Charlotte

Lawrence Livermore National Laboratory

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Yucca Mountain Project Office
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SUBJECT: Yucca Mountain Project Status Report - June 1993
SCP: N/A

Attached is the June Project Status Report for LLNL's participation in the Yucca Mountain Project.

If further information is required, please contact Elizabeth Campbell of my staff at 510-422-7854 or Jim Blink in Las Vegas at 702-794-7157.

Sincerely,

John C. Radcliffe for
W. L. Clarke

W. L. Clarke
LLNL Technical Project Officer
for YMP

WC/EC

cc:
Distribution

DISCLAIMER

The LLNL Yucca Mountain Project 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.

LAWRENCE LIVERMORE NATIONAL LABORATORY YUCCA MOUNTAIN PROJECT
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LAWRENCE LIVERMORE NATIONAL LABORATORY
(LLNL)
YUCCA MOUNTAIN PROJECT (YMP) STATUS REPORT
JUNE 1993

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

1) **1.2.2.2.4 Engineered Barrier System (EBS) Field Tests.** (Large Block Test (LBT) D. Wilder, W. Lin, S. Blair and J. Blink assisted by LANL, SNL, RSN and REECo personnel visited NTS on June 1-2 to map fractures and select a test area. W. Lin and D. Wilder continued mapping the fractures on June 10 and 15. W. Glassley visited NTS on June 28-29 to map and sample the fracture system. Emphasis was on identifying mineralogy of fractures, number of fracture generations, and characteristics of fracture alteration haloes and fracture surfaces.

2) **1.2.2.2.1 Chemical and Mineralogical Properties of the Waste Package Environment.** The contract for the work on the New Zealand natural analog site was initiated. The screening process to select specific sites for study has been started, with initial work focusing on Champagne Pool, where fluid mixing is occurring. The first sampling and simulation activities will consider the ability of the EQ3/6 code to simulate mixing in a setting where diverse chemistries, changes in temperature, and interaction with the atmosphere influence reaction progress. Discussions are underway with the principal corporations controlling proprietary data to schedule a meeting to discuss how best to handle requests for such information.

3) **1.2.2.3.1.1 Waste Form Testing - Spent Fuel.** (Spent Fuel Dissolution) The last subset of eight UO_2 dissolution experiments in the LLNL initial UO_2 flow-through test matrix were completed at the prescribed text matrix conditions in late May. These tests were continued at room temperature using the same buffers to obtain additional test replications and data. These results will provide additional data to test intrinsic UO_2 dissolution models that are developed. These continuations, plus the original test matrix runs, gives 35 experimental runs under a wide variety of conditions to develop dissolution response models.

4) **1.2.5.4.2 Waste Package Performance Assessment.** Information on the source term was presented to SNL for use in TSPA 93. As part of this effort, Near Field and PA staff modeled an important near-field hydrological process, localized water penetration beyond a boiling front, through a dried-out zone, down to the level of a repository. At random locations, this flux could wet some waste packages. In order for penetration to happen at some location, it is necessary that the localized water flux be greater than the amount of water that can be evaporated by the heat flux from the repository. This heat flux is assumed to be essentially uniform, whereas water fluxes are known to exhibit spatial heterogeneity. Using the lognormal distribution to characterize this heterogeneity (as is suggested in the literature), numerical results for the fraction of waste packages that get wet under the assumptions of 57 and 114 kilowatts per acre initial area power density, both at the

center and edge of the repository have been derived. For representative assumed input values, the fraction of waste packages in the repository center zone that get wet is on the order of a few per thousand for the first 50 to 100 years. The fraction then drops by about an order of magnitude in the 57 kW/acre case. The fraction drops by about three orders of magnitude in the 114 kW/acre case, to an expected value well below one waste package in the whole repository center zone after a few hundred years.

5) **1.2.2.2.2 Hydrologic Properties of the Waste Package Environment.** Work has begun to develop an analytical model that represents transient (or cyclic) refluxing and boiling in fractures. This model calculates the distance that channelized flow travels down the fracture before water in the fracture is boiled away. It also calculates the fluxes for those fractures with flows capable of reaching the repository.

6) **1.2.2.2.2 Hydrologic Properties of the Waste Package Environment.** Small scale, buoyant vapor flow in low thermal load repositories (10-20 kW/acre, 30-yr-old) was studies. This flow is driven by the difference in temperature of the emplacement drifts and the pillars between the drifts. For bulk permeabilities greater than about 10 darcy (10-11m2), the resulting convection cells can increase saturation above the repository horizon and challenge condensate drainage towards waste packages for about 1000 years, even though drift wall temperatures do not approach the boiling point of water. In order to diagnose the potential for these effects to impact WP performance and radionuclide transport, in situ heater tests conducted under sub-boiling conditions will be required.

7) **1.2.2.2.5 Characterization of the Effects of Man-Made Materials on Chemical & Mineralogical Changes in the Post-Emplacement Environment.** LLNL staff met with P. Gottlieb, J. Peters, P. Mariner and J. Houseworth (M&O), to discuss concerns regarding organic materials in general. They also reviewed the present diesel fuel experiments and visited the organic materials experimental facilities. Interest was expressed in obtaining information regarding the stability of hydraulic fluids. J. Peters agreed to supply information regarding the range of hydraulic fluids that may be used during the construction of the ESF.

1.2.1 SYSTEMS ENGINEERING

1.2.1.1 Systems Engineering Coordination and Planning

No significant activities.

1.2.1.5 Special Studies

Thermal hydrology calculations were provided to the M&O for the thermal loading systems study. More details are provided in the WBS element 1.2.2.2.2 section of this report.

