LAWRENCE LIVERMORE NATIONAL LABORATORY YUCCA MOUNTAIN PROJECT
JANUARY 1993 TECHNICAL HIGHLIGHTS AND STATUS REPORT
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LAWRENCE LIVERMORE NATIONAL LABORATORY
(LLNL)
YUCCA MOUNTAIN PROJECT (YMP) STATUS REPORT

JANUARY 1993

EXECUTIVE SUMMARY
(Items Proposed for Reporting in YMPO or OGD Reports)

**1) 1.2.2.2.2 (Hydrologic Properties of the Waste Package Environment).** Calculation of the SCP-CDR thermal loading case (47.5 MTU/acre) by B. Ross (an SNL subcontractor), indicates that a bulk permeability of 50 darcy ($5.0 \times 10^{-11}$ $m^2$) is sufficiently large to allow large-scale, buoyant gas-phase convection to significantly lower repository temperatures relative to the conduction-only case ($\Delta T = 9.5°C$ at t = 1000 yr). LLNL's SCP-CDR thermal loading case (49.2 MTU/acre), indicates that 84 darcy is sufficiently large to significantly lower repository temperatures relative to what is effectively a conduction-only case ($\Delta T = 13.1°C$ at t = 1000 yr). For 27.1 MTU/acre (30-yr-old SNF and 20 kW/acre), LLNL's calculations indicate that a $k_b$ of about 100 darcy is sufficiently large to result in large-scale, buoyant gas-phase convection significantly affecting repository temperatures and the UZ moisture distribution for t >1000 yr. Note that 27.1 MTU/acre and a $k_b$ of 100 darcy result in the same Rayleigh number as Ross' SCP-CDR thermal loading case with a $k_b$ of 50 darcy. Therefore, LLNL's determination of the "threshold" thermal loading and bulk permeability conditions for which sub- or marginal-boiling performance begins to become significantly affected by large-scale, buoyant gas-phase convection is corroborated by Ross' analysis.

**2) 1.2.2.2.4 (Engineered Barrier System (EBS) Field Tests).** The first draft of the Study Plan for the Engineered Barrier System Field Tests (SCP 8.3.4.2.4.4) is in internal review. The first draft of the Scientific Investigation Plan for the Large Block Test was completed.

**3) 1.2.2.2.5 (Characterization of the Effects of Man-Made Materials on Chemical & Mineralogical Changes in the Post-Emplacement Environment).** In anticipation of concern about organic materials (including diesel fumes and exhaust) that may be introduced into the ESF, a program of study is being designed to assess the present capabilities of the GEMBOCHS computer database in this area, and to identify deficiencies. This program is distinct from the literature review of colloids, completed in 1991, which included some organic materials, but did not address chemical stability (and conversely, reactivity) or degradation. A decision making strategy for identifying the database deficiencies of greatest concern, and thus the direction of experimental work, is being developed in tandem with this program.

**4) 1.2.2.3.1.1 (Waste Form Testing - Spent Fuel).** Test specimen preparations have been started on ATM-106 fuel (PWR fuel with burnup ~48 MWd/kgM and fission gas release ~18%) in both oxidized (O/M ~2.4) and unoxidized forms. Flow-through dissolution tests will be started on these specimens as soon as they have been prepared and their surface areas have been measured. Plans were made at PNL to start a dry bath oxidation test at 255°C using a variety of fuels in order to determine

real time transition to $U_3O_8$. An addendum to the test plan is being written. Plans are also being formulated for the restart of the Thermogravimetric Apparatus oxidation systems (TGAs). A new data acquisition system is being purchased, and the systems are being reassembled. B. Hanson, a graduate student from UC Berkeley, will arrive at PNL at the end of February to do his dissertation research using the TGAs.

**5) 1.2.5.4.2 (Waste Package Performance Assessment).** Modeling has been done to determine whether spent fuel cladding breach will occur for a variety of repository configurations. The phenomenon involves the temperature history of the cladding, stress from internal gas pressure, and creep toward eventual failure of the cladding by creep rupture. The creep rate is strongly temperature dependent. Some repository configurations will preserve a median spent fuel rod from creep rupture and some will not. For example, a configuration with 21 PWR assemblies per package, 33 GWdays/MTU burnup, 30-year age at emplacement, and 72 foot spacing of packages will give creep only up to about 25% of the limit, and has an areal mass loading (AML) of 71 MTU/acre, (about 1.5 times the SCP Conceptual Design Report AML) enough to provide substantial dryout of the host rock within and above the repository.

## 1.2.1 SYSTEMS ENGINEERING

### 1.2.1.1 Systems Engineering Coordination and Planning

No significant activities.

### 1.2.1.5 Special Studies

W. Simecka, C. Newbury (YMPO), N. Elkins, H. Kalia, G. Zyvoloski (LANL), L. Costin, J. Pott, E. Ryder (SNL), D. Stahl, E. Cikanek, W. Nelson, S. Saterlie, S. Nesbit, R. Datta (M&O) and J. Wang (LBL) visited LLNL on January 6 to discuss thermal testing in the ESF. At that meeting, T. Buscheck gave a presentation entitled "Repository-Heat-Drive Hydrothermal Flow: Analysis, Model Validation, and Testing".

T. Buscheck made a presentation entitled "Repository-Heat-Driven Hydrothermal Flow: Discussion of Conceptual Models, Numerical Models, Physical Data, and Assumptions" at YMPO on January 22.

M. Revelli represented LLNL at the January 19-21 workshop in Las Vegas for the Evaluation of Natural Barriers Important to Waste Isolation. The workshop was convened by YMPO to assist the Assessment Team (in accordance with AP 6.17Q) with the identification of natural barriers appropriate for placement on the Q-list. The scope of this assessment was limited to the SCP design and strategy; several items including human intrusion, repository expansion areas, and "extended-dry" repository concepts, were not take into consideration for this evaluation. Results of the Natural Barrier Evaluation Workshop wee presented in a report to the Assessment Team (draft 1/27/93).

### 1.2.1.6 Configuration Management

Affected document notices (ADNs) were completed for CRs 92/147, 93/040, 93/084 and 93/106.

## 1.2.2 WASTE PACKAGE

### 1.2.2.1 Waste Package Coordination and Planning

LLNL reviewed the draft LANL memorandum "Determination of Tracer Requirements for Construction-related Water and Compressed Air Usage in the ESF Starter Tunnel" and determined that these changes will have no negative impacts on either LLNL ESF testing or on waste package performance, based on currently available information.

B. Viani participated in the January Geochemistry Integration Task (GIT) teleconference meeting. B. Viani participated in organizing the GIT sponsored meeting focused on coupled hydrological/geochemical processes in the thermally altered zone.

### 1.2.2.2 Waste Package Environment

The following paper was approved and will be presented at the International High Level Radioactive Waste Management Conference in Las Vegas, April 26-30:

"Alternative Strategies - A Means for Saving Money and Time on Yucca Mountain" by D. Wilder.

#### 1.2.2.2.1 Chemical and Mineralogical Properties of the Waste Package Environment

Plans continue for the site visit to LLNL of the New Zealand collaborators B. Christenson, W. Giggenbach and A. Reyes on February 5. Arrangements have been made for them to also visit the Project Office and the Yucca Mountain site on February 8. The purpose of their visit is to discuss specific locations in the New Zealand hydrothermal system that may be useful for geochemical model validation exercises.

Development of a plan for model validation at the New Zealand site continued, with an extended outline of required activities developed in draft form. This information will be folded into the revised study plan for this task.

Installation of software to enhance our capability to model equilibrium/disequilibrium domains in the vicinity of waste packages was completed for the Silicon Graphics Indigo/XS-24 system. This will expand our ability to visualize the evolution of chemical environments as the thermal regime around waste packages changes. Testing of the package will continue in February.

Coordination activities continued between various project participants regarding coupling of geochemical and hydrological processes.

The paper by W. Glassley entitled "Validation of Hydrogeochemical Codes Using the New Zealand Geothermal System" was approved by YMPO. It will be published in the proceedings of the CEC Natural Analog Working Group meeting that was held in Toledo, Spain on October 5-9, 1992 and will also be published as an LLNL preprint.

Discussions were held regarding PACS workscope statements.

**1.2.2.2.2 Hydrologic Properties of the Waste Package Environment**

The first draft of the Study Plan for the Near Field Environment Hydrology Task is in the internal technical review process.

Model Calculations

Work continued to analyze the preliminary scoping calculations of the hydrothermal performance of the repository, using the new model which represents hydrothermal flow in the upper 1000 m of the saturated zone (SZ) as well as within the unsaturated zone (UZ). With respect to both bulk permeability, $k_b$, and the impact of large-scale, buoyant gas-phase convection on thermal performance and moisture redistribution, past work has primarily focused on intermediate- to high-AML (Areal Mass Loading, expressed in metric tons of uranium per acre - MTU/acre) cases for which rock dry-out primarily occurs as a result of boiling. Permeability values considered range from $1.9 \times 10^{-7}$ darcy (corresponding to no fractures) to 84 darcy (corresponding to one 1000-μm-fracture per meter). The reference-$k_b$ case has a $k_b$ of 0.28 darcy (corresponding to three 100-μm-fractures per meter). (One darcy is approximately $10^{-12}$ $m^2$). Current work is examining the impact of large-scale, buoyant gas-phase convection on thermal performance and moisture redistribution for low- to intermediate-AML (27.1 to 49.2 MTU/acre) cases for which dry-out primarily occurs under sub-boiling conditions.

