification (1.2.4.2.1.1.4), Rock Mass Analyses (1.2.4.2.1.2), Certification of Design Methods (1.2.4.2.3.1), Design Analysis (1.2.4.2.3.2), and Sealing and Design Requirements (1.2.4.6.1).

1.2.4.1.1 REPOSITORY COORDINATION AND PLANNING

Status Report on Ongoing Activities

Study Plan 8.3.1.15.1.8, "In Situ Design Verification," completed comment resolution and a final draft was submitted to the Project Office for approval. Work continued on revising Study Plan 8.3.1.15.1.5, "Excavation Investigations," and initial drafts of Study Plans 8.3.1.15.1.6, "In Situ Thermomechanical Properties," and 8.3.1.15.1.7, "In Situ Mechanical Properties," were started.

SNL completed initial planning for geotechnical monitoring activities to be conducted as part of the north portal and starter tunnel construction. These activities are associated with the implementation of Study Plan 8.3.1.15.1.8 under WBS 1.2.4.2.1.1.4. However, funding for these activities is provided under WBS 1.2.6.

SNL staff continues to work with the M&O and staff from Lawrence Livermore National Laboratory (LLNL) to develop a plan for resolving numerous issues related to the thermal loading of the potential repository. Meetings were held at LLNL and the Project Office to begin an evaluation of the current state of repository modeling and determine what additional modeling and laboratory-scale testing is required to provide the level of confidence in the modeling results that is necessary before a design

decision on thermal loading can be made. Also, a working group is being formed to revise the Site Characterization Plan (SCP) thermal goals for repository design. This is a critical step for defining the thermal envelope for Advanced Conceptual Design (ACD) design studies and for defining key information to be obtained from the testing program.

SNL staff is working with the M&O Exploratory Studies Facility (ESF) design team to define a set of thermal-structural analyses to support the ESF design. A series of meetings has been held to discuss the scope of the analyses and the schedule for delivery of results to ESF designers.

SNL staff has been working with principal investigators (PIs) from the USGS to define and conduct a series of thermal and mechanical tests on the core from the NRG holes. The testing will be done under WBS 1.2.3, but significant effort from WBS 1.2.4 is required to ensure that the testing is coordinated with ESF design needs.

Major Activities Upcoming Next Three Months

Significant effort will be required to plan and implement the geotechnical monitoring effort in the starter tunnel. SNL staff will work closely with LLNL staff to coordinate the preparation of a Test Planning Package. Analyses of the thermal and structural analyses of the north ramp will be initiated in support of the ESF design.



1.2.4.2.1.1.1 EXCAVATION INVESTIGATIONS

Status Report on Ongoing Activities

Staff continued to revise Study Plan 8.3.1.15.1.5, "Excavation Investigations," to reflect the current ESF configuration and proposed mining method.

Major Activities Upcoming Next Three Months

Staff will continue to revise Study Plan 8.3.1.15.1.5.

1.2.4.2.1.1.2 IN SITU THERMOMECHANICAL PROPERTIES

Status Report on Ongoing Activities

Staff continued work on the rough draft of Study Plan 8.3.1.15.1.6, "In Situ Thermomechanical Properties."

Major Activities Upcoming Next Three Months

Staff will continue drafting Study Plan 8.3.1.15.1.6.



1.2.4.2.1.1.3 IN SITU MECHANICAL PROPERTIES

Status Report on Ongoing Activities

Staff continued work on the rough draft of Study Plan 8.3.1.15.1.7, "In Situ Mechanical Properties."

Major Activities Upcoming Next Three Months

Staff will continue drafting Study Plan 8.3.1.15.1.7.

1.2.4.2.1.1.4 IN SITU DESIGN VERIFICATION

Major Accomplishments

At the comment resolution meeting of January 12, 1993, the final comments to Study Plan 8.3.1.15.1.8, "In Situ Design Verification," were resolved. All 138 comments have now been resolved and a revision of the Study Plan incorporating comment resolutions has been submitted to the Project Office.

Major Activities Upcoming Next Three Months

Staff will prepare a letter explaining how the revised study plan submitted to the Project Office addresses open items from the Nuclear Regulatory Commission (NRC) Site Characterization Analysis comments.



1.2.4.2.1.2 ROCK MASS ANALYSES**Significant Meetings Attended**

SNL and M&O personnel met in Albuquerque, NM, on January 27, 1993 to discuss SNL support of design activities. J. Jung and E. Ryder of SNL will meet with the M&O again on the topic in early February in Las Vegas, NV.

Status Report on Ongoing Activities

Laboratory work continued on the experiments involving small polycarbonate models. Last month, SNL developed and implemented a new data reduction scheme based on a Hilbert Transform. This scheme is designed to extract two-dimensional strain/displacement information from images of Moire fringes. This month, SNL tested the data reduction scheme on a simple test case using a solid sample of polycarbonate, which is geometrically similar to the jointed samples used for the multiple layered tests. This sample was loaded in uniaxial compression. Two sets of simple uniaxial loading tests were performed at each of four different stress levels. One set of tests was performed for displacements parallel to the loading direction, and one set was performed perpendicular to the loading direction. The data was compared to the analytical solution of a uniaxially loaded thin plate containing a circular hole. Considering the different boundary conditions between the theory and experiment, the agreement is quite good. SNL staff also tested the software on simulated fringe data containing displacement discontinuities. A problem resulting in occasional false displacement magnitude was identified and corrected. Next month, data from the jointed block experiment will be analyzed. A report describing the method is in preparation.

A study is underway to explore the surface characteristics of natural fractures and relate these to the frictional data gathered on replicas of the surfaces. This study will place special emphasis on determining whether the fitting parameters on the Barton Model for

frictional behavior have physical significance or not. The majority of the experimental work will be carried out by a University of Colorado at Boulder (CU) graduate student at SNL. Five natural fracture surfaces have been prepared for replication. These surfaces have a range in surface roughness from relatively smooth to very rough in appearance. The surfaces have been profiled for detailed analysis with fractal and other statistical techniques. Also, more than 10 gypsum cement samples (with varying amounts of water content) have been cast for testing beginning in February.

A series of experiments designed to study the effects of a nonstandard loading condition on frictional properties has been conducted at CU. Replicas of fractures in rock samples have been tested for normal stiffness and shear deformation properties. SAND 92-1853, "Effect of Boundary Conditions on the Strength and Deformability of Replicas of Natural Fractures in Welded Tuff: Data Report," a report detailing the experiment techniques, has completed technical review and is in management review. A graphical model used to predict the shear behavior has been compared to the data. This analysis is being reported in SAND92-2247, "Effect of Boundary Conditions on the Strength and Deformability of Replicas of Natural Fractures in Welded Tuff: Comparison Between Predicted and Observed Behavior," which is close to completing editorial and technical review. Additional analyses of the data will be reported in a third SAND document that is being drafted.

Major Activities Upcoming Next Three Months

R. Price and J. Jung of SNL will visit CU on February 10, 1993, to discuss the progress of the data and analysis reports and the new studies.

Data reduction and analysis will begin for tests performed on a set of layered plate experiments.

Plans for SNL support of the M&O's design efforts will be finalized and the supporting thermal and mechanical analyses will begin.