1.2.1.6 Configuration Management

No significant activities.

1.2.2 WASTE PACKAGE

1.2.2.1 Waste Package Coordination and Planning

No significant activities.

1.2.2.2 Waste Package Environment

1.2.2.2.1 Chemical and Mineralogical Properties of the Waste Package Environment

The contract for the work on the New Zealand natural analog site was initiated. The screening process to select specific sites for study has been started, with initial work focusing on Champagne Pool, where fluid mixing is occurring. The first sampling and simulation activities will consider the ability of the EQ3/6 code to simulate mixing in a setting where diverse chemistries, changes in temperature, and interaction with the atmosphere influence reaction progress. Discussions are underway with the principal corporations controlling proprietary data to schedule a meeting to discuss how best to handle requests for such information.

Work continued on the revised draft Study Plan 8.3.4.2.4.1 Characterization of the Chemical and Mineralogical Changes in the Post-Emplacement Environment. Completion of the Study Plan was delayed because of project budget exercises. The study plan will be completed in July.

Software for converting graphical displays to video images was obtained. Installation will occur in July. This capability will allow time sequences to be studied in detail such that regions of particular interest in the near-field environment can be better identified and examined. This capability will also allow visual presentation to the technical and public communities, in order to enhance comprehension of the nature of the problems being addressed.

The abstract entitled "Validation of Geochemical Codes Using Natural Systems: New Zealand Geothermal Systems" by C. Bruton, W. Bourcier and W. Glassley for submittal to the MRS Fall meeting in Boston, MA on November 29-December 3, was approved by YMPO on June 14.

1.2.2.2.2 Hydrologic Properties of the Waste Package Environment

Model Calculations

Over the past months, LLNL has been examining the sensitivity of thermo-hydrological performance of the repository-unsaturated zone-saturated zone (UZ-SZ) system to a broad range of thermal loading design parameters, thermo-hydrological properties of the UZ and SZ, and boundary conditions. In general, the only significant source of liquid water reaching a Waste Package (WP) and transporting radionuclides to the water table is from nonequilibrium fracture flow from three potential origins:

1) meteoric sources,
2) drainage of condensate generated under boiling conditions, and

3) drainage of condensate generated by buoyant vapor flow under sub-boiling conditions.

The second and third sources are generated by repository heat. Infiltration of meteoric water can be affected by repository-heat-driven changes to the moisture distribution and the intrinsic hydrological properties. Whether by boiling or buoyant vapor flow, the generation of condensate can either occur at a sub-repository scale (small-scale) or at the scale of the UZ (mountain-scale).

In recent months, sensitivity analyses of mountain-scale, buoyant vapor flow have been described. Mountain-scale, buoyant, gas-phase convection occurs within fracture networks having a connectivity with length scale comparable to the UZ thickness and repository width. Buoyant gas-phase convection cells develop as the warmer, less dense column of gas within the footprint of the repository is displaced by the cooler, denser column of gas outside of the repository footprint. As the initially cooler gas is heated up, its relative humidity is lowered, causing it to evaporate water from the rock matrix below the repository. This warm moist air is convected upward to where it cools above the repository, generating condensate that drains down fractures back towards the repository horizon, and/or is imbibed by the matrix, causing a saturation buildup above the repository horizon. Because water removed below the repository may be replenished by water imbibed from the SZ, this process can result in a net saturation buildup in the UZ. It was found that mountain-scale buoyant vapor flow can dominate moisture movement for on the order of 100,000 yrs.

Work began on a sensitivity analysis of small-scale, buoyant vapor flow. Small-scale, buoyant, gas-phase convection occurs within fracture networks having a connectivity with length scale comparable to the distance between the hot and cold regions of the repository. Buoyant gas-phase convection cells develop as the warmer, less dense column of gas within the footprint of the hot WPs is displaced by the cooler, denser column of gas in the adjacent areas (areas without WPs or with cooler WPs). As the initially cooler gas column is heated up, its relative humidity is lowered, causing it to evaporate water from the rock matrix below the hot regions of the repository. This warm moist air is convected upward to where it cools above the repository, generating condensate that drains down fractures back towards the repository horizon, and/or is imbibed by the matrix, causing a saturation buildup above the repository horizon. Small-scale, buoyant, gas-phase convection continues as long as significant temperature differences persist within the repository. It was found that small-scale, buoyant vapor flow can dominate moisture movement for up to 1000 years. At the outer edge of the repository, the distinction between small-scale and mountain-scale buoyant vapor flow is somewhat blurred. Because substantial temperature gradients persist at the outer edge of the repository, small-scale buoyant vapor flow may persist for thousands of years even if the fracture connectivity is not sufficient to support substantial mountain-scale vapor flow.