*Intermediate to High Thermal Loads*

Before discussing the impact of buoyant gas-phase convection on sub-boiling performance, it is necessary to summarize what has been learned about the impact of buoyant gas-phase convection on boiling performance. In cases for which rock dry-out is primarily driven by boiling (intermediate- to high-AMLs), it was found that thermo-hydrological performance can be classified into three distinct categories with respect to $k_b$. The low-$k_b$ category ($k_b$<0.01 darcy) corresponds to situations in which fracture density and connectivity throttle the rate of boiling and dry-out. Because heat flow is dominated by heat conduction, it is vertically symmetrical about the heater horizon. The low $k_b$ results in large gas-phase pressure gradients that elevate the boiling temperature, thereby resulting in higher peak temperatures. The intermediate-$k_b$ category 0.01 <$k_b$<10 darcy) corresponds to situations in which the fracture density and connectivity are sufficient to promote boiling that is not substantially throttled by flow resistance in the fractures. Because $k_b$ is not sufficiently large to promote substantial large-scale buoyant gas-phase convection, local boiling pressure gradients dominate the large-scale, buoyant, gas-phase pressure gradients, resulting in steam flow and condensate generation that is vertically symmetrical about the repository horizon. The heat convective effects in

the heat-pipe zone have a local, transient effect on the temperature distribution, but because convection does not significantly enhance the heat loss from the boiling zone to the far-field, the duration of boiling conditions is not significantly reduced.

The high-$k_b$ category ($k_b$>10 darcy) corresponds to situations in which fracture density and connectivity are sufficiently large to allow large-scale, buoyant gas-phase gradients to dominate the local boiling pressure gradients, causing significant asymmetry in the vertical temperature distribution. For this category of thermo-hydrological performance, $k_b$ = 84 darcy was considered. Although far-field convection completely dominates the direction of steam flow, causing all of the steam to be driven to the upper condensation zone, heat flow is still dominated by heat conduction, and the duration of the boiling period, $t_b$, is not substantially reduced (for high AMLs) relative to the intermediate-$k_b$ case. Because large-scale buoyant convection enhances the heat loss for the boiling zone to the far-field, heat convection has a definite influence on heat flow (e.g., lowering peak temperatures), yet it accounts for less than 50% of the overall heat flow; therefore, this situation is referred to as convection-influenced heat flow. The term convection-dominated heat flow is reserved for cases in which convection accounts for more than 50% of overall heat flow.

*Low to Intermediate Thermal Loads*

For 27.1 MTU/acre (30-yr-old Spent Nuclear Fuel (SNF), and Areal Power Density (APD) of 20 kW/acre), bulk permeabilities of 0.28, 84, 168, 410 and 840 darcy were considered. It was realized that the average $k_b$ in the UZ is not likely to approach the latter two values of $k_b$; however, calculations may be applicable to the local thermo-hydrological performance in highly fractured areas such as shear or fault zones. The primary purpose of this study was to identify the averaged conditions (thermal loading and $k_b$) required to result in heat flow being dominated by large-scale, buoyant gas-phase convection. Also considered were an intermediate and high bulk permeability for 49.2 MTU/acre (10-yr-old SNF and an APD of 57 kW/acre, corresponding to the reference SCP-CDR thermal loading); these values are 0.28 darcy and 84 darcy. Note that the high value is only a factor of two greater than some of the $k_b$ values that have been measured in TSw2 (the host rock for the repository horizon).

*Intermediate (Reference SCP-CDR) Thermal Loads*

For the 49.2 MTU/acre reference SCP-CDR thermal loading case, large-scale buoyant gas-phase convection occurring in the high-$k_b$ (84 darcy) case reduces the duration of the boiling period, $t_{bp}$, from 666 yr to only 117 yr, relative to the intermediate-$k_b$ (0.28 darcy) case. The peak temperature at the center of the repository, $T_{peak}$, is also reduced from 100.3 to 97.3°C. At t = 1000 yr, the temperature at the center of the repository is reduced by 13.1°C relative to the $k_b$ case. Interestingly, B. Ross (an SNL subcontractor) has conducted a calculation for a case with nearly the same AML (47.5 MTU/acre), with the primary differences being that he assumes 30-yr-old SNF, yielding an APD of 35 kW/acre, and a $k_b$ of 50 darcy. At t = 1000 yr, Ross found that buoyant gas-phase convection has reduced the temperature at the center of the repository by approximately 9.5°C, relative to the conduction-only calculation. When one takes into account that the Rayleigh number for this case is

approximately 45% less than that applicable to LLNL's calculation, the two models are seen to be in reasonably good agreement. Moreover, the shape of the temperature curves predicted by the two different models are very similar.

For cases which never get significantly above the nominal boiling point, large-scale, buoyant, gas-phase convection can significantly affect the duration of boiling. This buoyant convective effect can only significantly impact repository temperatures if substantial quantities of water vapor are transported from the repository horizon to the far-field. The transport of water vapor (and latent heat) that is sufficiently large to reduce repository temperatures is also associated with dramatic changes in the moisture redistribution. Simply put, in order for the hydrological (buoyant gas-phase) flow system to dominate heat flow generated by the repository, that repository-generated heat flow must have had a dominant impact on the hydrological flow system, including both liquid-phase and gas-phase flow.

For the reference SCP-CDR case, the intermediate $k_b$ (0.28 darcy) results in a very small vertical dry-out zone thickness, $h_{dz}$. For example, at t = 100 yr, $h_{dz}$ is only 12.2 m. The maximum $h_{dz}$ (14.4 m) occurs at t = 300 yr. At t = 1000 yr, the dry-out zone has nearly re-wetted back to ambient saturation. For the high-$k_b$ case, $h_{dz}$ at t = 300 yr is 23.3 m, nearly twice the $h_{dz}$ of the intermediate-$k_b$ case. Although boiling ceases at t = 117 yr, $h_{dz}$ continues to increase as a result of the large-scale, buoyant, gas-phase convection of water vapor under sub-boiling conditions, resulting in $h_{dz}$ = 109 m at t = 1000 yr. At t = 5000 yrs, $h_{dz}$ has grown to 167 m and the overlying condensate zone (where $S_l > 90\%$) is 213 m in thickness. It was also found that the net increase in liquid saturation, $S_l$, within the condensate zone exceeds the net decrease in $S_l$ within the dry-out zone. This indicates that large-scale, buoyant gas-phase convection is transporting water vapor from the lower dry-out zone (which in turn is supplied by water that is imbibed from the SZ) faster than the rate at which buoyant gas-phase convection can transport water vapor to the atmosphere.

Incidentally, it was assumed that the large values of $k_b$ are also applicable to the nonwelded vitric PTn even though preliminary data indicate that the PTn may be sparsely fractured. Had a smaller $k_b$ been applied to the PTn, this unit would effectively act as a barrier to the upward convection of water vapor, thereby enhancing the net rate of condensate buildup in the upper TSw2 and TSw1, relative to these calculations. It should also be noted that the model used the Equivalent Continuum Model (ECM) assumptions which preclude the occurrence of nonequilibrium fracture flow. Water vapor which is being generated "ubiquitously" throughout the connected fracture system is likely to return as spatially heterogeneous channelized fracture flow. Because this channelized fracture flow will probably exceed the ability of the local gas-phase flow system to evaporate that flow, this will result in nonequilibrium fracture flow persisting for some depth below the condensation zone. It is important to realize that a $k_b$ of 84 darcy is not likely to be applicable throughout the UZ. However, within shear or fault zones, the local value of $k_b$ is likely to be at least that large. Therefore, these calculations indicate the possibility of condensate generated above the repository draining back to the repository horizon (and possibly down to the water table) for tens of thousands of years following the end of the boiling period for the reference SCP-CDR thermal loading case.

*Low Thermal Load*

For 27.1 MTU/acre (30-yr-old SNF, yielding an APD of 20 kW/acre), the intermediate-$k_b$ case (0.28 darcy) results in virtually no net change in liquid saturation distribution; however, significant sub-boiling refluxing of water vapor and condensate does occur. This sub-boiling refluxing occurs as large-scale, buoyant, gas-phase convection drives water vapor upward to where it condenses and drains downward. The intermediate-$k_b$ case does not result in an upward mass flow rate of water vapor that is sufficiently large to exceed the mass flow rate at which condensate returns. For $k_b$ = 84 darcy, large-scale, buoyant gas-phase convection begins to have a noticeable (but very small) effect on temperatures and moisture distribution. For $k_b$ = 168 darcy, large-scale buoyant gas-phase convection has a minor impact on thermal performance, but a substantial impact on moisture redistribution, particularly for t > 5000 yr. For $k_b$ = 410 darcy, large-scale buoyant gas-phase convection has a more substantial effect on thermal performance and moisture redistribution, particularly for t>1000 yr. For example, $h_{dz}$ is 150 m at t = 5000 yr and the overlying condensate zone (where $S_l > 90\%$) has a vertical thickness of 173 m (extending all the way to the ground surface). The thermal perturbation to the liquid saturation distribution persists for more than 100,000 yr. The effect of large-scale buoyant gas-phase convection for $k_b$ = 840 darcy has a very substantial effect on thermal performance and moisture redistribution, particularly for t>600 yr.

The average $k_b$ in the UZ is not likely to approach the largest two values of $k_b$ used above; however, these calculations are probably indicative of local thermo-hydrological performance in highly fractured areas such as shear or fault zones. Even for 30-yr-old SNF (an APD of 20 kW/acre), the large-scale, buoyant gas-phase convection of water vapor will result in persistent condensate drainage in highly fractured zones for tens of thousands of years. Because some of this condensate drainage will occur as nonequilibrium fracture flow, it is likely to return to the repository horizon (and possibly to the water table). Therefore, if the definition of a "cold" repository is one that does not significantly perturb the ambient hydrological system, it appears very unlikely that a "cold" repository can be achieved.