1.2.4.2.3.1 CERTIFICATION OF DESIGN METHODSStatus Report on Ongoing Activities

JAC2D YMP V1.00, SNL's primary thermomechanical finite element code, has been converted to double precision and placed on the SUN local area network (LAN). This version of the code received QA certification. With this implementation, SNL can now conduct thermomechanical analyses at essentially the same precision as on a CRAY computer, but at a significantly reduced cost.

Work at CU is continuing to fit the experimental data developed in WBS 1.2.4.2.1.2 to a constitutive model that can be used for analyses. This month was spent primarily studying the discrete element code, DDA, to determine how a new joint constitutive model can be implemented.

In other work at CU, modifications to DDA are being studied. The concept of breaking rock blocks into sub-blocks to obtain higher accuracy is being explored. At SNL, the mathematical foundation for this concept is being pursued. The basic equations for the blocks have been reformulated to facilitate the sub-block concept. Also, different methods of joining the blocks together are being investigated at SNL. Penalty, Lagrangian, and augmented Lagrangian methods are being considered to enforce interblock compatibility.

In a separate activity, the continuum joint constitutive model is being reviewed. Several aspects of the model that can be improved, including the addition of more joint sets, the inclusion of joint dilation, and an increased model robustness are being implemented.

Major Activities Upcoming Next Three Months

J. Jung (SNL) will be traveling to CU in February 1993 to discuss progress on the joint constitutive model work and the discrete element activities.

1.2.4.2.3.2 DESIGN ANALYSISStatus Report on Ongoing Activities

SAND92-0589, "Yucca Mountain Site Characterization Project: New Three-Dimensional Far-Field Repository Field Thermomechanical Calculations," by R. Hardy et al., has been transmitted for policy review. This report documents the work completed for Problem Definition Memo (PDM) 75-25. The analyses defined in the PDM were intended to provide information on the temperatures, stresses, and strains expected in the vicinity of ESF openings that may become part of the repository. The "new repository design" was used in the analysis, with thermal loadings of 57 and 80 kW/acre. (SCP Section 8.3.2.4.1.1)

SAND92-7344C, "The Results of Near-Field Thermal and Mechanical Calculations of Thermal Loading Schemes," by J. Holland, has been accepted for presentation at the 1993 International High-Level Radioactive Waste Management Conference. This report documents predictions of the near-field thermal and structural response of an emplacement drift to in-borehole and in-drift emplacement over a range of initial thermal loadings.

SNL staff met with members of the M&O ESF design group to identify and define analyses needed to support the design of the ESF north ramp. Three analyses were defined for SNL to complete before the 90% design review. These include far-field thermal analyses to assess the potential for thermal loading of the north ramp, analyses of ramp cross sections to assess long-term stability and support requirements, and a three-dimensional analysis of the intersections of the north ramp with the ramp to the Calico Hills. Thermal as well as structural calculations will be carried out to assist in the completion of the 90% review package due in August 1993.

Major Activities Upcoming Next Three Months

SNL emphasis will be on defining and completing thermal/structural calculations supporting ESF design. Analyses will include far-field thermal evaluations of proposed repository layouts as well as near-field structural evaluations of the north ramp and proposed intersections.



1.2.4.6.1 SEALING DESIGN AND DESIGN REQUIREMENTS

Status Report on Ongoing Activities

Work associated with the development of a strategy to seal exploratory boreholes continued. The following table shows the status of specific areas of the strategy report.

Airflow performance calculations	Completed
Assessment of the relative significance (airflow only) of boreholes	Completed
Hydrologic calculations	Completed
Calculations due to stress induced from thermal, in situ, and backfill stresses	Completed
Casing stability calculations	Completed
Chapter 4 preparation	Completed
Chapter 5 preparation	Completed
Airflow calculation	Underway
Preparation of Chapter 2	Underway
Preparation of Chapter 3	Underway
QA checks for calculations	Underway
Development of strategy	Initiated
Preparation of Chapter 6	Not initiated
Technical editing	Not initiated

Final technical editing of SAND92-0960, "Initial Field Testing Definition of Subsurface Sealing and Backfilling Tests in Unsaturated Tuff," is underway. This technical editing was in response to DOE review.

Major Activities Upcoming Next Three Months

The draft borehole sealing strategy report will be completed.



1.2.5 REGULATORY

The objective of the Regulatory element is to assure site-related compliance with Nuclear Regulatory Commission agreements, requirements, and policies; evaluate the performance of the natural barriers, engineered barriers, and total systems for meeting regulatory standards; and manage, maintain, and accumulate technical data and information produced by site characterization, design development, and performance assessment activities for the project. The Regulatory element is comprised of 11 tasks: Regulatory Coordination and Planning (1.2.5.1), Site Characterization Program (1.2.5.2.2), Technical Database Input (1.2.5.3.5), Total System Performance Assessment (1.2.5.4.1), Repository Performance Assessment (1.2.5.4.3), Site Performance Assessment (1.2.5.4.4), Interactive Graphics Information System (1.2.5.4.5), Development and Validation of Flow and Transport Models (1.2.5.4.6), Support Calculations for Postclosure Performance Analyses (1.2.5.4.7), Development and Verification of Flow and Transport Codes (1.2.5.4.9), and Special Projects (1.2.5.5).

1.2.5.1 REGULATORY COORDINATION AND PLANNING

Significant Meetings Attended

At meetings in Albuquerque, NM, on January 14 and 29, 1993, SNL management met with DOE/YMP managers and M&O personnel to discuss assignments and detailed plans for the remainder of FY93.

Status Report on Ongoing Activities

SNL staff reviewed the regulatory sections in the report of the cost-evaluation working group. Comments were provided through the SNL Technical Project Officer (TPO).

SNL staff completed final adjustments to the baselined budget and work scopes for regulatory activities.

Major Activities Upcoming Next Three Months

The FY94 budget process will require significant effort from the SNL managers and task leaders for regulatory activities.

1.2.5.2.2 SITE CHARACTERIZATION PROGRAM

Status Report on Ongoing Activities

Study Plan 8.3.1.8.1.2, "Physical Processes of Magmatism and Effects on the Potential Repository," was technically reviewed by C. A. Rautman and submitted to the Project Office on January 6, 1993.

For Study Plan 8.3.1.2.2.2, Rev. 1, "Water Movement Test," the verification of comment resolution was completed by M. D. Siegel and submitted to the Project Office on January 8, 1993.

For Study Plan 8.3.1.12.2.1, Rev. 1, "Meteorological Data Collection at the Yucca Mountain Site," the verification of comment resolution was completed by Y. Behl and submitted to the Project Office on January 8, 1993.

The second draft of Study Plan 8.3.1.15.1.8, "In Situ Design Verification," was submitted by J. Pott to the Project Office on January 19, 1993.



1.2.5.3.5 TECHNICAL DATABASE INPUTMajor Accomplishments

D. Eley (Department 6351) assumed responsibility for this task from R. J. Orzel.

Status Report on Ongoing Activities

Eight Technical Data Information Forms (TDIFs) were submitted to the Automated Technical Data Tracking (ATDT) between December 18, 1992, and January 29, 1993. Five of these TDIFs were forwarded to the Central Records Facility (CRF).