The sensitivity analysis included Areal Power Densities (APDs) of 10 and 20 kW/acre for 30-yr-old Spent Nuclear Fuel (SNF) and bulk permeability, k_b, values of 10, 20, 40, 84, and 168 darcy (1 darcy ~$10^{-12}m^2$). The two-dimensional, cross-sectional, drift-scale model which assumes an infinite array of 4.8-m-high x 6.0-m-wide emplacement drifts with a uniform spacing between drift centerlines of

38.4 m and a WP cross-section of 1.6 x 1.6 m, was applied. The model represents the symmetry element from the WP centerline to pillar centerline. Because the effect of "edge-cooling" does not effect temperatures in the center of the repository for thousands of years, the drift-scale model is applicable to the center of the repository. The drift-scale model is primarily intended to examine hydrothermal behavior when significant temperature differences persist within the repository which is generally for the first 1000 years. If WPs are placed end-to-end with a 4.6 m spacing, the thermal load in the 20 kW/acre drift-scale model is equivalent to just one PWR SNF assembly per package. For 10 kW/acre, the thermal load is equivalent to only one-half of a PWR SNF assembly placed end-to-end down the emplacement drift. As with mountain-scale, buoyant gas-phase convection, the threshold bulk permeability ($k_{b,hyd}$) where buoyant vapor flow begins to dominate moisture movement is about 10 darcy. If $k_b > 10$ darcy within a fracture network having a connectivity with a length scale comparable to half the drift spacing (in this example, 19.2 m), then buoyant vapor flow is sufficient to result in regions of net dry-out below the WPs and regions of net saturation buildup above the WPs. This may result in significant nonequilibrium fracture flow of condensate back to the WPs. Incidentally, the peak drift-wall temperature, T_{peak}, for the 20 kW/acre case is 60°C. Although T_{peak} is well below the nominal boiling point, repository-heat-driven flow could result in condensate drainage in the vicinity of WPs for on the order of 1000 years. For larger drift spacing, temperature differences between the drift-wall and pillar centerline will persist even longer, prolonging the period during which small-scale, buoyant vapor flow will drive condensate drainage and saturation buildup effects. For an APD of 10 kW/acre, a $k_{b,hyd}$ of about 20 darcy can cause similar effects. For the 10 kW/acre case, although T_{peak} is only 42°C, small-scale, buoyant vapor flow may drive significant condensate drainage and saturation buildup effects in the vicinity of WPs. In order to diagnose the potential for these effects to impact WP performance and radionuclide transport, in situ heater tests conducted under sub-boiling conditions will be required.

With the use of the UZ-repository-SZ-scale model, a suite of calculations to support the Total Systems Performance Assessment II (TSPA II) was conducted. A blended repository thermal loading history provided by the M&O was applied; it is based on the oldest fuel first (OFF) waste receipt scenario yielding an average SNF age of 26 years. Calculations were conducted for APDs of 28.5, 57, and 114 kW/acre (yielding Areal Mass Loadings (AMLs), of 29, 58, and 116 MTU/acre). The results, which were provided to both SNL and the M&O included detailed temperature, liquid saturation, and liquid flux histories throughout the repository, and throughout the various units between the repository horizon and the water table. Incidentally, the 57 kW/acre case (which falls within the thermal loadings described in the SCP-CDR) has a boiling period duration, t_{bp}, of 2600 years at the repository center.

Work continued to develop a suite of analytical approaches to modeling the statistical variability in condensate drainage. This work has been supporting both TSPA II and the thermal loading systems study. In this approach, condensate flow as a log-normal random field is idealized. The analytical models estimate the variability about the mean of the condensate flux computed by the UZ-repository-SZ-scale and drift-scale numerical models. One of the analytical models represents steady-state focusing of condensate concentrated over a localized region. This

model estimates the probability that mean condensate flow averaged over an area with a given correlation length exceeds the local average condensate flux. The probability that a WP is wet and the expected value of the condensate flux on that WP are then calculated.

Work has begun to develop an analytical model that represents transient (or cyclic) refluxing and boiling in fractures. This model calculates the distance that channelized flow travels down the fracture before water in the fracture is boiled away. It also calculates the fluxes for those fractures with flows capable of reaching the repository.

Laboratory Experiments

Work continued to measure electrical resistivity as a function of moisture content of Topopah Spring Tuff samples from the G-4 and GU-3 holes using J-13 water as pore fluid. The samples from GU-3 are being used for the high temperature measurements. The determination of electrical resistivity as a function of water saturation was completed using G-4 samples at room temperature. The specimens are machined both parallel and perpendicular to the axis of the core. Isotropy in electrical resistivity will be determined. For the GU-3 samples, the experiments are at 40°C, in the increasing saturation phase. The electrical conductivity of J-13 water at high temperatures has been determined to be near 100°C.

The experiment of determining the moisture retention curve and one-dimensional imbibition using G-4 core continued. The data from this experiment will be used to calculate relative permeability as a function of water saturation. The samples for the determination of moisture retention curves are at 35% relative humidity. The one-dimensional imbibition experiment using J-13 water is complete. The sample is saturated with water, some of which will be extracted for chemical analysis. Data analysis and evaluation of the experiment will be started next month. A gas bubble developed at the bottom of the sample during the experiment. The chemistry of the gas was sampled and analyzed. The gas is very similar to normal air except that its CO_2 content is about one order of magnitude greater than that in normal air. This information will be evaluated later.

An intact Topopah Spring tuff sample from the G-4 hole has been put in the pressure vessel under a confining pressure of about 5 MPa. The sample will be re-saturated with J-13 water before the permeability will be measured.

Meetings and Publications

T. Buscheck participated in the dry-run presentations on June 1 and June 16-17 in Las Vegas for the upcoming Nuclear Waste Technical Review Board (NWTRB) full-board meeting on thermal loading to be held in Denver on July 13 and 14.

T. Buscheck and J. Nitao made presentations at the model validation workshop held in Las Vegas on June 29. T. Buscheck presented a paper entitled "Repository-Heat-Driven Hydrothermal Flow: Modeling and Analysis". J. Nitao presented two

papers, "Analytical Expressions Quantifying the Influence of Convection on Fluid and Heat Flow" and "Modeling Statistical Variability in Condensate Drainage".