B. Ross' analysis indicates that it requires about 1000 yr for large-scale, buoyancy-driven gas-phase convection cells in the UZ to become fully developed. LLNL's calculations also indicate that it requires about 1000 yr for large-scale, buoyant gas-phase convection cells to begin to significantly impact thermo-hydrological performance under sub-boiling conditions. Therefore, regardless of how substantial buoyant gas-phase convective effects may eventually become, the peak repository temperature, $T_{peak}$, for 30-yr-old SNF (which generally occurs within the first 600 yr) is not significantly influenced by large-scale gas-phase convective effects. For 30-yr-old SNF (an APD of 20 kW/acre), $T_{peak}$ is 59.9, 59.9, 58.8 and 59.0°C for $k_b$s of 0.28, 84, 414, and 840 darcy, respectively.

*Summary*

Ross' SCP-CDR thermal loading case (47.5 MTU/acre), indicates that a $k_b$ of 50 darcy ($5.0 \times 10^{-11}$ m$^2$) is sufficiently large to allow large-scale, buoyant gas-phase convection to significantly lower repository temperatures relative to the conduction-only case

($\Delta T$ = 9.5°C at t = 1000 yr). LLNL's SCP-CDR thermal loading case (49.2 MTU/acre), indicate that 84 darcy is sufficiently large to significantly lower repository temperatures relative to what is effectively a conduction-only case ($\Delta T$ = 13.1°C at t = 1000 yr). For 27.1 MTU/acre (30-yr-old SNF and 20 kW/acre), LLNL's calculations indicate that a $k_b$ of about 100 darcy is sufficiently large to result in large-scale, buoyant gas-phase convection significantly affecting repository temperatures and the UZ moisture distribution for t >1000 yr. Note that 27.1 MTU/acre and a $k_b$ of 100 darcy result in the same Rayleigh number as Ross' SCP-CDR thermal loading case with a $k_b$ of 50 darcy. Therefore, LLNL's determination of the "threshold" thermal loading and bulk permeability conditions for which sub- or marginal-boiling performance begins to become significantly affected by large-scale, buoyant gas-phase convection is corroborated by Ross' analysis.

Laboratory Experiments

Work continued to measure electrical resistivity as a function of moisture content of Topopah Spring tuff samples from U3hg-1 and GU-3 holes at room temperature. Four samples with different thicknesses were prepared from each rock type for the measurements. A gold electrode was deposited on the flat surfaces of the cylindrical disc samples. Two-electrode electrical resistance measurements were done on each of the four samples. The measurements have been completed in the drying phase. These measurements were made by using distilled water (DW) as pore fluid. DW has an electrical conductivity of ~0.4 μS/cm at 20°C. The same measurements will be repeated using a synthetic water with an electrical conductivity similar to that of J-13 water, which is about 33 siemens/m at 20°C. The purpose of following this experimental procedure is to determine the effect of the electrical conductivity of pore fluid on the relationship between the bulk electrical conductivity of a rock sample and the degree of saturation in it.

Work continued to investigate the different imbibition rates of water into a rock sample when the sample is either in a vapor environment or in liquid water. To understand the mechanism of the imbibition, capillary tubes of various inside diameters (ID) were put in a constant humidity chamber which will be set at various levels of humidity. The imbibition rate of water into each capillary tube will be determined. Last month it was found that a 100 micron ID is too large for the tubes to retain any moisture when they are put in a 95 - 98% relative humidity environment. Capillary tubes with ID ~33 microns have been obtained. They will be put in a 95 - 100% relative humidity environment and in liquid water. The amount of the imbibed water under these boundary conditions will be determined.

An experiment was started to determine the effect of fracture surface coatings on the imbibition of water into the matrix. Eight Topopah Spring tuff samples machined from Busted Butte outcrops were prepared for this purpose. Liquid water imbibition rates will be determined in these samples.

Meetings

The following papers were approved and will be presented at the International High Level Radioactive Waste Management Conference in Las Vegas, April 26-30:

1) "The Analysis of Repository-Heat-Driven Hydrothermal Flow at Yucca Mountain" by T. Buscheck and J. Nitao, and

2) "Large-Scale In Situ Heater Tests for Hydrothermal Characterization at Yucca Mountain", by T. Buscheck, D. Wilder and J. Nitao.

These papers are also available as LLNL preprints.

The paper by G. Danko (University of Nevada, Reno) and T. Buscheck (LLNL) entitled "Single-Hole In Situ Thermal Probe for Hydrothermal Characterization at Yucca Mountain" for presentation at the International High Level Radioactive Waste Conference in Las Vegas, April 26-30, was submitted to YMPO for approval.

The following papers were submitted to the American Nuclear Society Journal, Nuclear Technology:

1) "Implications of Episodic Nonequilibrium Fracture-Matrix Flow on Repository Performance" by J. Nitao, T. Buscheck and D. Chesnut,

2) "The Impact of Repository-Heat-Driven Hydrothermal Flow on Hydrological Performance at Yucca Mountain" by T. Buscheck and J. Nitao, and

3) "Large-Scale In Situ Heater Tests for the Characterization of Hydrothermal Flow at Yucca Mountain" by T. Buscheck, D. Wilder and J. Nitao.

W. Lin attended the workshop on flow and transport in unsaturated fractured rocks, on January 25-28 in Tucson, AZ. He presented some results of using electrical resistivity tomography in the laboratory and in the field to monitor water flow.

**1.2.2.2.3 Mechanical Attributes of the Waste Package Environment**

Plans were started for laboratory scale block testing in support of Study Plan 8.3.4.2.4.3 and the Large Block Test. This included interviewing technicians for support of the testing, and review of instrumentation systems for physical property measurements.

**1.2.2.2.4 Engineered Barrier System (EBS) Field Tests**

H. Kalia, and N. Elkins (LANL) visited LLNL on January 5 to discuss the thermal testing program.

The first draft of the Study Plan for the Engineered Barrier System Field Tests (SCP 8.3.4.2.4.4) is in internal review.

Large Block Test (LBT)

W. Lin collected some small pieces of Topopah Spring tuff from the Fran Ridge outcrop for determining the present moisture content in the rock. This information will be used in the design of the Large Block Test.

As requested, LLNL-YMP has reviewed its planned FY93 field work for the use of Tracers, Fluids, and Materials (TFM). The only field work planned is the Large Block Test at the Fran Ridge Test Pits.

The first draft of the Scientific Investigation Plan for the Large Block Test was completed.

**1.2.2.2.5 Characterization of the Effects of Man-Made Materials on Chemical & Mineralogical Changes in the Post-Emplacement Environment**

The revision of the Man-Made Materials Study Plan has begun. The revisions are primarily those made necessary by the changes in Study Plan requirements during the period that the Man-Made Materials task was not funded.

In the anticipation of concern about organic materials (including diesel fumes and exhaust) that may be introduced into the ESF, a program of study is being designed to assess the present capabilities of the GEMBOCHS computer database in this area, and to identify deficiencies. This program is distinct from the literature review of colloids, completed in 1991, which included some organic materials, but did not address chemical stability (and conversely, reactivity) or degradation. A decision making strategy for identifying the database deficiencies of greatest concern, and thus the direction of experimental work, is being developed in tandem with this program.

**1.2.2.3 Waste Form and Materials Testing**

**1.2.2.3.1 Waste Form**

**1.2.2.3.1.1 Waste Form Testing - Spent Fuel**

Spent Fuel Dissolution

One set of low-oxygen dissolution experiments at LLNL was completed. Two more room-temperature dissolution experiments at 2% oxygen are on-going using the newly developed gravity-flow systems. These are included in the test matrix. The two lowest-oxygen room temperature experiments, also part of the test matrix, were begun late in the month. Dissolution cells and associated tubing for the remaining reduced-oxygen, higher temperature runs have been fabricated. To increase the progress of these experiments, the systems are being assembled in another laboratory where additional are available. The room temperature runs are being completed in the original laboratory.

The last two tests at PNL of the original spent fuel flow-through test matrix (a total of 20 tests) are still in progress to reevaluate some results that appear inconsistent with the others.

Equipment that will allow the BET surface areas of spent fuel test specimens to be measured has been installed in the Bldg. 325 hot cells at PNL, and initial operation tests have been satisfactorily completed on an unirradiated $UO_2$ specimen with a

known surface area. Surface area measurements on spent fuel specimens will begin by early February.

Test specimen preparations have been started on ATM-106 fuel (PWR fuel with burnup ~48 MWd/kgM and fission gas release ~18%) in both oxidized (O/M ~2.4) and unoxidized forms. Flow-through dissolution tests will be started on these specimens as soon as they have been prepared and their surface areas have been measured.

Spent Fuel Oxidation

A paper by R. Stout, E. Kansa and A. Wijesinghe entitled "Kinematics and Thermodynamics of Non-Stoichiometric Oxidation Phase Transitions in Spent Fuel" was presented at the MRS meeting in Boston, MA on November 30-December 4 and is now available as an LLNL preprint.

The abstract by R. Stout, E. Kansa and A. Wijesinghe entitled "Kinematics and Thermodynamics Across a Propagating Non-Stoichiometric Oxidation Phase Front in Spent Fuel Grains" for presentation at the ASME Micromechanical Random Media Conference at the University of Virginia on June 6-9 was submitted to YMPO.