Major Activities Upcoming Next Three Months

D. Eley will meet with J. Beckett at Edgerton, Germeshausen, and Grier Corp. (EG&G) to discuss GENISES input.

1.2.5.4.1 TOTAL SYSTEM PERFORMANCE ASSESSMENTMajor Accomplishments

Papers written by SNL staff that have been approved by the Project Office and submitted to the 1993 International High-Level Radioactive Waste Management Conference include:

- "Sensitivity Analyses for Total System Performance Assessment," SAND92-2600C, by M. L. Wilson;
- "Implications of Stability Analysis for Heat Transfer at Yucca Mountain," SAND93-7005C, by B. Ross, Y. Zhang, and N. Lu;
- "The Most Likely Groundwater Flux Through the Tuff Matrix at USW H-1," SAND92-2386C, by J. Gauthier;
- "A Working Definition of Scenarios and a Method of Scenario Construction," SAND92-2828C, by G. Barr and E. Dunn; and
- "Scenario Development for Performance Assessment—Some Questions for the Near-Field Modeler," SAND92-2784C, by G. Barr and R. Barnard.

"A Semianalytical Method of Path Line Computation for Transient Finite-Difference Ground Water Flow Models," SAND92-7035J, by N. Lu, was submitted to the Project Office for programmatic review.

Significant Meetings Attended

One person from SNL participated in the tour of the Waste Isolation Pilot Project (WIPP) facility in Carlsbad, NM, on January 12, 1993. The tour was held in conjunction with the YMP/WIPP roundtable meeting held for the NRC in Albuquerque, NM, on January 13, 1993.

SNL staff attended a meeting with M&O/INTERA personnel in Albuquerque, NM, on January 13, 1993, to discuss the use of the Repository Integration Program (RIP) computer code from Golder Associates, Inc. for total system performance assessment (TSPA). The M&O/INTERA personnel presented their recent results; the SNL staff commented on the models, data, and interpretations embodied in those results. Together, the two groups identified further work with the RIP code.



Status Report on Ongoing ActivitiesTotal System Performance Assessment-93

Work is continuing on the development of SAND92-2431, a report on the selection of radionuclides to be used in performance-assessment analyses. The current effort will expand the list of nuclides by incorporating more geochemical sorption and solubility data.

SNL staff members have defined the near-field interactions for the source term for the next TSPA iteration. They will assume that throughout the thermal history of the repository, it will be possible to have weeps dripping on waste packages.

Furthermore, throughout the history, it will be possible for locally saturated conditions to exist such that fracture flow from the repository to the water table can occur. To model this will require developing a distribution in time and space of "input" weeps at the repository and "draining" from the repository. SNL staff has been meeting with LLNL staff to coordinate analyses. SNL staff has also started developing the features, events, and processes (FEP) diagrams to describe these processes.

As part of the SNL interaction with LLNL on the radionuclide source term for total-system performance assessment, SNL staff transmitted a portion of the Total System Analyzer (TSA) program for LLNL staff use for sensitivity studies. A new source term is being encoded, and the TSA is being run for colloid sensitivity studies.

An SNL report is being written to help define the calculational regimes for which one-dimensional calculations are appropriate. For total-system assessments, one-dimensional codes are currently the only feasible way to compute multiple realizations of water and solute transport through Yucca Mountain because of their relatively short execution-time requirements. SNL staff intends to approximate as many two-dimensional effects in these one-dimensional codes as possible. To produce the report, staff will examine the past work in two-dimensional simulations and run additional simulations as necessary.

A series of three-dimensional stratigraphies of Yucca Mountain for TSPA-93 is being developed, along with

the necessary data sets. The stratigraphies will be based on welded/nonwelded categories. Two-dimensional slices through the baseline stratigraphy will be used for gas-flow calculations. For the composite-porosity groundwater-flow calculations, 10 one-dimensional columns through the baseline stratigraphy and perhaps 10 other stratigraphies will be taken. Monte Carlo simulations are being performed with the TSA to develop the columns and flow tubes for the composite-porosity model. A new automatic mesh generator for TOSPAC was designed and programmed. The new mesh generator should allow the TSA to run with many different stratigraphies without having to construct each calculational mesh by hand.

A group was formed to develop a plan to address the thermal modeling problem. A three-pronged approach was planned: (1) performing laboratory experiments, (2) modeling laboratory experiments, and (3) modeling Yucca Mountain. One proposed experiment uses a container filled with glass beads and water with a 60°C heat source at the bottom and a 20°C source at the top. The experiment is expected to provide information about the relative importance of convection and conduction under these conditions. Discussions with K. Preuss of Lawrence Berkely Laboratory (LBL) have resulted in changes to ensure that competing effects are reduced and also to decrease the possibility that three-dimensional effects are introduced into a two-dimensional problem. The experiment is currently being designed (reported under WBS 1.2.5.4.6) and is expected to be completed in the summer. At that time, SNL workers will attempt to model the phenomena observed using TOUGH. Although full results of this plan will not be available in time to be incorporated in TSPA-93, the work is expected to provide insights that can be incorporated.

Scenario Development

"Scenarios Constructed for Basaltic Igneous Activity at Yucca Mountain and Vicinity," SAND91-1653, by G. Barr, E. Dunn, R. Barnard, H. Dockery, B. Crowe, and G. Valentine, has completed SNL's internal technical review process and is undergoing review by the coauthors from LANL. Progress is being made on the development of figures for the nominal-flow scenarios report.



1.2.5.4.3 REPOSITORY PERFORMANCE ASSESSMENT

Status Report on Ongoing Activities

SAND92-2838C, "Comparison of Predicted Far-Field Temperatures for Discrete and Smeared Heat Sources," by E. Ryder, has been approved for presentation at the 1993 International High-Level Radioactive Waste Management Conference. The study evaluates the use of areally extensive plate sources as opposed to discrete canister representations in three-dimensional thermal modeling. (SCP Design Activity 1.11.6)

Near-field thermal calculations have been initiated that will provide M&O waste package designers with near-field boundary conditions for detailed modeling of the internal waste package environment.

Documentation of a study comparing the predictions of near-field thermal response using approximations of smeared two-dimensional heat sources and discrete three-dimensional representations continued. This study is intended to provide a preliminary evaluation of the adequacy of smeared source approximations in two-dimensional thermal modeling. Local areal power densities of 20, 25, 34, 57, 80, and 114 kW/acre were examined.

Major Activities Upcoming Next Three Months

Work will begin on a series of laboratory-scale experiments to validate modeling concepts of hydrothermal flow in the unsaturated zone. Small fractures will be inserted into thin models of specially prepared porous sand. The visualization experiment will observe the extent of the dry zone and location and extent of the condensation zone. Numerical model simulations of the experiment will be performed for comparison of results.

1.2.5.4.4 SITE PERFORMANCE ASSESSMENT

Major Accomplishments

SAND92-0461, "Pre-Waste-Emplacement Ground-Water Travel Time Sensitivity and Uncertainty Analyses for Yucca Mountain, Nevada," by P. Kaplan, has been printed and distributed.

Papers written by SNL staff that have been approved by the Project Office and submitted to the 1993 International High-Level Radioactive Waste Management Conference include:

- "Recent Developments in Stochastic Modeling and Upscaling of Hydrologic Properties in Tuff," SAND92-2671C, by C. Rautman and T. Robey; and
- "Numerical Methods for Fluid Flow in Unsaturated Heterogeneous Tuff," SAND92-2672C, by T. Robey.