The paper by J. Nitao, T. Buscheck and D. Chesnut entitled "Implications of Episodic Nonequilibrium Fracture-Matrix Flow on Repository Performance" for submittal to the Journal of Nuclear Technology was approved by YMPO on June 2.

1.2.2.2.3 Mechanical Attributes of the Waste Package Environment

Work continued on responses to the NRC comments and associated revisions to Study Plan 8.3.4.2.4.3 and on Activity Plans for both laboratory and numerical studies of the geomechanics of the near-field environment.

S. Blair attended the 34th U.S. Symposium on Rock Mechanics in Madison, WI, June 28-30.

1.2.2.2.4 Engineered Barrier System (EBS) Field Tests

Large Block Test (LBT)

The draft Scientific Investigation Plan for the LBT has been revised in response to comments by YMPO reviewers. The procurement package for the load-retaining frame has been sent to potential venders. A topographic survey and fracture mapping of the site at Fran Ridge was completed. Determination of the strike and dip of the fractures will continue next month. The preparations for laboratory tests on smaller blocks and quarrying of the large block are continuing.

D. Wilder, W. Lin, S. Blair and J. Blink assisted by LANL, SNL, RSN and REECo personnel visited NTS on June 1-2 to map fractures and select a test area. W. Lin and D. Wilder continued mapping the fractures on June 10 and 15. W. Glassley visited NTS on June 28-29 to map and sample the fracture system. Emphasis was on identifying mineralogy of fractures, number of fracture generations, and characteristics of fracture alteration haloes and fracture surfaces.

Set-up of laboratory apparatus was initiated for testing of small blocks to be taken from the outcrop site. Review of specifications continued for several diagnostic systems for the LBT.

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

Draft of the Man-Made Materials Study Plan (8.3.4.2.4.5) continues.

K. Jackson and S. Carroll have initiated the first series of diesel fuel stability experiments. Their preliminary results demonstrate that diesel fuel is comprised of a vast array of constituents of varying stabilities.

K. Jackson, K. Knauss and A. Meike (LLNL) met with P. Gottlieb, J. Peters, P. Mariner and J. Houseworth (M&O), to discuss concerns regarding organic materials in general. They also reviewed the present diesel fuel experiments and visited the organic materials experimental facilities. Interest was expressed in obtaining information regarding the stability of hydraulic fluids. J. Peters agreed to supply information regarding the range of hydraulic fluids that may be used during the construction of the ESF.

The abstract entitled "Introduced Materials and Colloid Formation, A Report on the Current State of Knowledge" by A. Meike and C. Wittwer for submittal to the MRS Fall meeting in Boston, MA on November 29-December 3 was approved by YMPO on June 18.

The abstract entitled "Chemical Implications for the Presence of Introduced Materials in the Post-Emplacement Environment" by A. Meike for submittal to the MRS Fall meeting in Boston, MA on November 29-December 3 was approved by YMPO on June 10.

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

The last subset of eight UO_2 dissolution experiments in the LLNL initial UO_2 flow-through test matrix were completed at the prescribed text matrix conditions in late May. These tests were continued at room temperature using the same buffers to obtain additional test replications and data. These results will provide additional data to test intrinsic UO_2 dissolution models that are developed. These continuations, plus the original test matrix runs, gives 35 experimental runs under a wide variety of conditions to develop dissolution response models.

Work is continuing on the two long-term, room-temperature dissolution experiments ongoing since early last Fall. These experiments use UO_2 powder from a batch provided by PNL that were used by them in similar experiments. Our Canadian colleagues at Pinawa, Manitoba are performing similar experiments. The first buffer composition is 0.02M sodium bicarbonate at a pH of 8. The second composition is a 'standard' saline solution with 0.01M sodium bicarbonate and 0.1M sodium chloride saturated with air; the pH is not controlled. Since February, the uranium dissolution rate for the first non-saline solution slowly increased to about 2 mg/m^2-day in mid-April. The experiments were stopped for about one month during a move of the equipment to another building. Upon resuming the experiment in mid-May, the dissolution rate has increased to 2.5-4.0 mg/m^2-day. The UO_2 dissolution rate in the saline solution did not change during the one month stoppage. Its dissolution rate has also slowly increased over time, but is less variable at about 4-5 mg/m^2-day.

Documentation is being completed to begin a new sequence of experiments to examine the effects of oxidation state on uranium oxide dissolution. A prototype experiment is being assembled to measure the dissolution of schoepite at room temperature. These experiments will be similar to experiments beginning at PNL on spent fuel.

A test matrix for flow-through dissolution tests at PNL with three different spent fuels (ATM-104, ATM-105, and ATM-106), three oxidation states (UO_2, O_4O_{9+x} and O_3O_8), two temperatures (25° and 75°C), and three carbonate/bi-carbonate concentrations (0.2, 2, and 20 millimolar) was developed and approved. Some preparation of test specimens that will be used in these tests is in progress, but other preparations have been delayed as noted below.

Changes in the mission for the PNL Bldg. 325 analytical hot cells have required a transfer of a portion of the spent fuel test specimen preparations into a different shielded hot cell located in another building. Equipment needed for the work in the new hot cell is being purchased, fabricated, or transferred from the previous hot cell. This will incur a delay of three to four weeks and cost about $10K.

The abstract entitled "Modeling of UO_2 Aqueous Dissolution Over a Wide Range of Conditions" by S. Steward and H. Weed for submittal to the MRS Fall meeting in Boston, MA on November 29-December 3 was approved by YMPO on June 17.

