Lawrence Livermore National Laboratory

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SUBJECT: Yucca Mountain Project Status Report - October 1994 (SCP: N/A)

Attached is the October Project Status Report for LLNL's participation in the Yucca Mountain Site Characterization Project.

If further information is required, please contact Carol Passos at 702-794-7511 or Jim Blink at 702-794-7157.

Sincerely,

W.L. Clarke
Technical Project Officer
LLNL-YMP

WC/CP

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Lawrence Livermore National Laboratory Yucca Mountain Project
Technical Highlights and Status Report
October 1994

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LAWRENCE LIVERMORE NATIONAL LABORATORY
(LLNL)
YUCCA MOUNTAIN SITE CHARACTERIZATION PROJECT
(YMP)
STATUS REPORT

October 1994

EXECUTIVE SUMMARY

1) **WBS 1.2.1.5, Special Studies:** As a means of evaluating the impact of thermal loading on repository performance, LLNL has performed repository and drift scale calculations for a range of thermal loads. Drift scale calculations show that waste package surface temperatures can be 60 to 100°C higher than the repository scale average temperatures, for loads ranging from 24 to 111 MTU/acre. In addition, for low thermal loads, aging the fuel prior to emplacement can substantially reduce the temperature at which the relative humidity returns to pre-emplacement values. Closely spaced drifts (with more widely spaced waste packages), smaller waste packages, and ventilation are other design options that can reduce the corrosion potential in the near-field.

2) **WBS 1.2.2.4.1, Spent Fuel:** Spent Fuel Characterization Testing of PWR spent fuel under drip conditions at Argonne National Laboratory (under LLNL sponsorship) has revealed dissolution rates much higher (one to two orders of magnitude) than predicted by bounding performance assessment calculations. These high rates appear, for one of the two PWR fuels tested, to be due to alteration of the sample. Rapid oxidation of the sample surfaces occurred over a six month period about two years after the test began. For the other PWR fuel tested, changes were noted in the leachate (stratification and rapid precipitation following transfer). Investigation continues on these samples; the results will be used to produce new bounding performance assessments.

3) **WBS 1.2.2.5.1, Metallic Barriers:** An Integrated Corrosion Facility is being equipped at LLNL to simultaneously test a range of waste package material candidates in several repository-appropriate and bounding environments. Twenty-two reaction vessels will be included. Detailed design is underway, and the test matrix and specimen geometries are being finalized. The results from these long term (up to five years of exposure) tests will support a license application. Early (interim) results will support the Technical Site Suitability evaluation.

4) **WBS 1.2.3.4.2.1, Geochemical Modeling:** In FY94, Version 7.2a of LLNL's EQ3/6 geochemical modeling code was certified for use in quality affecting work. Simultaneously, Version 8 was developed, adding new capabilities for thermodynamic pressure corrections and ion-exchange modeling. In FY95, Version 8.0 will be verified and validated, leading to its certification for quality affecting work. Simultaneously, new capabilities are being developed, with an emphasis on boiling and vapor phase phenomena.

5) **1.2.3.4.2.2, Geologic and Engineering Materials Bibliography of Chemical Species (GEMBOCHS):** LLNL completed incorporation of the CHEMVAL4 and CHEMVAL5 thermodynamic databases into the GEMBOCHS database. Modification of the JEWEL software to facilitate generation of CHEMVAL-based EQ3/6 datafiles was also completed. CHEMVAL contains approximately 1000 chemical species and is commonly used for comparative radiological assessment calculations in Europe.

6) **WBS 1.2.3.12.2, Hydrologic Properties of the Waste Package Environment:** Repository scale thermo-hydrological models at LLNL were used to investigate the sensitivity of temperature-relative humidity history and boiling duration to spent nuclear fuel aging (or aggressive ventilation during the pre-closure period) and to repository depth, all as a function of areal mass loading (AML). The results show that an aggressive thermal management strategy to minimize the magnitude and duration of repository temperature buildup would incorporate:

1) SNF aging and/or drift ventilation to reduce repository temperature buildup during the first 1000 yr, and
2) a shallow overburden thickness which would reduce repository temperature buildup for later times ($t > 1000$ yr).

This approach could also be useful if the decision were made to increase the AML of portions (or all) of the repository area prior to closure in order to enhance moisture removal and the duration of reduced-*RH* conditions. The use of either older-age SNF and/or long-term ventilation of heat and moisture from the repository result in a substantial delay for the WPs to reach peak temperatures. Increasing the time required to reach peak temperature greatly facilitates how effectively a nonuniform, optimized-AML distribution can be applied to levelize the *T-RH* conditions throughout the repository.

7) **WBS 1.2.3.12.3, Mechanical Attributes of the Waste Package Environment:** LLNL is developing a laser based instrument for precise measurement of small displacements in subsurface environments such as boreholes and drifts. Development of the Multipoint Borehole Laser Extensometer (MBLEX) has been underway for a few months, including completion of a design and a survey of available components. Several components have been received and tested on an optical table. These include a 91 m (300') optical cable and a fiber optic power meter. Recent work includes testing of techniques for collimating a laser beam after it is transmitted through an optical cable and then into the atmosphere. The system is based on a phase modulated laser measurement instrument; delivery of this instrument is expected in early November.

8) **WBS 1.2.3.12.4, Engineered Barrier System (EBS) Field Tests:** LLNL staff visited Aircraft Engineering Corporation (AEC) in Los Angeles on October 28. The four completed sections of the frame sides were assembled for a trial fitting, and the dome was placed on top of them. Non-destructive evaluation (NDE) results from AEC were reviewed, and a schedule for finish welding on the dome was discussed. AEC intends to ship the completed side sections to NTS during the week after Thanksgiving. The dome will be shipped on December 5, subject to oversize load permits.