"Geostatistics and Upscaling of Hydrologic Properties for an Adaptive Mixed Finite Element Method Applied to Unsaturated Porous Media Flow," SAND92-2419A, by T. Robey, was submitted for the SIAM Conference on Mathematical and Computational Issues in the Geosciences in Houston, TX, on April 19 through 21, 1993.

M&O staff have reviewed 17 unsaturated flow codes that have been developed for modeling water flow through unsaturated porous media. They selected 7 codes for further testing, one of which was LLUVIA-II. They encountered long execution times when LLUVIA-II was used to compute the Jornada Trench test problem. By request from the M&O, SNL staff reviewed these results after obtaining a copy of the LLUVIA-II deck modified for personal computer (PC) use. The modifications appear to have been done correctly. A test case was executed on the SUN and Cray computers. Additionally, a timing test program was written and run on the SPARC 2 and 10 and Cray computers. The resulting execution times appeared to be consistent. The results of these investigations were provided to the M&O staff.

Significant Meetings Attended

A member of the SNL staff attended the National Ground Water Association short course "Probability, Statistics, and Geostatistics for the Environmental Professional" in Tampa, FL, on January 26, 27 and 28, 1993. The material presented in this course has direct



application to the probabilistic modeling being performed in WBS 1.2.5.4.4.

A member of the staff participated in an NRC workshop entitled "Flow and Transport Through Unsaturated Fractured Rock" in Tuscon, AZ, on January 25 through 28, 1993.

Two SNL staff members attended a course entitled "Risk Assessment for the Environmental Professional" sponsored by the National Groundwater Association. It covered the methods of preparing a risk assessment and other technical information appropriate to the statistical methods under development in WBS 1.2.5.4.4.

Status Report on Ongoing Activities

A program was written to convert the digitized polygons from the Scott and Bonk geologic map to a regular grid with the corresponding unit assigned. The program has been tried out on a test file. The output is to be used to compute variograms for the indicator simulations. Review of the drill holes for determining breakpoints between hydrogeologic classes has been completed. The input parameters have also been reviewed and updated, except those dependent on the digitizing of the Scott and Bonk cross-section maps.

Yucca Mountain drill-hole stratigraphy interpretation relevant to performance assessment was completed. The structural elements of strike and dip have been determined. A breakout in percent of welded to nonwelded with emphasis on the Prow Pass welded was determined. These parameters have been examined and provided for stratigraphy model generation. An interesting fact that became apparent was that the stratigraphy between holes H-4 and UZ-16 show very little dip. This is due to the fact that this area is bounded by faults that offset the regional dip of 6° to the southeast. Even the accepted regional dip of 6° may be too shallow by about 0.8°. A logic check on the completed, reinterpreted stratigraphies from the boreholes was accomplished to add confidence to the results to date. Documentation of the reexamination

and interpretation of the Yucca Mountain stratigraphy has started and will be complete in early February. This will be the first documentation available for the new TSPA report.

Work proceeded in the continuing effort to develop realistic groundwater-flow models of Yucca Mountain. Presently, the effort has several fronts, including upscaling of hydrologic properties, correlating hydrologic parameters to attach hydraulic conductivities and moisture-retention curves to the porosity-based geostatistical stratigraphies, developing graphical images, and incorporating an analytical integration method for constructing element matrices in the porous-media flow solver, DUAL.

Output from the three-dimensional geostatistical simulations contains complex interfaces between geologic units. A geostatistical unit adaptive method (GUAM) has been programmed to take output from the geostatistical simulations and to superimpose simplified boundaries. The program will be revised as better interpretations of the drill-hole logs are developed. GUAM has been modified to correspond with interpretations of the drill-hole information and is being debugged and tested.

Chapter 4 of the draft of SAND92-0799, "Model Domains and Hydrologic Data Base to Support Early Site Suitability and Total Systems Performance Assessment Models," by Gainer et al., was completely rewritten. Chapter 5 also requires major changes and will be rewritten during the month of February.

Data-base management is being maintained by a temporary person until a permanent solution is found. She has accessed the system and become familiar with the system and the contents. Transmissivity data have been retrieved for members of the SNL staff to apply to TSPA efforts. The transmissivity data were reformatted to meet analysis requirements. The interface role has been reactivated between the data base and ARC/INFO to provide ready access to the Yucca Mountain through the geographical information system (GIS).



1.2.5.4.5 INTERACTIVE GRAPHICS INFORMATION SYSTEM

Status Report on Ongoing Activities

Work continues on the development of data conversion techniques. A data dictionary has been started to provide users with a guide to the ARC/INFO coverage now available.

Major Activities Upcoming Next Three Months

Staff will begin development of visualization techniques using Advanced Visualization Systems (AVS). Additional training in AVS will be obtained as needed.

Staff will begin work with GENISES to develop techniques to transfer data via the networks. Staff will begin replacing existing data with data qualified under a QA procedure when it becomes available.

The following CALMA jobs are in progress:

- Job 386 for H. A. Dockery - Drill holes/Section
- Job 397 for D. L. Eley - Convert GTMs to ARC/INFO
- Job 398 for D. Guerin - Hydrogeologic Drill Holes
- Job 399 for J. A. Fernandez - New Proposed/Exist Drill Holes

1.2.5.4.6 DEVELOPMENT AND VALIDATION OF FLOW AND TRANSPORT MODELS

Significant Meetings Attended

R. Glass attended the workshop on "Unsaturated Flow and Transport Through Fractured Rock—Related to High-Level Radioactive Waste Disposal," in Tucson, AZ, hosted by the NRC. R. Glass also presented an "Update on the Subsurface Flow and "Contaminant Transport Laboratory" at the meeting.

R. Glass gave a tour of the YMP flow and transport visualization laboratory to K. Pruess of LBL on January 14, 1993. Discussions covered flow in fractures, fracture-matrix interaction, and experiments to challenge nonisothermal flow calculations.

Status Report on Ongoing Activities

Flow and Transport Through Single Fractures

In early January, work emphasis was on completion of the following papers for the 1993 International High-Level Radioactive Waste Management Conference:

"Small-Scale Behavior of Single Gravity-Driven Fingers in an Initially Dry Fracture," by M. J. Nicholl, R. J. Glass, and H. A. Nguyen. Abstract: This paper presents experiments investigating the behavior of individual, gravity-driven fingers in an initially dry, rough-walled analog fracture. Fingers were initiated from constant flow to a point source. Finger structure is described in detail. Specific phenomena observed include desaturation behind the finger tip, variation in finger path, intermittent flow structures, finger-tip bifurcation, and formation of dendritic subfingers. Measurements were made of finger-tip velocity, finger width, and finger-tip length. Nondimensional forms of the measured variables are analyzed relative to the independent parameters, flow rate, and gravitational gradient.