Spent Fuel Oxidation

Dry Bath Testing

Two interim examinations were conducted on the 255°C drybath tests. The Turkey Point fuel has the fastest weight gain. It has reached an O/M of ~2.47; no powder was observed in any of the fragment samples. The weight curves are leveling off but at an O/M greater than those samples oxidized at 175°C. The 175°C samples are showing little or no weight gain. A subsample was taken of the sample at O/M = 2.47 for x-ray diffraction (XRD) analysis. An interim examination will be conducted next month on the main drybath tests.

The abstract entitled "Effects of Air/Steam Oxidation on the Initial Dissolution of Soluble Radionuclides from Spent LWR Fuel" by W. Gray, L. Thomas and R. Einziger (PNL) for submittal to the MRS Fall meeting in Boston, MA on November 29-December 3 was approved by YMPO on June 14.

Thermogravimetric Apparatus (TGA)

Work continues on bringing the TGAs out of mothballs. An $^{18}O_2$ run indicated that the equipment was leak tight. Fluctuations in the balance are still above the desired range but are well within tolerable limits. These fluctuations, apparently caused by thermal convections, were also present in previous TGA runs.

PNL has determined the inventory of MCC spent fuel Approved Test Materials (ATMs) that should be retained to support the YMPO program. The ATM number and quantities of the fuels that should be retained are as follows:

1) ATM-103, 24 inch-long section
2) ATM-104, 24 inch-long section
3) ATM-105, 24 inch-long section
4) ATM-106, 24 inch-long section
5) ATM-108, 24 inch-long section, and section "EE", rod ADN0106, 18 inches long.

Based on past, current and projected budgets, these samples should be sufficient to meet the current and projected needs of the spent fuel oxidation and spent fuel dissolution tests. These fuels should provide sufficient cladding for performance testing should the need arise.

The paper entitled "Rationale for Determining Spent Fuel MCC Acquisitions" by S. Marschman, R. Einziger (PNL) and R. Stout (LLNL) was sent to YMPO for approval.

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 86 months. The N3 tests (ATM-10, a West Valley actinide-doped glass) continue and have been in progress for 67 months.

A QA surveillance on the N2/N3 activities at ANL was performed on June 30. All Scientific Notebooks and logs were reviewed. M&TE were checked for proper labels identifying calibration due dates. It was noted by the QA personnel that no sampling has occurred during this surveillance period.

1.2.2.3.2 Metal Barriers

Work is progressing to complete the installation of the G.E. slow crack growth monitoring system in the new corrosion testing laboratory. The assembly of the flow system was nearly completed. The initial system operation was checked out for the pump, heater assemblies, system leak check, and the efficiency of the heat exchangers. The heaters and heat exchanger operated as designed, and the pump appears to operate at a maximum of 7 gallons/hr, a flow rate better than expected. A missing switch that controls the interlocks for pump and heater shutdown was ordered and is expected in July. The G.E. data acquisition and reversing DC system was turned on. Work is proceeding on running shake-down tests to evaluate the software performance. Work is planned for conducting slow crack growth studies on carbon steels and other ferrous materials under repository relevant environment conditions.

An experimental arrangement is being designed for use in conjunction with the thermal gravimetric analysis (TGA) system for monitoring the low corrosion and oxidation rates in low and high humidity environments. Experiments are planned over a temperature range from ambient to above the normal boiling point of water and humidities ranging from very dry to saturation. A check is being made in the LLNL procurement department on the status of the TGA unit, which was ordered in April.

The draft of the degradation mode survey on ferrous-base materials (carbon steels, low alloy steels, cast irons) is nearing completion. It is expected to be submitted for internal review in July.

J. Mitchell and other LLNL personnel visited the Yucca Mountain site on June 10. He and R. Van Konynenburg made arrangements to visit the REECo sub-dock in Area 25 to observe the carbon steel tubing string exposed to the USW H-5 well. Their visit is planned for July 7, and they will obtain samples from different parts of the string. The samples will be characterized for the amount of corrosion loss and the pattern of corrosion attack. The string had been exposed for ten years; part of it was exposed in the saturated zone and part in the unsaturated zone.

Meetings were held on June 17 with representatives from the M&O (H. Benton, D. Stahl, R. Fish and P. Gottlieb) to discuss the budget for the EBS materials characterization activities in FY94. On June 18, meetings were held with the M&O (R. Fish, D. Stahl and K. McCoy) to review the current technical progress and forecast for the next year.

Principal investigators and the task leader attended a meeting on June 29 with J. Podobnik, LLNL-YMP Project Control, to review the financial status of this task. The Metal Barrier expenditures and work progress are tracking reasonably well.

The abstract entitled "Limitations on the Development of a Scientific Basis for Nuclear Waste Management" by R. Van Konynenburg for submittal to the MRS Fall meeting in Boston, MA on November 29-December 3, was approved by YMPO on June 14.

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

Activities in this element for June will be reported in the July report.

1.2.2.3.4.2 Thermodynamic Data Determination

The abstract entitled "Collinear Photothermal Deflection Spectroscopy of Liquid Samples at Varying Temperature" by J. Spear, R. Silva, G. Klunder and R. Russo for submittal to Applied Spectroscopy was approved by YMPO on June 18.

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

This WBS element has not been funded in FY93.

1.2.3 SITE INVESTIGATIONS

1.2.3.1 Site Investigations Coordination and Planning

This WBS element has not been funded in FY93. A Cost and Schedule Change Request (C/SCR) has been submitted requesting addition of LLNL to the list of participants for this WBS element in the WBS Dictionary.