Dry Bath Testing

Plans were made at PNL to start a dry bath test at 255°C using a variety of fuels in order to determine real time transition to $U_3O_8$. An addendum to the test plan is being written. Tests are being conducted to determine the stability of the dry baths at the higher temperature. The moisture probes had to be sent back to the factory for sensor replacement and calibration. The remaining dry baths continue to run without incident.

Plans are being formulated for the restart of the Thermogravimetric Apparatus systems (TGAs). A new data acquisition system is being purchased, and the systems are being reassembled. B. Hanson, a graduate student from UC Berkeley, will arrive at PNL at the end of February to do his dissertation research using the TGAs.

Materials Characterization Center (MCC) Hot Cell Activities

The paper entitled "Methodology for Determining MCC Spent Fuel Acquisitions" by S. Marschman, R. Einziger (PNL) and R. Stout (LLNL) was reviewed by LLNL-YMP technical staff and returned to the first author with review comments.

**1.2.2.3.1.2 Waste Form Testing - Glass**

D-20-27 Unsaturated Testing of WVDP and DWPF Glass

The N2 tests (SRL actinide-doped glass) continue with no sampling period occurring this month. These tests have been in progress for 356 weeks (almost 7 years). The N3 tests (ATM-10, a West Valley actinide-doped glass) continue and have been in progress for 274 weeks.

#### 1.2.2.3.2 Metal Barriers

The paper by R. Van Konynenburg, W. Halsey, W. Clarke, D. McCright (LLNL) and G. Gdowski (KMI, Inc.) entitled "Selection of Candidate Container Materials for the Conceptual Waste Package Design for a Potential High Level Nuclear Waste Repository at Yucca Mountain" was approved by YMPO and will be published as an LLNL report in February. This completes Milestone T363 and T364 (Waste Package Plan milestone M08).

#### 1.2.2.3.3 Other Materials

This WBS element has not been funded in FY93.

#### 1.2.2.3.4 Integrated Testing

##### 1.2.2.3.4.1 Integrated Radionuclide Release: Tests and Models

Determination of Elemental Profiles in Rocks, Minerals, and Glasses using the Ion Microscope

Epoxy mounted clinoptilolite crystals were polished in preparation for secondary ion mass spectroscopy (SIMS) analysis. D. Phinney was given the sample and developed a tentative SIMS analysis protocol.

Optimum etching times and temperatures for developing autoradiography film were identified. Development of techniques to obtain high contrast "positives" from radiography film were initiated.

Interactions of Actinide-bearing Solutions with Rock Core Samples

Programming and hardware changes to the flow-through apparatus were begun to automate the measurement of fluid flux.

The saw-cut core was sterilized in situ by subjecting it to two heat treatments at 140°C. Room temperature hydraulic measurements were begun.

Work continued on the Transmission Electron Microscopy (TEM) analysis of Milli-Q water to be used in the flow-through system. Results now indicate that the silica particles previously observed are no longer present and that filtration of the Milli-Q water resulted in a very low background of suspended particles. Analysis of holey-carbon coated TEM grids supplied by various vendors showed that a significant difference exists in the background colloidal particle load on the grids. Grids with the lowest background of particles were ordered.

##### 1.2.2.3.4.2 Thermodynamic Data Determination

A summary of FY92 and projected FY93 NEA activities was provided to YMPO in preparation for OCRWM interactions with the NEA in February.

### 1.2.2.3.5 Nonmetallic Barrier Concepts

This WBS element has not been funded in FY93.

## 1.2.2.4 Design, Fabrication, and Prototype Testing

### 1.2.2.4.3 Container/Waste Package Interface Analysis

The following paper was approved and will presented at the International High Level Radioactive Waste Management Conference in Las Vegas, April 26-30:
Drift Emplaced Waste Package Thermal Response" by D. Ruffner, G. Johnson, E. Platt, J. Blink (LLNL) and T. Doering (M&O).

## 1.2.3 SITE INVESTIGATIONS

## 1.2.3.1 Site Investigations Coordination and Planning

This WBS element has not been funded in FY93.

## 1.2.3.2 Geology

### 1.2.3.2.1.2.1 Natural Analogue of Hydrothermal Systems in Tuff

This WBS element has not been funded in FY93.

## 1.2.3.4 Geochemistry

### 1.2.3.4.2 Geochemical Modeling

The 10-page Rev. 0 of "Software Requirements Specification (SRS) for EQ3/6, Version 8" received final review and approval by the Task Leader. The 26-page Rev. 0 of "Software Design Documentation (SDD) for EQ3/6, Version 8" was submitted to the Task Leader for review and approval.

The Lahey F77L EM/32 Fortran compiler was received and is being installed on the 486 PC. It is expected to provide significantly improved error detection than the compiler on the SPARCstation. Future versions of EQ3/6 will be supported on both platforms.

### 1.2.3.10 Altered Zone Characterization

YMPO has notified LLNL of its decision to fund this WBS element with FY92 underrun funds; however, the funds have not yet been furnished to LLNL in an Approved Financial Plan (AFP).

## 1.2.5 REGULATORY

### 1.2.5.1 Regulatory Coordination and Planning

This WBS element has not been funded in FY93.

### 1.2.5.2 Licensing

#### 1.2.5.2.2 Site Characterization Program

LLNL staff assisted the M&O in the preparation of responses to "Open Items" dealing with Engineered Barrier System and Near Field Environment issues, resulting from the NRC's Site Characterization Analysis review of the YMP Site characterization Plan.

The LLNL reviewer, J. Nitao, accepted and signed off on Study Plan 8.3.1.2.2.2.2, R1, "Water Movement Test".

The LLNL reviewer, D. Carpenter, accepted and signed off on Study Plan 8.3.1.17.4.4, "Quaternary Strike-Slip Faulting Proximal to the Site Within Northeast-Trending Fault Zones".

The LLNL reviewer, B. Viani, reviewed Study Plan 8.3.1.3.4.1/3 "Batch Sorption Studies and Development of Sorption Models" and submitted his comments.

The LLNL reviewer, D. Chesnut, reviewed Study Plan 8.3.1.8.5.2 "Characterization of Igneous Intrusive Features" and Study Plan 8.3.1.15.2.2 "Characterization of the Site Ambient Thermal Conditions" and submitted his comments.

### 1.2.5.3 Technical Data Management

#### 1.2.5.3.4 Geologic and Engineering Materials Bibliography of Chemical Species (GEMBOCHS)

The prototyping of an Ingres WINDOWS/4GL front-end for D0OUT began. When completed, this mouse-driven software will permit GEMBOCHS users to point-and-click their way to rapid generation of customized thermodynamics datafiles for use with geochemical packages such as EQ3/6 and GT.

Ingres/Net was installed on Nodes s60 and s05 of the local Sun network.

The modification of the CNGBOCHS documentation began per last month's revision of the software. The final document will be available in February.

J. Johnson attended the Ingres classes, "Designing Ingres Databases" on January 11-12 and "Designing Ingres Applications" on January 13-14 at Ingres Headquarters in Alameda, CA.

#### 1.2.5.3.5 Technical Data Base Input

No significant activities.

### 1.2.5.4 Performance Assessment

#### 1.2.5.4.2 Waste Package Performance Assessment

Modeling has been done to determine whether spent fuel cladding breach will occur for a variety of repository configurations. The phenomenon involves the temperature history of the cladding, stress from internal gas pressure, and creep toward eventual failure of the cladding by creep rupture. The creep rate is strongly temperature dependent. The model parametrizes the cladding's temperature time history as a function of several repository design parameters. This has been parametrized for the compact repository (large spent fuel packages in drifts), using thermal calculations from the paper "Drift Emplaced Waste Package Thermal Response" by D. Ruffner, G. Johnson, E. Platt, J. Blink (LLNL) and T. Doering (M&O) for the drift and container-surface temperatures, and using an analysis of an equal-sized transportation container (with an adjustment for a disposal-only function) to get the edge-to-center temperature rise as a function of container heat generation rate. The creep rate and creep failure equations are taken from Chin and Gilbert, (Nuclear Tech. 85, 57, 1989). Some of the repository configurations used in the parametric study of Ruffner et al. will preserve a median spent fuel rod from creep rupture and some will not. For example, the configuration with 21 PWR assemblies per package, 33 GWdays/MTU burnup, 30-year age at emplacement, and 72 foot spacing of packages will give creep only up to about 25% of the limit, and has an AML of 71 MTU/acre (about 1.5 times the SCP Conceptual Design Report AML), enough to provide substantial dryout of the host rock within and above the repository (ref: T. Buscheck and J. Nitao, 3rd IHLRWM Conf., 1992).

## 1.2.9 PROJECT MANAGEMENT

### 1.2.9.1 Management and Coordination

No significant activities.

#### 1.2.9.1.2 Technical Project Office Management

W. Clarke and J. Blink attended the TPO meeting in Las Vegas on January 20. W. Clarke, J. Blink and D. Wilder attended the TAG meeting in Las Vegas on January 21. D. Wilder made a presentation on the extended dry concept.

LLNL-YMP staff briefed the Fission Energy and Safety Systems Program of LLNL on the Yucca Mountain Project on January 14.

J. Blink described current LLNL programs at the Southern Nevada ASME meeting in Las Vegas on January 21.

J. Blink presented hands-on science classes to 225 students and 13 teachers at the John S. Park Elementary School in Las Vegas on January 13.

J. Blink attended the software advisory group (SAG) meeting on January 7, the Infrastructure Cost Reduction meeting on January 22, the Test Coordination Office

ESF monthly status meeting on January 25 and the ALARA Committee meeting on January 28; all four meetings were in Las Vegas.