"Wetting Front Instability in an Initially Wet Unsaturated Fracture," M. J. Nicholl, R. J. Glass, and H. A. Hguyen. Abstract: This paper presents experimental results exploring gravity-driven wetting front instability in a pre-wetted, rough-walled analog fracture. Initial conditions considered include a uniform moisture field wetted to field capacity of the analog fracture and the structured moisture field created by unstable infiltration into an initially dry fracture. As in previous studies performed under dry initial conditions, instability was found to result both at the cessation of stable infiltration and at flux lower than



the fracture capacity under gravitational driving force. Individual fingers were faster, narrower, longer, and more numerous than observed under dry initial conditions. Wetting fronts were found to follow existing wetted structure, providing a mechanism for rapid recharge and transport.

"Surface and Aperture Characteristics for Saturated Fluid Flow and Transport Calculations in a Natural Fracture," by P. W. Reimus, R. J. Glass, and B. A. Robinson. Abstract: This paper discusses the aperture distribution within a natural fracture determined from surface profile data measured with a noncontact laser profilometer. The surfaces and apertures were found to be isotropic. The aperture distribution was equally well described by either a normal or a lognormal distribution. The aperture spatial correlation varied over different areas of the fracture, with some areas being much more correlated than others. The fracture surfaces did not have a single fractal dimension over all scales, which implied that they were not self-similar. The saturated flow field in the fracture was approximated by solving a finite-difference discretization of the fluid flow continuity equation in two dimensions. Tracer breakthrough curves were then calculated using a particle-tracking method. Comparison of breakthrough curves obtained using both coarse- and fine-resolution aperture data (0.5 mm and 0.05 mm spacing between points, respectively) over the same subset of the fracture domain suggest that the spacing between aperture data points must be less than the correlation length to obtain accurate predictions of fluid flow and tracer transport.

"Modeling Gravity-Driven Fingering in Rough-Walled Fractures Using Modified Percolation Theory," by R. J. Glass. Abstract: Pore-scale invasion percolation theory is modified for imbibition of wetting fluids into fractures. The effects of gravity, local aperture field geometry, and local in-plane air/water interfacial curvature are included in the calculation of aperture filling potential, which controls wetted structure growth within the fracture. The inclusion of gravity yields fingers oriented in the direction of the gravitational gradient. These fingers widen and tend to meander and branch more as the gravitational gradient decreases. In-plane interfacial curvature also greatly affects the wetted structure in both horizontal and nonhorizontal fractures, causing the formation of macroscopic wetting fronts. The modified percolation model is used to simulate imbibition into an analog rough-walled fracture, where both fingering and horizontal imbibition experiments were previously conducted. Comparison of numerical and

experimental results showed reasonably good agreement. This process-oriented physical and numerical modeling is a necessary step toward including gravity-driven fingering in models of flow and transport through unsaturated, fractured rock.

Development of a methodology to produce epoxy casts of natural fractures continued. A natural tuff fracture, collected from the Bandelier formation near Los Alamos, NM, was prepared for casting. Silicon rubber was used to create negative replicas of both sides of the fracture. In February, the negative molds will be used to create clear epoxy replicas of the original fracture. Other natural fracture samples, also collected from the Bandelier tuff, were cut to rectangular shape in preparation for additional casting.

A second natural fracture from the Bandelier formation was used in an experiment demonstrating gravity-driven wetting front instability. The fracture was cut to a rectangular shape (33 cm x 66 cm) and carefully cleaned prior to reassembly. The two halves were fitted into place and then clamped. The complete fracture was then placed in a fixture such that the long axis of the fracture was oriented vertically and the upper boundary was horizontal. Silicon putty encircled the fracture along the upper boundary, creating a reservoir. Thirteen ml of deionized water was rapidly introduced into the reservoir, using a linear array of 15 10cc syringes. To increase visual contrast, the deionized water was dyed blue with FD&C blue #1 at a concentration of 1 g/l. The fluid was allowed to infiltrate for several minutes and the fracture was disassembled for inspection. The wetted structure clearly showed the development of individual fingers oriented primarily in the downward direction. All steps of this experiment were recorded photographically. The fracture surfaces are being cleaned in preparation for additional experiments.

Preliminary experiments investigating the effects of air entrapment on fracture permeability and tracer migration continued. Additional scoping experiments were performed to further develop an experimental methodology. Work concentrated on testing and refining computer control of the pumps, scales, and solenoid valves.

Fracture/Matrix Interaction

Work was completed on the paper "Investigation of Fracture-Matrix Interaction: Preliminary Experiments in a Simple System," by S. D. Foltz, V. C. Tidwell, R. J. Glass, and S. R. Sobolik, prepared for submission to the International High-Level Radioactive Waste



Management Conference. Abstract: Paramount to the modeling of unsaturated flow and transport through fractured porous media is a clear understanding of the processes controlling fracture-matrix interaction. As a first step toward such an understanding, two preliminary experiments have been performed to investigate the influence of matrix imbibition on water percolation through unsaturated fractures in the plane normal to the fracture. Test systems consisted of thin slabs of either tuff or analog material cut by a single vertical fracture into which a constant fluid flux was introduced. Transient moisture content and solute concentration fields were imaged by means of x-ray absorption. Flow fields associated with the two different media were significantly different owing to differences in material properties relative to the imposed flux. Richards' equation was found to be a valid means of modeling the imbibition of water into the tuff matrix from a saturated fracture for the current experiment.

Field, Lab, and Numerical Experimentation to Determine Scaling Laws for Effective-Media Properties in Heterogeneous Media

Work is 90% complete on construction of the automated gas permeameter. Efforts are increasingly being turned to the development of software to drive the automated system. Models for predicting the gas permeability based on permeameter data are also being explored to evaluate suitability for application in this project.

Caisson Test

Preliminary studies of sorption of mixtures of nickel, lithium, and bromine by the Wedron 510 sand have been initiated to determine if competition between tracers for the sorption sites will affect tracer transport in the caisson. Long-term studies of nickel solubility in 0.001 M NaCl electrolyte over the pH range 6 to 10 continued. "Preliminary Characterization of Materials for a Reactive Transport Model Validation Experiment," SAND93-0039C, by M. D. Siegel, D. B. Ward, W. C. Cheng, C. Bryan, C. S. Chocas, and C. G. Reynolds, was prepared for presentation at the 1993 International High-Level Radioactive Waste Management Conference in Las Vegas, NV.

A joint LANL/SNL paper entitled "Testing Models of Flow and Transport in Unsaturated Porous Media," by E. Springer, M. Siegel, P. Hopkins, and R. Glass, was prepared for presentation at the 1993 International High-Level Radioactive Waste Management Conference in Las Vegas, NV.

Reactive Transport Model Development

Efforts to implement the LEHGC coupled reaction-transport computer code on a massively parallel architecture continued.

Reactive Transport Experimentation

Long-term stability studies of pH in batch titration systems containing acid-cleaned Wedron 510 sand and the reference α -quartz continued. Progress was made in development of a method to perform in situ batch sorption studies in unsaturated media. A method to measure the concentration of aqueous uranium in wet sand using laser excitation was demonstrated at the Massachusetts Institute of Technology. A Nd-YAG laser was used to obtain a time-dependent fluorescence signal from a 2ppm uranium solution without use of a phosphorescence enhancer. Planning and instrumentation of the reactive transport laboratory continued. A Perkin Elmer Lambda 2 UV/VIS double-beam scanning spectrophotometer with a flow-through cell and an AMINCO Bowman Series 2 luminescence spectrometer were ordered for use in column studies and uranium batch sorption studies.