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

At the request of the database group, the release of Version 7.2 of EQ3/6 was postponed. A new set of data files is being prepared to correct minor inconsistencies with the published NEA data. These data files will be incorporated into the code package, which will now be released in July.

Work is continuing on Version 8.0. As specified in the Software Design Description (SDD), this version is a major re-write, incorporating major changes in the data structure to accommodate improvements in numerical methods and the addition of new functional capabilities. The new capabilities planned for Version 8.0 include:

1) allowing for redox disequilibrium in reaction-path calculations (important to treating the metastable persistence of dissolved components such as sulfate, nitrate, and organics,
2) a generic ion-exchange model, and
3) correction of supporting data, mostly thermodynamic, to pressures off the 1.013 bar-steam saturation curve.

1.2.3.5 Drilling

1.2.3.5.2.2 Engineering, Design, and Drilling Support

NTS personnel were indoctrinated into the YMP and personnel files were established.

1.2.3.10 Altered Zone Characterization

The principal effort has been on obtaining information on coupled codes. Emphasis has been on the code PRECIP.

Evaluation is proceeding on methodology used for examining changes in permeability and porosity.

1.2.5 REGULATORY

1.2.5.1 Regulatory Coordination and Planning

This WBS element has not been funded in FY93. A Cost and Schedule Change Request (C/SCR) has been submitted requesting addition of LLNL to the list of participants for this WBS element in the WBS Dictionary.

1.2.5.2 Licensing

1.2.5.2.2 Site Characterization Program

D. McCright attended meetings at YMPO on June 2, 15 and 16 to plan for the upcoming July 13-14 meeting of the Nuclear Waste Technical Review Board (NWTRB) to be held in Denver, CO. The meetings involved a scoping session and a two day dry run. His talk for the NWTRB will be on "Corrosion Aspects Under Various Thermal Scenarios". T. Buscheck will give a talk entitled "Numerical Modeling of Proposed Yucca Mountain Repository Under Various thermal Loads". D. Wilder will give a talk entitled "Waste Package Environment Thermal Tests". Completed viewgraphs were submitted to YMPO for eventual distribution at the July meeting.

D. Chesnut verified his comments on Study Plan 8.3.1.2.2.9, Site Unsaturated-Zone Modeling and Synthesis.

W. Lin has completed his review of Study Plan 8.3.1.3.6.1, Dynamic Transport Column Experiments.

J. Savy has completed his review of Study Plan 8.3.1.17.4.12, Tectonic Models and Synthesis.

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

The GEMBOCHS Change Requests 3, 7, 8, 10 and 11 which were submitted using the CNGBOCHS system were resolved. These requests and their resolution history are filed in CNGREQ; their summary fields are as follows:

1) CR-3, request for minor change of data0 format
2) CR-7, request to revise naming convention of organics
3) CR-8, request to capitalize native-element species
4) CR-10, invalid request, and
5) CR-11, update U data from 92gre/ful to reflect final publication.

Work continued to develop a WINDOWS/4GL (mouse-driven) version of JEWEL. This program facilitates interactive point-and-click generation of thermodynamic datafiles for EQ3/6, GT, and other geochemical modeling packages.

J. Johnson attended a meeting of the YMP-TDB Radionuclide Solubility Working Group in Las Vegas on June 16.

1.2.5.3.5 Technical Data Base Input

A correction was submitted to YMPO on June 1 to the request for completion of the Site and Engineering Properties Database (SEPDB) Backlog Submittal Packages.

J. Blink attended the Technical Data Working Group Meeting in Las Vegas on June 3.

1.2.5.4 Performance Assessment

1.2.5.4.2 Waste Package Performance Assessment

Information on the source term was presented to SNL for use in TSPA 93. As part of this effort, Near Field and PA staff modeled an important near-field hydrological process, localized water penetration beyond a boiling front, through a dried-out zone, down to the level of a repository. At random locations, this flux could wet some waste packages. In order for penetration to happen at some location, it is necessary that the localized water flux be greater than the amount of water that can be evaporated by the heat flux from the repository. This heat flux is assumed to be essentially uniform, whereas water fluxes are known to exhibit spatial heterogeneity. Using the lognormal distribution to characterize this heterogeneity (as is suggested in the literature), numerical results for the fraction of waste packages that get wet under the assumptions of 57 and 114 kilowatts per acre initial area power density, both at the center and edge of the repository have been derived. For representative assumed input values, the fraction of waste packages in the repository center zone that get wet is on the order of a few per thousand for the first 50 to 100 years. The fraction then drops by about an order of magnitude in the 57 kW/acre case. The fraction drops by about three orders of magnitude in the

114 kW/acre case, to an expected value well below one waste package in the whole repository center zone after a few hundred years.

Thermal hydrology calculations were provided to the SNL and the M&O for the TSPA II. More details are provided in the WBS element 1.2.2.2.2 section of this report.

W. Halsey contributed information to the 1994 Annual Plans for both Waste Package WBS 1.2.2 and Regulatory (Performance Assessment WBS 1.2.5).

The following two workshops were hosted at LLNL to develop models and data for Total System Performance Assessment - II. LLNL is responsible for a NFE/EBS Source Term which incorporates thermal processes:

1) June 11, Thermal History Workshop (participants from LLNL, DOE, SNL and M&O)

2) June 23, Hydrothermal Water Flux Workshop (participants from LLNL, SNL and M&O)

1.2.9 PROJECT MANAGEMENT

1.2.9.1 Management and Coordination

1.2.9.1.2 Technical Project Office Management

J. Blink reviewed AP-5-38 R2, Environmental, Safety and Health Appraisal".

J. Blink provided LLNL-YMP NTS population projections to RSN on June 3. He worked with SAIC Socio-Economic staff members to streamline the Employee Survey to be conducted in July 1993. He attended the YMP Safety Committee meeting on June 3 and the ESF Enhancement Meeting on June 28 in Las Vegas. He attended Infrastructure Reduction Assessment Team (IRAs) meetings in Albuquerque on June 17-18 and in Las Vegas on June 23. He also participated on June 28-30 in the ESF backup power valve engineering study.