### 1.2.9.2 Project Control

#### 1.2.9.2.2 Participant Project Control

The December FTE report was submitted to YMPO. The report format was changed and requires more extensive data. The reporting system had to be modified to collect the information required. The December actual schedule progress and costs were submitted via the PACS reporting system. Variance analysis explanations were developed for several P&S accounts for activity undertaken during the 1st quarter of FY93.

The updated Cost Plan will include December actuals.

The process is continuing to prepare a capital acquisition plan for four computer systems which exceed $15k each. While these systems were identified in the PACS planning base, LLNL did not submit the acquisition plans to support the Information Resource Management (IRM) requirements.

Inputs were completed for the FY95 IRM Long Range Plan. The plans data include a site software profile.

Training began for additional staff resource personnel for project control activities. This resource consists of a Computer Technologist, T. Henson (.5 FTE) to develop the local area network (LAN), trouble shoot small system problems, install software and to conduct limited training and a Project Control Technician, P. Krantz who is being trained to assist in IRM activities, Property Management and PACS activities.

The response was completed to a GAO questionnaire that addresses the entire Nuclear Waste Fund for the past four years. Also a response was made to internal LLNL questions concerning data provided on the questionnaire.

The effort is continuing to automate the transfer of data between the laboratory financial systems and the PACS workstation. Several iterations have been submitted; however, extensive work remains to be accomplished before the software will meet requirements.

An FTE analysis was submitted to YMPO. Work continued to update the manpower matrix to ensure correct distribution of manpower and to verify the current individuals who are using YMP cost accounts.

A planning meeting was held to define the LAN requirements and options and a schedule for its implementation.

J. Podobnik and P. Krantz attended a Project Information Resource Manager Council Committee meeting in Las Vegas on January 13.

## 1.2.11 QUALITY ASSURANCE

### 1.2.11.1 Quality Assurance Coordination and Planning

The LLNL-YMP QA Manager, Dean Wolfe has resigned effective January 22 in order to accept a position with Bechtel. M. Revelli was named interim QA Manager and the position was posted.

The 1993 surveillance and audit schedules were updated and reissued.

### 1.2.11.2 Quality Assurance Program Development

Work began to review the QARD that was issued by OCRWM at the end of December. Work also began on the first draft of the QARD Matrix and the transition plan as required by OCRWM and YMPO. Personnel attended users training in Las Vegas on the QARD Requirements Matrix database. Due to the YMP audit of LLNL activities, this QARD work was interrupted. An extension was requested to the January 29th due date for the implementation plan.

QP-1.0, Rev. 3 (Organization) and QP-16.0, Rev. 4 (Corrective Action) were completed and distributed. Change Notice 1.0-3-1 (Organization) was completed and distributed.

### 1.2.11.3 Quality Assurance Verification

An extension was requested for all outstanding YM CARs (91-056, 92-064, 92-065 and 93-017) resulting from previous DOE Audits and Surveillances. All of these CARs involve one or more procedural revisions and will be resolved in concert with the QARD implementation plan.

#### 1.2.11.3.1 Quality Assurance Verification - Audits

Audit YMP-93-04 was conducted of LLNL by DOE during the week of January 11-14. There were no findings adverse to quality noted. The LLNL QA Program was judged to be effectively implemented in the areas audited.

It was requested that DOE audit YMP-93-13 be rescheduled from June to July to allow for completion of LLNL independent internal audit prior to the DOE audit.

#### 1.2.11.3.2 Quality Assurance Verification - Surveillance

Surveillance Report S93-03 (Document Control and Records) was issued. Surveillance Report S93-14 (Organization) was completed and issued.

CAR-LLNL-026 was completed, verified and transmitted to YMPO.

### 1.2.11.4 Field Quality Assurance/Quality Control

This WBS element has not been funded in FY93.

### 1.2.11.5 Quality Assurance - Quality Engineering

Support continued for the Waste Form Characterization area.

## 1.2.12 INFORMATION MANAGEMENT

### 1.2.12.2 Records Management

#### 1.2.12.2.2 Local Records Center Operation (LRC)

Document Control issued two new revisions and one change notice under controlled distribution. Routine follow-up for receipt acknowledgments continues.

#### 1.2.12.2.3 Participant Records Management

A total of 186 items were logged into the LLNL-YMP tracking system. This includes 31 records/records packages that were processed through to the CRF. Eleven action items were closed.

All 1991 records have been cross referenced from the database to microfilm. The 1992 records are now being entered.

#### 1.2.12.2.5 Document Control

LLNL received no funding under this WBS. Work performed to complete LLNL's obligation in this WBS is funded under WBS 1.2.12.2.2.

## 1.2.13 ENVIRONMENT, SAFETY AND HEALTH

### 1.2.13.1 Environment, Safety and Health Coordination and Planning

This WBS element has not been funded in FY93.

## 1.2.15 SUPPORT SERVICES

### 1.2.15.2 Administrative Support

No significant activities.

### 1.2.15.3 Yucca Mountain Site Characterization Project (YMP) Support for the Training Mission

Twenty four different self-study assignments were issued, and 157 people were trained to these assignments. Currently, there are 66 participants on the project who are to be trained and/or tracked.

# LLNL PROJECT STATUS REPORT DISTRIBUTION

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REC'D IN YMP
2/25/93

WBS 1.2.9.1
QA N/A

1-338010

February 19, 1993

TWS-EES-13-02-93-109

Mr. Carl P. Gertz, Project Manager
Yucca Mountain Site Characterization Project Office
US Department of Energy
P.O. Box 98608
Las Vegas, NV 89193-8608

Dear Mr. Gertz:

**Highlights of the Los Alamos Monthly Activity Report—January 1993**

Attached are the highlights of the Los Alamos Monthly Activity Report for January 1993. This internal document describes our technical work; however, the report has not received formal technical or policy review by Los Alamos or the Yucca Mountain Site Characterization Project. Data presented in this document represent work progress, are not referenceable, and are not intended for release from the US Department of Energy. If you have changes to our distribution list, please call Susan Klein at (505) 667-0916.

Sincerely,

Julie A. Canepa

SHK/elm

Attachment: a/s

Cy w/att:
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W. L. Clarke, LLNL, Livermore, CA
W. R. Dixon, YMPO, Las Vegas, NV
J. R. Dyer, YMPO, Las Vegas, NV
N. Z. Elkins, EES-13/LV, MS J900/527
L. D. Foust, CRWMS, M&O/TRW, Las Vegas, NV
L. R. Hayes, USGS, Denver, CO
V. F. Iorii, YMPO, Las Vegas, NV
S. H. Klein, EES-13, MS J521
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A. R. Pratt, EES-13, MS J521
L. Shephard, SNL, Albuquerque, NM
W. Simecka, YMPO, Las Vegas, NV
M. Voegele, SAIC, Las Vegas, NV
RPC File (2), MS M321
TWS-EES-13-File, MS J521

Cy w/o att.:
CRM-4, MS A150

# January 1993
# Highlights from Los Alamos

**WBS 1.2.3.2.1.1.1 (Mineralogy/Petrology)**

D. Vaniman replaced D. Broxton as technical coordinator for Mineralogy/Petrology Studies, and D. Bish has replaced D. Vaniman as principal investigator for WBS 1.2.3.2.1.1.1.

The first fracture samples from UE-25 UZ-16 were received on January 27. J. Whelan (USGS Denver) and E. Roedder (Harvard University) traveled to Los Alamos to prepare samples for fracture calcite studies and discuss fluid inclusion results.

D. Vaniman participated in the Natural Barriers Evaluation Workshop in Las Vegas on January 19-21. Workshop participants identified those natural barriers important for site performance that could be compromised during site characterization activities.

S. Levy discussed ESF starter-tunnel integrated sample program needs at a meeting in Las Vegas, and, as a result of information presented at the meeting, we are re-evaluating our sampling needs.

**WBS 1.2.3.2.1.1.2 (Alteration History)**

Research staff began using the new electron microprobe began this month. The quantitative results from standards were generally good, but additional work is needed on fine-tuning background settings and devising a setup file for zeolite analysis.

We have determined the Cl, N, P, S, and oxalate content of ashed plant roots from the vicinity of Trench 14 and from pinon-juniper woodlands. This data, along with INAA data on trace-element content of the roots, will be used to help characterize the chemical contents of the plant material.

**WBS 1.2.3.2.3.1.(Volcanism)**

We completed new calculations on the space and volume attributes of basaltic volcanism in the Yucca Mountain region.

We completed collection of paleomagnetic data for the lava-flow units of the Lathrop Wells volcanic center and found the data on monogenetic versus polycyclic models to be nondiscriminatory .

Staff completed 232U/232 Th isotopic analyses for samples from the $Ql4_a$ lava at Lathrop Wells and a lava flow at Little Black Peak.

Trenches LW-3 and LW-4 were infilled; the southernmost section of Trench LW-1 was infilled, and the remaining parts were fenced. The northern and central sections of LW-1 were left open so that further soil, stratigraphic, geomorphic, and paleomagnetic studies may be conducted.

Newly cut exposures revealed the southwest flanks of the main cone of the Lathrop Wells center. We found no sequences of young tephra and soils in this section, which is consistent with Wells interpretation based on petrologic data that the tephra units are local and not derived from the main cone (1990; 1991).