Major Activities Upcoming Next Three Months

The automated gas permeameter test system will be completed and tested. Experiments on blocks of tuff involving the measurement of gas permeability at different scales will be initiated.

Systematic experimentation of the effect of flow rate, fracture and matrix properties, and initial saturation on the matrix imbibition of water from an unsaturated fracture will be initiated. These studies will be conducted in thin experimental systems cut normal to the plane of the fracture.

Detailed studies of sorption of boron, bromine, lithium, and nickel by sand to be used in caisson or in supporting laboratory studies will continue. Lithium-nickel ion exchange studies with sand will be performed. Staff will fill and instrument the caisson, continue isotherm experiments to determine the linear range of sorption of tracers, continue surface potentiometric titration of sand, and implement the LEHGC code on massively parallel architecture. Staff will also continue development of the method for unsaturated K_d measurements with a Turbula mixer and optimize the method for laser fluorescence measurements of uranium in sand.



1.2.5.4.7 SUPPORTING CALCULATIONS FOR POSTCLOSURE PERFORMANCE ANALYSES

Major Accomplishments

SLTR92-0005, the document describing the performance assessment plan for the ESF Title II design support has been completed. The plan described in the document will be developed and implemented.

One effort has been completed using the calculations described in PDM 72-32 to estimate the effects on repository performance of surficial water use in the controlled zone outside the repository. Recommendations for controls on surficial water usage and locations of surficial ponds have been submitted for inclusion in Appendix I of the ESF Design Requirements (ESFDR) document and the Surface-Based Testing Field Requirements Document (SBTFRD). These recommendations had previously completed a technical review in accordance with Department Operating Procedure (DOP) 2-4.

Status Report on Ongoing Activities

The calculations described in PDM 72-32 to estimate the effects on repository performance of surficial water use in the controlled zone outside the repository will be documented in SAND92-2248. This report is currently being drafted and should be submitted for technical review shortly.

Preliminary efforts for model validation exercises in isothermal flow are continuing in collaboration with WBS 1.2.5.4.6. Preliminary calculations are being performed in conjunction with a series of experiments investigating matrix/fracture interaction by modeling

flow through a discrete fracture. These experiments are being performed by SNL Department 6115. Results of initial calculations were included in a paper to be presented at the 4th International High-Level Radioactive Waste Management Conference in Las Vegas, NV, in April 1993.

Preliminary efforts have begun for model validation exercises in nonisothermal flow in collaboration with WBS 1.2.5.4.3 and with the Department 6115 Flow Laboratory. A series of experiments using two different constant temperature boundaries has been tentatively planned for late summer/early fall.

A new ESF PA Analysis is being formulated with the writing of a work agreement. This analysis will address concerns regarding underground water usage for dust control during excavation and fire fighting in the north ramp tunnels and future ESF tunnels.

Major Activities Upcoming Next Three Months

SAND92-2248 will be completed.

A new ESF PA Analysis investigating the sensitivity of previous analyses to uncertainty in the hydrologic properties of the nonwelded Paintbrush tuff will be initiated with the writing of a work agreement.

Hydrologic flow codes (either LLUVIA-II or TOUGH-2) will be submitted to the Software Management System for use in ESF PA Analysis 13.

Information will be gathered for borrowing or buying various pieces of test equipment for the nonisothermal experiments planned with WBS 1.2.5.4.3. Information will be gathered on thermocouples, thermopiles, infrared scanners, and potential flow media materials (silica, alumina, sands, etc.).



1.2.5.4.9 DEVELOPMENT AND VERIFICATION OF FLOW AND TRANSPORT CODES

Status Report on Ongoing Activities

Software QA (No SCP activity)

A group of interested SNL staff formed a software Process Management Team (PMT). However, the acceptance of the QARD, Supplement I, December 18, 1992, by the NRC, led to postponement of the PMT meeting until January 14, 1993, to allow time to evaluate the impact of Supplement I on the procedures. Items of discussion planned for the first meeting included the impact of Supplement I upon the existing procedures, definition of a mission statement, definition of the process of entering codes into the system, and determination of a PMT leader. When the first meeting was held, the members decided to make this group a Quality Action Team (QAT) rather than a PMT. W. Miller was chosen as the QAT leader. In the meeting discussions, it was determined that the QARD now requires that verification and validation plans be written and reviewed for all scientific and engineering software (SES) codes. Only SES codes may now have to meet the requirements of the QARD; all other types of software may be exempt. The QAT is waiting for a determination from the Project office on this issue. A draft of QAIP 3-2 that will meet the requirements of the QARD for SES codes is in preparation. It was suggested that desk instructions containing examples of how to enter codes into the system be issued with the next revision of QAIP 3-2. Two action items were assigned: 1) determine the software contact at the Project Office, whether the Software Advisory Group (SAG) will remain intact to provide QARD interpretations, and whether the QARD addresses only SES codes, and 2) develop a draft of the QAT mission statement.

Work is continuing to revise the process for placing non-SES calculational codes under configuration control. The procedure for handling platform changes for qualified codes was also changed. Some procedures in QAIP 3-2 were revised, and an Interim Change Notice (ICN) reflecting these changes has been issued to the staff. These changes provide a more expedient method for entering software into the system by speeding up the process without sacrificing quality. The ICN will become effective on January 22, 1993.

M. Wernig will be leaving Department 6351 at the end of the month. SNL software QA staff are currently determining allocation of remaining personnel.

TOSPAC Version 1.10 has been entered into the Software Configuration Management System. A computer-readable copy of the source code, a listing of the source code, and a draft of the "Installation and Checkout Report for TOSPAC Version 1.10" were produced. The "Installation and Checkout Report for TOSPAC Version 1.10" was completed and the necessary paperwork—the MOD Request form, the MOD Resolution Form, and the Software Classification Form—was completed and submitted. Although SNL has versions of TOSPAC that run on VAX computers and personal computers, the TOSPAC Version 1.10 only runs on SUN workstations. The VAX and PC programs write out a warning message stating that they are not identical to the TOSPAC Version 1.10 in the Software Configuration Management System.

In response to an SNL YMP Corrective Action Report (CAR) concerning TOSPAC Version 1.00, comparison was made of the output from TOSPAC Version 1.00 with the published version of the TOSPAC User's Guide. Six discrepancies were identified. A memorandum to 110/12147/110-12771.00/6.5/QA, from J. H. Gauthier, Technical Contact for TOSPAC, addressing the subject of "Software Documentation, Section 6.5 of QAIP 3-2," was written to document these discrepancies. All discrepancies were caused by improvements to TOSPAC during the two years between the time TOSPAC Version 1.00 was entered into the Software Configuration Management System and the TOSPAC User's Guide was published. The discrepancies were as follows:

- (1) The mass-balance calculation was made more accurate.
- (2) The characteristic-curve tables were modified to provide greater resolution near residual saturation.
- (3) An extraneous error message was omitted.
- (4) The groundwater-travel-time (GWTT) plot was modified to include GWTT calculated using the composite water velocity.
- (5) A new source option was added.
- (6) An option to allow calculation of solute transport in the saturated zone was added.