J. Blink coordinated LESSON teacher training workshops at Valley High School (for Clark County teachers) and at NTS (for Nye County teachers). He also taught the physics portion of the courses and acted as a tour guide for tours of the NTS and Yucca Mountain.

1.2.9.2.2 Participant Project Control

The May Cost/FTE report was submitted to YMPO. The Cost Plan was updated to include May actuals. The May actual schedule progress and costs were submitted via the PACS workstation. Variance analysis explanations were developed for four P&S accounts:

1) Man-Made Materials, 1.2.2.2.5
2) Waste Form Testing-Glass, 1.2.2.3.1.2
3) Project Control, 1.2.9.2.2
4) Administrative Support, 1.2.15.2

The FY93 Estimate at Completion analysis is being conducted. A series of meetings with the Technical Area Leaders and their Principal Investigators were held to discuss current status and forecasts for expenditures through the end of the FY.

Staff met with representatives of the M&O on June 17 in Livermore to discuss FY94 Waste Package budgets. The M&O proposed two budget cases with distribution of workscope, deliverables and budgets at the P&S account level. The proposals were modified and presented to the Engineering Development Division Director in Las Vegas on June 23.

Two candidates were interviewed for the Engineering/Scientific Coordinator. Difficulties are being encountered in finding a candidate with the appropriate background. It is anticipated that it will be necessary to submit a job posting for these positions through the internal employees posting. To date, all candidates have been "displaced persons".

A review was completed of the Compliance Evaluation Plan for the DOE-IRM activity. LLNL's comments address the need to be funded for the IRM activity if this Compliance Evaluation is to be implemented. IRM activity is now being undertaken as an "overhead function"; however the requirements and time expended are becoming significant and should be recognized as a budget area.

A Basis of Estimates package is being assembled that was previously provided to YMPO in June of 1992. The second submittal is required for M&O records.

A modified acquisition plan to reflect a change in the FY93 IRM Short Range Plan was submitted. Two IBM 370s are being purchased instead of Sun SPARCstations as specified in previous capital planning documents.

1.2.11 QUALITY ASSURANCE

1.2.11.1 Quality Assurance Coordination and Planning

A response was made to the YMPO request to verify that the LLNL internal procurement procedures comply with DOE procurement controls.

R. Monks and B. Bryan attended the QARD Orientation Meeting in Las Vegas on June 28.

1.2.11.2 Quality Assurance Program Development

The Grading Report LLNL-QAG-L070 for Activity N-20-1, Direct Geotechnical Data Acquisition Support of Testing at NTS, was completed and distributed.

The Activity Plan for Flow-Through Dissolution Tests on UO_2, D-20-53b, Rev. 1, was completed and distributed.

1.2.11.3 Quality Assurance Verification

1.2.11.3.1 Quality Assurance Verification - Audits

Audit 93-02, an internal audit of LLNL-YMP covering Criteria 2-9, 12, 13, and 17, was conducted on June 15 - 30.

Audit 93-03, an independent audit of the LLNL-YMP QA organization covering Criteria 1, 2, 15, 16, and 18, was conducted on June 23 - 25 by (non-YMP) LLNL Quality Assurance staff.

1.2.11.3.2 Quality Assurance Verification - Surveillance

No significant activities.

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

No significant activities.

1.2.12 INFORMATION MANAGEMENT

1.2.12.2 Records Management

1.2.12.2.2 Local Records Center Operation (LRC)

Four new revisions were issued by Document Control. There were no change notices issued.

1.2.12.2.3 Participant Records Management

A total of 216 items were logged into the LLNL-YMP tracking system. This includes 15 records/records packages that were processed through to the CRF. Ten action items were closed.

The records staff reviewed and commented on AP-1.17Q.

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

A request was submitted for FY94 funding for this WBS element in anticipation of work needed to support the Large Block Test at NTS.

1.2.15 SUPPORT SERVICES

1.2.15.2 Administrative Support

HQ comments were received on the first draft of PR 8, Site Characterization Progress Report: Yucca Mountain, Nevada. LLNL reviewed the report and responded to these comments on June 24 as requested.

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

Twenty one different self-study assignments were issued, and 21 people were trained to these assignments. Currently, there are 85 participants on the project who are to be trained and/or tracked.

INFORMATION COPY

Reynolds Electrical & Engineering Co., Inc.

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

IN REPLY REFER TO:
580-01-548

WBS 1.2.9.1
QA: N/A

July 14, 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 June 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.