WBS 1.2.3.3.1.2.2 (Water Movement Test)

Chlorine-36 analyses for nine samples from USW UZ-N54 and N55 were received from Lawrence Livermore National Laboratory. They showed that the extremely high $^{36}Cl$ levels previously observed in the Paintbrush nonwelded (PTn) unit in N-55 (see June 1992 monthly report) extended into the welded units above and below the PTn, all the way to the bottom of the hole, 256 ft below ground. These new results confirmed that $^{36}Cl$ levels observed in the PTn unit in N-54, only 200 feet away, are at background levels. The $^{36}Cl$ levels and their pervasive distribution in N-55 cannot be explained easily by any natural hydrologic process, and the most likely explanation is that the separator was contaminated when used to drill several shallow holes near Test Cell C immediately before drilling N-55. Calculations by the J. Fabryka-Martin indicated that extremely high levels of $^{36}Cl$ (about six orders of magnitude above natural background) would have been produced near Test Cell C during testing of nuclear-powered rocket engines in the early 1960's, which could easily account for those measured in the N-55 cuttings samples. Several experiments are planned to test this hypothesis.

Results indicating a stable chlorine isotope were received from C. Eastoe (University of Arizona, Laboratory of Isotope Geochemistry) on seven soil samples collected from five Midway Valley soil pits. These samples were submitted to ascertain variability in the stable Cl isotope ratio of meteoric Cl.

Collection of cutting samples from UZ-16 for $^{36}Cl$ analysis continued.

The SMF sent to Hydro Geo Chem a shipment of 31 barrels containing 221 cuttings samples from UZ-16 and from neutron holes USW UZ-N11, N27, N37, and N53.

J. Fabryka-Martin summarized results of $^{36}Cl$ study at two meetings, the Unsaturated Zone Modelers meeting in Las Vegas and the University of Arizona's Hydrology and Water Resources Workshop on flow and transport through unsaturated fractured rock in Tucson. She presented a preliminary interpretation of the $^{36}Cl$ data and estimates of the magnitude of and extent of contamination of surface soils by $^{36}Cl$ produced by NTS activities between 1950 and 1969. She also participated in the Consolidated ESF Sampling meeting in Las Vegas.

**WBS 1.2.3.3.1.3.1 (C-Well Reactive Tracer Test)**

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.

**WBS 1.2.3.4.1.2.1 (Sorption)**

Staff conducted batch sorption experiments to address the role of trace minerals in the tuff in retardation of Np. A $^{237}Np$ solution was prepared with ground-water from Well J-13 and tuffs from the Calico Hills (G4-1530, which is 55% clinoptilolite, 16% opal-CT, 12% mordenite, 7% quartz, 7% feldspar, and 2% smectite). We used a magnetic separator to enrich a fraction of the crushed tuff G4-1530 and thus increase its iron oxide content.

**WBS 1.2.3.4.1.3 (Speciation/Solubility)**

Speciation. Using PAS, we determined the oxidation states of 250 nM Pu / bicarbonate solutions at pH 8.5–9 at elevated (75°C) temperatures. As reported last month, solutions originally made with Pu(IV) in $NaHCO_3$ solution retain the $Pu^{4+}$ oxidation state from 1 M to 3 mM bicarbonate concentration at room temperature. Our results now suggest that even elevated temperatures do not cause an oxidation state change. Unfortunately, this study was cut short, and it is necessary to continue to observe long-term behavior.

We prepared Np(V) stock solutions in carbonate media for study using UV-VIS-NIR, PAS, and NMR spectroscopic techniques. We ordered an ultra-pure Np solution, which is free of trace amounts of Pu, to prepare Np(V) stock for use in sorption studies.

We began our UV/Vis absorption study on $NpO_2^+$ species in (bi)carbonate media. At least three species were observed for 0.4 mM Np at 0.9 M (bi)carbonate concentrations between pH 8.4 and 13. These results will serve as a starting point for parallel NMR studies, as well as bicarbonate-concentration and temperature-dependent UV/Vis experiments.

We believe that our results of oxygen-17 and carbon-13 NMR experiments on the U(VI) carbonate system, within the pH range of 6–10 and temperature range of 0–25°C, indicate that there are only two

observable uranyl-containing species present in solution under these conditions. The NEA-OECD database predicts three species, all at significant concentration, should be observable. This discrepancy may exits because the NEA data is based on model-fitting, whereas our data is based on a species-specific spectroscopic probe. These studies have provided the necessary groundwork so that we may proceed with similar studies of Np(V) in carbonate solution.

**Solubility.** Work continued on the current undersaturation experiments in UE-25p #1 well water. The Np undersaturation experiment at pH 6 has not yet reached the steady state value determined in the oversaturation experiment; therefore it will continue. We determined the oxidation states of the Pu undersaturation experiments at pH 6 and 7.

**WBS 1.2.3.4.1.4.1 (Dynamic Transport)**

This month we began radionuclide migration studies through a column made of fractured tuff from drill hole USW G-1, at a depth of 1,941 feet and established a constant flow with J-13 water through the column. Next month, we will begin to determine the hydrological parameters of the column by eluting tritiated water through it.

A majority of our time this month was devoted to organizing the Colloid Workshop to be held 3-5 May. This workshop is being held to evaluate whether colloids will significantly increase radionuclide release to the accessible environment at Yucca Mountain. We sent out invitations and coordinated participation of the twenty four speakers and six moderators. There will be six workshop sessions: Colloid Transport Calculations, Evidence of Colloids from Sampling Studies, Evidence of Colloids Transport at the Field Scale, Potential Sources of Colloids at Yucca Mountain, Laboratory and Field Experiments Relevant to Yucca Mountain, and Future Direction of Colloid Studies in YMP. Each session will consist of a formal presentation followed by a panel discussion.

**WBS 1.2.5 (Site Characterization Program)**

The sections on (1) the petrology and geochemistry of basaltic volcanism in the Great Basin, (2) an overview of magma dynamics for basaltic systems, and (3) the history of volcanism studies for the Yucca Mountain Project of the Volcanism status report have been completed.

**WBS 1.2..5.4.6 (Flow and Transport Models)**

A special work permit for installation of sampling equipment in the caisson was prepared and is in review.

United States Department of the Interior

GEOLOGICAL SURVEY
BOX 25046 M.S. 425
DENVER FEDERAL CENTER
DENVER, COLORADO 80225

TAKE PRIDE IN AMERICA

IN REPLY REFER TO:

WBS: 1.2.9.2
QA: N/A

I-337757 8

February 11, 1993

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

SUBJECT: U.S. Geological Survey Yucca Mountain Project Monthly Summary for January 1993

Dear Carl:

In compliance with Yucca Mountain Project monthly reporting procedures, following is the YMP USGS input for January 1993. If you have any questions, please contact Raye Ritchey at (303)236-0517.

WBS 1.2.3 - SITE INVESTIGATIONS

An onsite visit was made to the University of Reno Seismological Laboratory (UNRSL) to discuss QA implementation actions, action items for two deficiency reports, equipment transfer, records, data, and technical procedure preparation.

The Hydrologic Research Facility (HRF) experienced numerous problems connecting and transferring data to the HIP LAN. New cables were installed, the hub was replaced, and different software was installed on all Pcs. The HRF is now fully operational. W. Wilson, DOE/FOC informed the USGS computer operations unit that, by March 1, a wiring closet will be installed in order for the building to be networked. If funding allows, all USGS staff can be connected by May 1. A draft of the USGS input to the ITR Long Range Plan was hand delivered.

The surface water monitoring project reports that proposed locations of three planned continuous-recording gages in upper Fortymile Wash were relocated to selected sites on Yucca Mountain. Installation of these gages at Yucca Mountain will provide surface water data in support of current groundwater studies in the unsaturated zone. Three sites in selected washes were examined and flagged, and a memo requesting prerequisite environmental surveillance and permits was forwarded to DOE. Cumulative precipitation associated with a series of large, regional storms from the Pacific Coast, ranged from about three to six inches, as measured from network precipitation gauges. Standard and Pygmy meter measurements were made at several locations. Discharge computed from these meter measurements ranged from less than 0.10 to 150 cubic feet per second. These measurements constitute some of the first current meter measurements made on ephemeral washes within the regional network. Data collected as a result of these measurements will provide valuable information on the hydraulic characteristics of runoff in ephemeral channels within a semi-arid environment.

In support of regional groundwater flow systems studies, groundwater levels were collected in UE-29 a#1 and a#2 and UE-29 UZN#91; readings were taken from rain wedges at UE-29 UZN#91 and #92. Data collection frequency was increased to document ongoing groundwater recharge from rainfall/runoff events in Fortymile Wash.

The natural infiltration project reports that preliminary plans were made to conduct a detailed TDR study near N13 and N14 by the Bowen ratio station in Pagany Wash. A regular grid will be laid out covering the terrace and channel with 36 probes. This study will provide field calibration data for the artificial infiltration project, along with providing surface water content changes and heterogeneity for the upper boundary conditions in small watershed models. Additional neutron logs have been taken in Fortymile Canyon to monitor runoff events due to the large amounts of rainfall this winter. Several runoff events have resulted in downward infiltration in obvious pulses to below 18 feet in N91. Plans have been discussed with the saturated zone researchers to do some time series analyses to estimate infiltration rates in the alluvium.

In support of matrix hydrologic properties testing, physical property measurements on the USW-UZN-54 canned core samples continued. Data from this analysis is expected to indicate the dehydration sensitivity of various clay and zeolite minerals in the rocks, as well as showing the temperatures at which non-refractory minerals, such as carbonates, dissociate and cause abrupt changes in rock weight. Saturated hydraulic conductivity measurements continued on samples collected last spring from the transect up the prow of Yucca Mountain. Saturated hydraulic conductivities also were run on approximately 24 cores from the c-hole complex on samples of non-zeolitic Calico Hills tuff. Analysis of data collected several months ago from 15 prow sample permeability runs was completed, after which three more runs of prow transect core were analyzed.