None of the discrepancies influenced the results of the quality-affecting Exploratory Studies Facility Performance Assessment Analysis 72-28.

Other ongoing work has included transitioning the duties of the software librarian, qualifying the SUN version of JAC2D YMP 1.00, and processing software QA records.



1.2.6 EXPLORATORY STUDIES FACILITY

The objective of the Exploratory Studies Facility element includes work scope related to the design, construction, and operation of the Exploratory Studies Facility. The Exploratory Studies Facility element includes the Exploratory Studies Facility Coordination, Planning, and Technical Assessment (1.2.6.1.1) task.

1.2.6.1.1 *ESF COORDINATION, PLANNING, AND TECHNICAL ASSESSMENT*

Status Report on Ongoing Activities

Construction monitoring plans for the ESF starter tunnel continued to be refined. An Experiment Procedure and work agreement are being drafted and input to the test planning package is being prepared.

Major Activities Upcoming Next Three Months

Staff will work with LLNL staff, under LANL coordination, to consolidate ESF thermomechanical testing with hydrothermal testing.

Documentation for construction monitoring activities for the ESF starter tunnel, including a work agreement, an experimental procedure, and a QA grading report, will be developed. A data acquisition system (DAS) will be assembled, geotechnical instruments will be procured, and monitoring activities begun.



1.2.9 PROJECT MANAGEMENT

The objective of the Project Management element includes work scope related to project-level planning and control, and management of contract activities. The Project Management element includes two tasks: Technical Project Office Management (1.2.9.1.2) and Project Control (1.2.9.2.2).

1.2.9.1.2 TECHNICAL PROJECT OFFICE MANAGEMENT

Significant Meetings Attended

L. E. Shephard attended the TPO meeting in Las Vegas, NV, on January 19, 1993.

Status Report on Ongoing Activities

J. Schelling has relocated to Las Vegas, NV, to act with D. Kessel as SNL's on-site representatives.

1.2.9.2.2 PROJECT CONTROL

Major Accomplishments

During January, the December cost report was transmitted to the Project on schedule; the revised budget with carryover was also transmitted. The monthly report and the weekly reports were transmitted electronically to YMP. The first monthly cost and Full Time Equivalent (FTE) report was submitted to the M&O. The new NOVELL server for the Project Control group is online, with all users connected to the new server. A dramatic improvement in response time has been noted on Primavera.

Status Report on Ongoing Activities

Progress continues on corrections and refinements to the personnel database in INFORMIX for the Configuration Management System. Modifications are being made to detailed reports generated to support the budget planning process. The modifications will simplify the report-generation process and will eventually address errors due to rounding budget amounts to the nearest \$1000.00. Work is progressing on developing detailed descriptions of Level 3 milestones.

Major Activities Upcoming Next Three Months

The procurements database will be revised to reflect the FY93 WBS structure.



1.2.11 QUALITY ASSURANCE

The objective of the Quality Assurance element includes work scope related to the development and maintenance of project participants' assurance programs consisting of all those planned and systematic actions necessary to provide adequate confidence that the information to obtain a license for siting, constructing, and operating a geological repository and monitored retrievable storage facility will be met and complies with Federal regulations.

1.2.11 QUALITY ASSURANCE

Status Report on Ongoing Activities

The transition of the SNL YMP QA Program necessitated by the new Office of Civilian Radioactive Waste Management (OCRWM) QA Requirements and Description (QARD) document is well underway. The first four major steps of the Transition Plan specified by the OCRWM Office of QA have been completed at SNL. These steps are:

- to generally review the document for familiarization and to assign personnel to be trained on the Requirements Tracking Network,
- to determine specifically which major sections of the QARD do and do not apply to us as a Participant organization,
- to complete and submit a draft QA implementation matrix, providing a "snapshot" of QARD implementation, and
- to prepare and submit an impact analysis and transition plan.

The next major step, that of revising the various QAIPs to make them consistent with the QARD, has been initiated. Prioritization of these revisions has been established in a way to support preparation for the ESF starter tunnel field investigations. As a result, revisions to QAIPs 1-2, 2-10, 5-1, 6-3, and 11-1 have begun.

QA personnel have been working with research staff in the development of Experiment Procedures (EPs) for

the acquisition of subsurface information in the Systematic Drilling Program.

A software QAT has been established and has begun efforts to improve software processes, identify simplifications to the software QA procedure, and to implement the the software QA requirements of the new QARD.

Major Activities Upcoming Next Three Months

Planning and preparation for field work at the Yucca Mountain site for collection of geotechnical data at the ESF north portal starter tunnel will start in February. L. Costin, the responsible SNL manager for the work, and J. Pott, the PI, met with SNL QA staff to develop a plan to address applicable QA requirements.

During the coming months, the investigators will, among other activities, work with QA staff to translate the work into a work agreement, establish the graded application of QA to the work, develop an EP, and define calibration requirements for the instrumentation to be used.

Two audits are planned for the next three months. Disposal Safety Inc. and the Massachusetts Institute of Technology will be audited. Also, surveillances will be performed on initiating and implementing work agreements and on JAC2D software certification.

Other Items to Report

Two Department 6319 personnel attended Requirements Traceability Network (RTN) training at YMP. All SNL YMP procedures have been entered into the RTN database. Requirements will be entered next.



1.2.12 INFORMATION MANAGEMENT

The objective of the Information Management element includes work scope related to the project-level establishment of systems to facilitate organization, storage, and retrieval of information/documents. The Information Management element is comprised of four tasks: Information Management Coordination and Planning (1.2.12.1), Local Records Center Operation (1.2.12.2), Participant Records Management (1.2.12.3), and Document Control (1.2.12.5).

1.2.12.1 INFORMATION MANAGEMENT COORDINATION AND PLANNING

Significant Meetings Attended

Staff attended the Information Resource Management (IRM) council meeting in Las Vegas, NV, on January 13, 1993.

Major Activities Upcoming Next Three Months

The Information Technology Report/Long Range Plan (ITR LRP) and the Information Technology Report/Short Range Plan (ITR SRP) responses will be developed and submitted to YMP. Input to the IRM Strategic Plan will be provided.

1.2.12.2 LOCAL RECORDS CENTER OPERATION

Major Accomplishments

Seven boxes of YMP Limited Value Records were delivered to SNL Microfilming for processing.

A study was initiated to evaluate the installation of a record scanning and optical character recognition (OCR) software program for use in the Records Management Program. The software reviewed included LaserFiche, File Net, RKYVE, SNL Organization 2800 software, and Text Pro.

Major efforts included reviews of Project documents from three individuals no longer on YMP and one completed subcontract. Three thousand pages of duplicate materials were identified and destroyed.

Verification of pre-1990 hardcopy records against the Project microfilm was conducted with 6,000 pages being reviewed.

Status Report on Ongoing Activities

SNL Records Center inventory performed liaison activities for SNL/YMP staff, including planning meetings, introductions to YMP managers, and scheduling YMP personnel for interviews by the Millican & Associates Contractor Group, who are doing the records inventory for Sandia National Laboratories. In addition the following activities are underway:

- (1) An update of the NTS photo database was initiated,
- (2) A plan to review and process cancelled/closed datasets was initiated,
- (3) Corrections or changes were submitted for three laboratory experiments,
- (4) One new dataset was opened,



- (5) Five TDIFs were submitted to the RMS, and
- (6) Eight TDIFs were entered into the YMP ATDT.