FOR

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

RFP:RRK:mab

Enclosure
Status Report (3 pages)

cy: See page 2

cy w/encl.
Information Services Center, M/S 408
K. W. Powers, 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
C. E. Hampton, DOE/YMP, M/S 523
D. J. Harrison, DOE/YMP, M/S 523
B. D. Hutchinson, DOE/YMP, M/S 523
V. F. Iorii, DOE/YMP, M/S 523
S. B. Jones, DOE/YMP, M/S 523
E. H. Petrie, DOE/YMP, M/S 523
W. B. Simecka, DOE/YMP, M/S 523
D. R. Williams, DOE/YMP, M/S 523
W. A. Wilson, DOE/YMP, M/S 717
L. D. Foust, M&O, M/S 423
M. M. Martin, M&O, M/S 423
R. L. Robertson, M&O/Fairfax, VA
P. Justus, NRC/Las Vegas, NV
R. C. Furtek, REECo, M/S 235
B. R. Gardella, REECo, M/S 408
W. J. Glasser, REECo, M/S 408
J. L. Henze, REECo, M/S 751
S. L. Hughes, REECo, M/S 408
D. L. Knight, REECo, M/S 408
D. L. Koss, REECo, M/S 408
R. B. Land, REECo, M/S 585
T. M. Leonard, REECo, M/S 751
K. L. Limon, REECo, M/S 408
C. J. Mason, REECo, M/S 751
S. O. Straub, REECo, M/S 408
J. R. Trujillo, REECo, M/S 590
M. Brodeur, SAIC, M/S 517/T-23
J. J. Brogan, SAIC, M/S 517/T-12
R. D. Hutton, SAIC, M/S 517
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)

JUNE 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)

Completed support of IDAS to include technical support, equipment testing, maintenance and repairs. Funding to support this activity has been expended for Fiscal Year (FY) 1993.

WBS 1.2.3.5
Task: Capital Equipment to support Drilling Programs

Requisitions for tubing tongs, breakout table/rotary tool service, and dust collector were prepared and forwarded to Procurement with instructions to proceed up to award. The funding transfer of $100,000 requested in March is expected in July.

Task: USW UZ-14 Drilling (Job Package 92-17)

Continued drilling/coring operations. Borehole has been continuously cored to a depth of 897.75 feet. The 12-1/4 inch reamed hole has been advanced to 884.22 feet. Scheduled total depth for UZ-14 is 294.06 feet.

Task: UE-25 NRG-2 North Portal Ramp Borehole (Job Package 92-19)

Completed drilling operations on June 7, 1993. Total depth reached was 294.06 feet.

Task: UE-25 NRG-4 Access Road (Job Package 93-2)

Completed NRG-4A road and pad construction. Commenced drilling operations on June 17, 1993. Currently coring at 560 feet.

Task: UE-25 NRG-5 North Portal Ramp Borehole (Job Package 93-3A)

Completed drilling operations on June 9, 1993. Total depth reached was 1350 feet.

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 three SCP sets during this reporting period.

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. Participated in FY1994 ESF Construction Conceptual Plans with the M&O, and supported the DOE Audit of Quality Affecting Construction Department activities.

Task: Technical Support and Underground Excavation for the ESF

A new proposal was received on June 3, 1993. Negotiations with the Subcontractor were held on June 7, 1993 and again on June 11, 1993. Areas of the Terms and Conditions, with which the Subcontractor took exception, have been resolved. The Procurement Package was submitted to DOE/NV for review and approval on June 21, 1993.

Task: Procurement of a Tunnel Boring Machine

Technical personnel conducted a site visit to a proposed vendor for the Concrete Batch Plant during this period. The proposed plant was not adequate, and we are attempting to locate another vendor(s).

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

Drilled and blasted 36 rounds. Advanced the rib slashes from 0+56 to 0+99 and the full face from 0+99 to 1+36. Installed 6 lattice girder sets at the portal. Shot 218 super sacks of fibercrete. Trained and tested 13 miners to the ACI Standard. Pumped 601 cubic feet of grout to the permanent rock bolts. Installed 159 - ten foot split set bolts, 50 - sixteen foot permanent rock bolts, 15 - ten foot permanent bolts, and 14 - twenty foot spiling bolts at 1+22 to turn under the horizontal joint. Supported FOD/DOD mock emergency at P-Tunnel, Area 12. Installed 100 horsepower fan. Completed second lift of aggregate base course on the North Portal Access Road. Began rework of the Diversion Channel. Began site work at the concrete batch plant. Began fencing of material control areas on the ESF Pad.

TEST FACILITIES (1.2.7)

Task: Field Operations Support

Continued logistical and tour support for DOE Yucca Mountain Site (YMSO) staff. Seven tours were held during this period with 267 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. Continued to experience problems with the chiller system for the Field Operations Center, Building 4015 in Area 25 when the rental chiller failed to cycle back on. The Site Maintenance Department has been working with the chiller manufacturer to resolve the problem and complete the installation.

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. Received an acceptable response to the Corrective Action Report (CAR) identifying a significant condition adverse to quality in the area of Control of Material. Actions are to be completed by August 20, 1993.

The responses to the CARs issued as a result of the March 1993 YMP Inspection Audit have been evaluated as acceptable. Actions are in progress to verify the implementation of the corrective actions.

The DOE/YMP Quality Assurance Division conducted an audit of REECo/YMP activities in the area of Procurement; Identification and Control of Items and Services; Measuring and Test Equipment; Inspection, Test and Operating Status; and Nonconformance Control. Seven CARs are to be issued.

A CAR documenting a significant condition adverse to quality was issued, in that the ESF work activities were conducted based on verbal direction rather than per approved drawings and specifications.

Initiated an investigation to determine the cause of low break test results on the HLN(cc) grout used for pattern rockbolts.

ENVIRONMENT, SAFETY & HEALTH (1.2.13)

WBS 1.2.13

Task: Safety & Occupational Health

Provided medical, occupational safety, industrial hygiene, and fire protection support. Prepared and provided updated estimates for FY1994 support, per the request of R. B. Baumeister.

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.

Attended the American Nuclear Society Annual Conference in San Diego, California; participated as a member on the Power Division's Program Committee.