Staff from the surface based borehole studies continued monitoring drilling activity at UZ-16. At the end of January, the borehole was cored and reamed at 1350 feet. Drilling has penetrated through the Topopah Spring member and is now in the Calico Hills unit. Penetration rates have increased dramatically. Special instructions were given to RSN to adjust the mode of operations from 1400 feet to total depth. Instructions require setting a bailer at the bottom of the hole at the end of each shift, retrieving the bailer at the beginning of the next shift. The purpose is to sample water that may drain from the Calico Hills as the borehole approaches the water table. Free gravity drainage should occur prior to reaching 100 percent saturation.

Staff from the vertical seismic profiling project are preparing to conduct velocity measurements on UZ-16 core. A private company was contacted that specializes in core velocity measurements under confined stresses that will approximate the in-situ stress environment. The next step is to certify the company through the QA office to perform velocity measurements on UZ-16 core. Approximately 30 core specimens have been tagged for these measurements. It is estimated that a total of 50 core specimens will be run to establish velocities for the different rock types encountered during drilling of UZ-16.

Staff supporting percolation testing in the ESF terminated the final phase of the large block test. During the last phase, water pressure was maintained at +14 cm of water at the top of the block. Water flow fluctuated between 100 and 0 cubic cm per day. Steady state was not achieved. Data was collected, indexed, backed-up, processed, and archived on computer disks. The paper, "Laboratory Study of Water Infiltration into a Block of Welded Tuff", describing the large block test setup and some results that will affect the design of the ESF test, was completed.

In support of prototype cross hole testing, the first draft of the results section on the thermocouple psychrometer prototype testing at the Apache Leap Tuff Site was completed. The TCP shows that the boreholes were at saturation and that water vapor was condensing in the test intervals during the entire testing period.

In support of studies of hydrochemistry in the ESF, locations of short hole drilling were discussed at the consolidated ESF sampling meeting in Las Vegas. The PI would like to have the five to eight short holes drilled soon after 20 feet of tunnel are mined, but safety and other factors may intervene. The test coordinator will work this out with field construction personnel. During the

tunnel mining of North Ramp starter 200 feet, gas tracer will not be used; however, anthropogenic Freon-11 and Freon-12 existing in the air will be traced during the short hole gas sampling to observe the effect of mining in contaminating the in-site rock gas.

Staff from the gaseous-phase circulation study formulated plans and began preparations for conducting convergent-flow tests in borehole USW UZ-6s. Fourteen shallow (approximately 1.2 ft deep) 1-inch diameter sampling boreholes were drilled in the vicinity of boreholes USW UZ-6 and UZ-6s, which will be used during tracer tests. Results from these tests will be used to model $^{14}CO_2$ and other gaseous radionuclide emanations from the repository to the atmosphere.

Staff supporting conceptual and numerical modeling of flow in unsaturated zone fractured rock report that model imbibition experiments have been delayed because the nature of the imbibition experiment has changed. Changes include a new non-fractured sample, continuous rather than periodic data collection, and introduction of a psychrometer in the middle of the sample to measure water potential and inflow rates in real time. Hardware for the new design is being assembled.

In support of conceptualization of the unsaturated zone hydrogeologic system, in November, an investigation was made into possible statistical correlations between saturated hydraulic conductivity, porosity and unsaturated hydraulic parameters used to characterize moisture retention properties. In December, results of these statistical analyses were used to estimate water potential, effective hydraulic conductivity, and liquid flux profiles at four UZ boreholes. Data from a variety of sources also was compared to assess consistency of existing data. The draft of the paper summarizing results of the statistical analyses was incorporated into the draft of a second, longer paper, summarizing not only the regression analyses, but also the application of these results to the four UZ boreholes.

LBL staff supporting simulation of the natural hydrogeologic system included fracture flow in the welded units Tiva Canyon and Topopah Spring in the simulation. A set of simulations was performed with the new matrix rock properties chosen from A. Flint's INTRAVAL dataset, using different assumptions regarding properties of fault zones (high and low permeability zones), and three uniform infiltration rates. Results were analyzed in terms of preferential pathways, vertical and lateral flow, and the influence of the characteristic curves.

Staff supporting site saturated groundwater flow system studies calibrated transducers at WT-3, G-3, b#1, H-5 (upper zone), H-3, and H-1 (tubes 2,3,4); replaced transducers at H-4; continued investigation of water-level and fluid-pressure responses in wells at Yucca Mountain to earthquakes; realigned antennae for data transmissions to satellites at all DCP sites; repaired and calibrated chain #2, and reduced transducer data from several wells for inclusion in various reports or for data requests.

In support of the conceptualization of saturated zone flow models, discussions continued on coordination of the site scale groundwater flow model (10's of km) at Yucca Mountain and the regional groundwater flow model (100's of km). The regional model will provide input to the site scale model in the form of boundaries and recharge and discharge information and has approximately 300 node cells (of the thousands in the model) planned in the area around Yucca Mountain. The cells are 1.4 $km^2$ in size.

Staff supporting development of the fracture network model continued fracture geometry simulations at the UE-25 c-hole complex. The conceptual model for flow at the multiple-well complex is based on work done by A. Geldon and outcrop data collected from the Crater Flat tuff. The purpose of this work is to assist in placement of packers during the c-hole cross-hole testing.

A presentation of all efforts towards an integrated computerized 3-D model was

given to the DOE, USGS and others. The presentation included an overview of all software tested to date, including advantages and disadvantages of each, a synopsis of the data modeled to date, and a review of the technical problems involved.

In support of stratigraphic studies, staff completed technical reviews of the 1:6000-scale geologic compiled cross sections depicting the north ramp, south ramp, and the main Topopah-level drift alignments beneath Yucca Mountain. This review included development of detailed structure contours of unit contacts in the Tiva Canyon Member of the Paintbrush Tuff. This method delineates map-scale structure and is used to fill in information from areas where strike and dip measurements are widely separated. In several locations, the strike and dip measured on foliation in the field differ from those determined from the structure contour maps. Differences of orientation emphasize that foliation and unit contacts are not always parallel; the specific reasons for the nonparallelism are under investigation. Preliminary core log from UZ-16 was extended to a depth of 1260 feet in January, with logging of 90 additional feet of core. The contact between the vitrophyre and lower partially welded tuff in the Topopah Spring Member is at 1165 feet. The contact between nonwelded tuff of the Topopah Spring Member and tuffaceous rocks of Calico Hills is at 1182 feet, indicated by the occurrence of quartz as phenocrysts in the rocks of Calico Hills. Textural variations in tuffaceous rocks of Calico Hills suggest that the rocks formed from two or three pyroclastic flow deposits. Zeolitization has altered the glass in the partially welded and nonwelded tuff of the Topopah Spring member and the tuffaceous rocks of the Calico Hills.

The surface-based geophysics project reports that contract negotiations were conducted with potential vendors on the seismic reflection study at Yucca Mountain, with February 16 set as the date for best and final offers. Discussions continued with DOE and NTS staff to clarify safety, security and training requirements.

Staff supporting the geologic mapping of zonal features set grid points in Split Wash, and began mapping. Eighteen areas were located and six were mapped at a scale 1:240.

USBR staff began geologic mapping of the North Ramp portal for the ESF. Four traceline surveys were completed in the portal cut, one horizontal survey and three vertical. Work began on a plan-view map of the exposed geology. Photogrammetry targets were placed on the exposed rock, and overlapping stereophotos were taken by staff from Johnson Controls.

USGS and LBL staff attended a meeting with DOE, the M&O, and RSN representatives to discuss interfacing work in the NRG holes with the upcoming vertical seismic profiling (VSP) work. If the work can be done on a "non-interference" basis by both LBL and others involved with NRG holes, a VSP will be carried out in NRG-6 to examine the utility of check-shot data for tunnel design criteria. Anticipated results would include internal Poisson ratio and a volumetric estimation of elastic properties.

Staff supporting the assessment of hydrocarbon resources began digitizing sonic logs from a well in Railroad Valley. This will allow computation of accurate depth vs. time curves for key exploration wells along seismic reflection lines near the prolific Grant Canyon oil field. Preliminary analysis of sonic velocities indicates that the Late Cenozoic valley-fill values can vary from below 7,000 ft/sec to almost 15,000 ft/sec, and that every well should be digitized (if the logs were run), rather than depend on a single or a few generalized depth vs. times curves for this valley. About 20 sonic well logs have been digitized, with plans to double that number over the next five months. Density, gamma ray, and other logs are also being selectively digitized in order to help identify formations which are seldom identified in other reports. Very high velocities are found near the Grant Canyon field, and appear to be associated with high bottom hole temperatures which are indicative of a strong hydrothermal or convective flow system.

In support of the surface facilities exploration program, NRG-2, the 60 degree from horizontal inclined drill hole located on the west side of Exile Hill, reached total depth (TD) at 215 feet on January 26. Compilation of the preliminary core log has begun; depths have not been converted to elevations.

Staff compiling the historical earthquake record discovered additional very precarious rocks in Solitario Canyon, Yucca Mountain, and Yerington, Nevada, and in Baja, California just south of the U.S. border. Further correlations were made with maps of historical seismicity in the west. Portable seismic instruments near Little Skull Mountain were removed and transported to test cell C for redeployment.