Major Activities Upcoming Next Three Months

All Desk Guidances will be completed.

All microfilm will be verified against records from 1989 to the beginning of the Project. Verified hardcopy will be destroyed if approvals are issued or boxed and sent to the SNL Archives. No direction has been issued by OCRWM regarding ownership and disposition of dual storage YMP records.

Literature research has been initiated to research and propose a phased approach to development of a Disaster Preparedness and Recovery Plan for the YMP Records Management Program.

Staff will identify all "completed or cancelled" technical data activities to ensure that all records packages were appropriately identified, prepared, and forwarded to the YMP CRF. A plan for completion of this activity will be established if the quantity is too large to process in three months.

Staff will work through the Records Management QAT to review the technical data record packaging process to determine if improved processing is possible to reduce redundancy and duplication of efforts and improve protection of data.

Staff will review and revise Desk Guidance for Participant Data Archive (PDA) activities.

Issues/Potential Problems Needing Resolution and Potential Impacts

A possible breakdown in implementation of AP 5.2Q in identification of data to be submitted to the YMP Technical Data Base has been identified. Staff will work with the Task Leader to clarify responsibilities and processes.

1.2.12.2.3 PARTICIPANT RECORDS MANAGEMENT

Major Accomplishments

Staff was appointed co-chair of the OCRWM Technology Integration and Methodology Analysis (TIMA) committee on "Communication." A preliminary charter was prepared and committee members are corresponding via E-mail and teleconference.

Staff prepared a Records Management Processes List to be used in the OCRWM TIMA Requirements and Regulations Committee matrix.

Significant Meetings Attended

On January 5, 1993, the first SNL Records/Nonrecords Inventory meeting was held to conduct strategic planning for implementation within SNL Nuclear Waste Management Division 6300. Information from the OCRWM YMP Records/Nonrecords Inventory was shared and discussed.

In Las Vegas, NV, on January 11, 1993, staff chaired a meeting of all YMP Records Coordinators to discuss common concerns and to request operational records management clarifications. On January 12, 1993, staff attended the NIRMA DOE SIG and presented the Preliminary Draft of a committee paper addressing "What Is A Nuclear Quality Assurance Record?" Staff also attended the YMP Records Coordinators Meeting and the YMP IRM Council Meeting.

Status Report on Ongoing Activities

Staff prepared cost estimates for equipment and furniture for the Nuclear Waste Management Center Records and Information Center.

Major Activities Upcoming Next Three Months

Staff will initiate the Records Management QAT to review the Record Series, the Master List of File Codes, and revise records packaging processes to simplify work and enhance the organization of project or topic files.

Staff will obtain SNL and OCRWM approval/ authorization for the identification of YMP Project duplicate storage records as Federal nonrecords. When so designated, approval/authorization for the verification and destruction of said records will be obtained.



January 1993

1.2.12.2.5 DOCUMENT CONTROL

Status Report on Ongoing Activities

Several modifications have been made to the SNL Controlled Documents System in INFORMIX, and detailed program code documentation has been initiated.

Major Activities Upcoming Next Three Months

QRPs for superseded and recalled Controlled Documents will be prepared and submitted to the LRC. The goal is to have all back-log ORPs submitted.



1.2.15 SUPPORT SERVICES

The objective of the Support Services element includes work scope related to project-level general administrative and project support activities. The Support Services element is comprised of three tasks: Support Services Coordination and Planning (1.2.15.1), Administrative Support (1.2.15.2), and YMP Support for the Training Mission (1.2.15.3).

1.2.15.1 SUPPORT SERVICES COORDINATION AND PLANNING

Status Report on Ongoing Activities

Routine oversight of support service activities were conducted.

1.2.15.2 ADMINISTRATIVE SUPPORT

Major Accomplishments

A list of excess equipment was sent to DOE/YMP. This property will be dispositioned as soon as a response is received. Priorities for property actions were identified.

Two SAND reports were printed and distributed.

One SLTR was completed and distributed.

Seventeen 1993 International High-Level Radioactive Waste Management Conference papers were approved by the Project Office.

Significant Meetings Attended

Staff attended a meeting regarding the implementation of the semi-annual forecast for the Socioeconomic Monitoring Plan in Las Vegas, NV, on January 12, 1993.

Status Report on Ongoing Activities

The "Desk Guidance for Reports Publication" preliminary draft was reviewed and approval was given to produce the final draft.

"Nuclear Waste Fund" tags are being applied to all property.

Major Activities Upcoming Next Three Months

Work has been initiated on compiling historical data for the purpose of forecasting procurements and labor resources through FY2001. This information is being compiled for the YMP Socioeconomic Monitoring Report. All property actions identified will be completed.



1.2.15.3 YMP SUPPORT FOR THE TRAINING MISSION

Major Accomplishments

The "Geology for Non-Geologists" course was completed.

A new training manager was selected.

Status Report on Ongoing Activities

Video tapes of the "Geology for Non-Geologists" course are being edited. Training record packages were prepared and submitted to the LRC.

Major Activities Upcoming Next Three Months

Editing of the "Geology for Non-Geologists" course tapes will continue.

Training for improving computing skills will be initiated.

Replacement training support staff may be hired. The new training manager will attend the "Train the Trainer" course and the Training Coordinator meeting in Las Vegas, NV, in February.

A three-day course entitled "Initial Instructor Training" will be offered on site at SNL by the YMP Training Department in February.



MAR 11 8 45 AM '93

Sandia National Laboratories

Albuquerque, New Mexico 87185

I-338655

WBS: 1.2.9
QA: NA

MAR 3 1993

Carl P. Gertz, Project Manager
Yucca Mountain Site Characterization
Project Office
U. S. Department of Energy
Nevada Operations Office
101 Convention Center Drive
Phase 2, Suite 200
Las Vegas, Nevada 89193-8518

Attention: V. F. Iorii

Subject: January, 1993 Monthly Highlights and Status Report

Dear Carl:

Enclosed is the Monthly Highlights and Status Report for the month of January, 1993. If you have any questions, please call Alice Hotchkiss at FTS 844-7515.

Sincerely,



L. E. Shephard
Technical Project Officer
YMP Project Management
Dept. 6302

AH:6352:pe
Enclosure

DIVISION Iorii
 CC: Williams / Brodsky
 CC: Oyer / Jones S
 CC: Osborn / Stucker - RWR
 CC: Petru
 CC: Simecka
 CC: Harrison
 CC: Gertz
 CC: John White, J - w/o

REC'D IN YMP

3/11/93

ENCLOSURE 5

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YMPO J. R. Dyer
YMPO W. R. Dixon
YMPO E. B. Pietrie
YMPO J. Robson
YMPO W. B. Simecka
YMPO V. F. Iorii
YMPO D. J. Harrison
NRC P. S. Justus
M&O S. J. Bodnar (2)
M&O E. M. Fortsch (2)
M&O R. K. St. Clair (2)
M&O L. Wildman
M&O L. D. Foust
ORNL R. B. Pope
CCS S. O'Connor
RSN R. L. Bullock
LANL J. A. Carepa
LLNL W. L. Clark
USGS L. R. Hayes
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