Staff evaluating the Bare Mountain Fault zone requested authorization from the YMP-USGS Corrective Action Report (CAR) Board to 1) conduct surficial geologic mapping of the Bare Mountain Fault zone; and 2) conduct reconnaissance verification of existing fault scarps and lineaments of the Death Valley-Furnace Creek and Pahrump-Ash Meadows fault zones. No quality-affecting work can be done until Study Plan 8.3.1.17.4.3 is approved.

Staff supporting the evaluation of age and recurrence of movement on Quaternary faults at Yucca Mountain continued to clean exposures and identify and flag contacts and structures on exposures 1, 2, and 4 on the west side of Busted Butte. Field review was conducted of completed logs in Trench 14D (inner wall, north branch and outer wall, southwest branch).

Staff working on releveling the base-station network continued resurveying of the level-line network. The distance leveled during the month was 69.2 kilometers, completing 35 percent of the total level line survey.

In support of the evaluation of tectonic models, two strike-slip fault models were singled out for consideration - the transfer fault model and the throughgoing deep-seated strike-slip fault model. One example of a throughgoing deep-seated strike-slip fault was examined in the field. Staff spent three days evaluating geologic mapping in the "Noble Hills" along the southern Death Valley fault zone.

Staff evaluating Quaternary faults within 100 km of Yucca Mountain began field verification of the Beatty Scarp, in conjunction with investigations of the Bare Mountain fault and faults southwest of Yucca Mountain.

In support of the analysis of stratigraphy-sedimentology of marsh, lacustrine and playa deposits, a field trip was conducted to several field sites in southern Nevada to collect fossil and chemical sedimentary material, and to identify sites that can be cored. Material from the cores will provide the paleontological and isotopic basis for reconstructing past regional climate and geology from the late Pleistocene and Holocene. Cores were selected from sites in the Las Vegas, Indian Springs, Cactus Springs, Pahrump Valley, and Ash Meadows areas. A summary of the field trip was drafted to describe the stratigraphic sequences of late Pleistocene and Holocene sediments. The units described contain fossil and isotopic evidence that indicates elevated levels of past discharge from the sediments during the late Pleistocene and early Holocene.

The regional paleoflood evaluation project reports that preparation and analysis of geomorphometric, climatic, and hydrologic data pertaining to modern and past regional flooding in the Yucca Mountain area is complete. Further data evaluations undoubtedly will be required, however, during the report preparation stage of the investigation. Additional field reconnaissance also will be required to validate data analysis. Physical, surface water conditions for modern-day flooding in the Amargosa River and Fortymile wash drainages have been established. These estimated precipitation-runoff values ultimately will enable development of regional paleoflood models depicting past runoff conditions and probable magnitudes and frequencies of past floods. Maps, tables, and figures showing the results of this phase of the regional paleoflood evaluation will be published as part of the summary reconnaissance report. Heavy rains occurred

during January resulting in moderate to heavy runoff in shallow lakes filling otherwise dry playa lake basins. Field reconnaissance investigations were conducted to evaluate the magnitude of this runoff and to determine whether lake level rises were caused by local or regional runoff.

In support of arid zone geochemistry, staff collected a sample of the top and bottom of a boulder at the head of a debris flow channel on the mountain front; collected boulder samples from two fan surfaces, one from a terrace surface, and one from a microwatershed; collected 12 soil samples from terrace surfaces and 11 soil samples from fan surfaces; measured the stone content of 11 terrace soil samples and prepared samples for total Cl measurement; measured 7 calcrete samples for total Cl content 3 times, and for $CaCO_3$; and measured 16 boulder samples for total Cl content.

Staff from the calcite silica project report that scoping studies of the $^{14}C$ ages of UZ drill hole calcites are a bit discouraging with respect to paleoclimate studies. With the exception of one sample from USW G-1, the other thirteen samples had very old ages. The calcite analyzed came from surfaces of free-growing crystals and should have represented the latest precipitation in these samples. The very old ages probably represent incorporation of "dead" carbon, perhaps provided by dissolution of older calcite or from equilibration of infiltrating waters with soil zone calcrete, into the precipitating fluids. Another set of samples will be submitted to verify these somewhat negative results, but it appears that paleoclimate studies based on deep calcite will have to depend on U-series dating, which requires approximately 20X more sample. Staff determined the Pb isotopic contribution and U, Th, and Pb contents of six samples of fracture filling calcite from drill holes USW G-1, G-2 and G-4. This data, combined with earlier results, further confirms the thesis of descending soil zone waters transporting and precipitating the calcite found in the UZ. Calcite deposited above the water table shows a Pb isotopic signature indicating derivation from the soil zone environment, whereas SZ calcite appears to have derived its Pb from the host volcanic rocks.

Staff of the Isotope and Geochemistry Group contributed to Rock Characteristics, Tectonics, and Paleodischarge programs. Work in support of stratigraphic studies included interactions with personnel from UNLV to investigate the possibility of joint funding for a visiting Russian scientist, as well as further collaborative geochemical studies on 78 samples of volcanic rocks from the geochemical reference sections supplied to the Harry Reid Center for Environmental Studies. Analytical data from these samples will extend the number of trace elements currently used as baseline data to model elemental mobility in unaltered and altered tuffs. In addition, ten Nd isotopic analyses from the Topopah Springs high silica rhyolite from the saturated and unsaturated zones were completed. Results are being evaluated for their implications on primary stratigraphic variability as well as secondary elemental mobility in the saturated zone. Work in support of tectonic studies focused on dating of pedogenic deposits offset by Quaternary fault movement. Initial $^{234}U$-$^{230}Th$ results from buried soils at the Busted Butte sand ramps suggest that the latest movement on the Paintbrush Canyon fault is bounded by undisplaced and displaced soils dated at approximately 50 and 100 k.y., respectively. Work on thermoluminescence dating of soils also progressed including the preparation of a technical procedure as well as technical training and scoping studies. Work in support of paleoclimate studies included preparation and analyses of a wide range of soils, rocks, minerals and waters. Sr isotopic analyses were performed on precipitation water from Yucca crest, tufas of different ages from Pyramid lake, well waters from Army#1 and NA-7, and carbonates from UZN55 and the Amargosa desert. In addition, statistical results from duplicate Sr isotopic analyses in the current database were compiled and showed a typical two sigma standard deviation of approximately ± 0.00007 or 0.01%, although exclusion of outliers in several groups can reduce this to about ±0.00003 or 0.005%. Samples of carbonate-rich layers in the extensive paludal spring discharge deposits of Pahrump Valley were sampled and prepared for $^{234}U$-$^{230}Th$ dating. These samples are from sections which have been well documented by $^{14}C$ geochronology and will provide an empirical test of $^{234}U$-$^{230}Th$ dating techniques being applied to carbonate

deposits at Yucca Mountain.

WBS 1.2.5 - REGULATORY

USGS responses to State of Nevada comments on Study Plan 8.3.1.2.2.7, Unsaturated Hydrochemistry, were submitted to YMPO on January 21, 1993.

Fifty-two data submittals were received in the Participant Data Archives. Inventory of all data submitted prior to 11/01/92 was completed as part of a response to CAR-92-08. All data submitted from that date forward also is being tracked.

In support of site performance assessment modeling, the 1-D matrix model developed for USW UZN-55 and UE25 UZ-16 as part of the INTRAVAL test case was presented an NRC/University of Arizona workshop on flow and transport in fractured porous media. In addition, another 1-D model was developed to determine steady state conditions with a specified lower water potential boundary. The model quickly provides initial conditions that are being used in TOUGH for long term climate change analysis.

In support of the development and validation of flow and transport models, additional data, consisting of improved water characteristic curves developed using the Decagon CX-2, was added to the INTRAVAL test case.

WBS 1.2.9 - PROJECT MANAGEMENT

The USGS Committee for the Advancement of Science in the Yucca Mountain Project (CASY) convened a symposium to discuss USGS and UNRSL data and interpretations regarding the June 29, 1992 Little Skull Mountain earthquake.

A composite list of all level 3 milestones/deliverables (FY93/FY94) was compiled, along with completion criteria, and submitted to the M&O contractor. Work is continuing on development of Basis of Estimate forms and the USGS Participant Work Breakdown Structure Dictionary.

WBS 1.2.11 - QUALITY ASSURANCE

Three Activity Controls Specification Reports (ACSR) were prepared for the Hydrologic Investigations Program, and submitted to the Grading Acceptance Committee. The five remaining SIPs and QALAs are being evaluated for deletion from the controlled distribution system.

Audit Report USGS-92-02, of criterion 5 was written, resulting in two Audit Findings and four Audit Observations. An audit of the Colorado Department of Agriculture was performed with satisfactory results. Three vendor evaluations were accomplished.

Approximately 40 software documents were received, reviewed and/or processed by the Software Configuration Committee Coordinator in accordance with QMP 3.03, R3.

WBS 1.2.12 - INFORMATION SYSTEMS

The Local Records Center (LRC) reports that the first batch of backlog individual records are ready for transmittal to the Central Records Facility (CRF). About 90 percent of the material being reviewed already has been processed into the system. The LRC transmitted a total of 4,791 pages to the CRF. This included 90 individual records and 28 criteria records packages (1,215 pages), six current and five backlog publication packages (359 pages), six data packages (2,524 pages), and 18 cited references (693 pages).

WBS 1.2.13 - ENVIRONMENTAL

The water resources monitoring project reports that ground-water levels were measured at 26 sites. Discharge was measured at one flowing well.

Sincerely,

Kaye E. Kitchey

for Larry R. Hayes
Technical Project Officer
Yucca Mountain Project
U.S. Geological Survey

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