9) **WBS 1.2.3.12.4, Engineered Barrier System (EBS) Field Tests:** The neutron logging data obtained from some of the Large Block Test vertical holes both before and after the sawing have been reduced, based on the LLNL calibration data of the neutron tool. The saturation levels of the block were between 60 and 80% at the time of the measurement. The data indicate that the sawing process did not significantly increase the saturation level of the block.

10) **WBS 1.2.5.4.2, Waste Package Performance Assessment:** At LLNL, the YMIM model was analyzed using an object-oriented program development approach. Such an approach will aid in the software QA process by allowing the recording of design-stage developments in progress and by providing complementary views of the model structure. The analysis was done in parallel with the testing of a commercial software package for object-oriented modeling which includes diagramming, database, and internal consistency checking features. The test was a two-week trial-basis test of the package. The test application on YMIM resulted in some proposed streamlining of the code operation and some streamlining of the higher-level structure so that it is easier to

communicate the model structure and assumptions to the engineering and earth science subject-matter experts.

11) WBS 1.2.9.1.2.1, TPO management: In October, LLNL and TRW signed a Memorandum of Understanding that begins the process of integrating LLNL into the CRWMS-M&O team. The contractual vehicle will be a Memorandum Purchase Order, which is a DOE Integrated Contractor agreement that incorporates the provisions of each M&O's (TRW and the University of California) contract with the DOE. The motivation for this unprecedented agreement is two-fold. First, the OCRWM Director indicated that he would prefer to have a team led by the M&O, rather than numerous organizations reporting directly to DOE. Second, LLNL is in the OCRWM program to apply its multi-disciplinary approach to solving a key environmental and economic problem; since much more of the program technical work is being conducted by the M&O, LLNL will be more effective as an integral part of the M&O.

TECHNICAL SUMMARY

1.2.1. SYSTEMS ENGINEERING

1.2.1.5 Special Studies

J. Blink participated in the ESF Concept of Operations development. J. Blink, J. Nitao, and D. Wilder participated in the M&O's thermal loading meeting in Las Vegas on October 25.

Modeling Support for theThermal Loading Systems Study: Analysis of the Impact of SNF Age and Binary Gas-Phase Diffusion on Temperature and Relative Humidity Conditions on the Waste Package

In order to augment the thermo-hydrological calculational support of the thermal loading systems study, LLNL has been conducting the calculations in the near-field/altered zone hydrology task with the same set of thermal loading assumptions. We assume a Youngest Fuel First Spent Nuclear Fuel (SNF) receipt scenario with a 10-yr cut-off for the youngest fuel [referred to as YFF(10)] and account for the emplacement of BWR waste packages (WPs) containing 40 assemblies per WP, and PWR WP containing 21 assemblies per WP. The waste receipt schedule was supplied by the M&O. Areal Mass Loadings (AMLs) of 24.2, 35.9, 55.3, 70, 83.4, 100, 110.5, and 150 MTU/acre have been analyzed assuming the matrix hydrological properties given in the Reference Information Base (RIB) and Klavetter and Peters (1986).

This month we focused on investigating the impact of SNF age and binary gas-phase diffusion on temperature-relative humidity (*T-RH*) conditions around WPs. Section 1.2.3.12.2 provides additional related information. It discusses the sensitivity of *T-RH* conditions to an optimized, nonuniform-AML distribution and to repository depth (overburden thickness).

In past status reports, we have described the temperature and relative humidity conditions throughout the repository (center to edge) for cases with repository depths of 200, 343, and 430 m. Those analyses used a repository-scale model that smears the generated heat over a circular disk-shaped area. Results from the repository-scale model are representative of average repository conditions rather than local conditions on the WP surface. In this section, we report on results from a drift-scale model. Drift-scale behavior is represented by a two-dimensional model that incorporates the geometric details of the WPs and emplacement drifts in a cross section orthogonal to the drift axis. Conditions on the WP surface can be significantly hotter and drier than the average repository conditions. This is particularly true for low AMLs, or near the repository edge for higher AMLs. The drift-scale model averages the WP heat generation along the drift axis; this assumption is quite reasonable for the 12-m center-to-center WP spacings assumed in this study. The center-to-center drift spacings are 99, 66.8, 43.4, and 21.7 m for AMLs of 24.2, 25.9, 55.3, and 110.5 MTU/acre, respectively.

Tables 1 and 2 summarize the peak temperature and corresponding *RH* on the WP surface during three different time periods for different AMLs and 12- and 41-yr-old SNF, assuming nominal binary gas-phase diffusion, where the binary, gas-phase diffusion tortuosity factor, τ_{eff}, is 0.2. Table 3 summarizes *T-RH* conditions on the WP surface for the case of "enhanced" binary gas-phase diffusion, where the binary, gas-phase diffusion tortuosity factor, τ_{eff}, is 2.0.

Table 1: Binary gas-phase diffusion tortuosiy factor τ_{eff} = 0.2 Peak temperature and corresponding relative humidity on the WP surfaces during the indicated time period for different AMLs, based on the drift-scale model. The heat generation is for a composite of 21-PWR WPs and 40-BWR WPs with 12 m WP spacing. Also, applicable to 12-PWR and 21-BWR WPs with 6.86 m WP spacing.						
Table 1a: AML = 24.2 MTU/acre; 99.0-m drift spacing.						
SNF age (yr)	Peak temperature during indicated time period (°C)			Relative humidity corresponding to peak temperature (%)		
	0-30 yr	30-100 yr	100-1000 yr	0-30 yr	30-100 yr	100-1000 yr
41	104	100	85	43	50	62
12	170	160	124	9	14	36
Table 1b: AML = 35.9 MTU/acre; 66.8-m drift spacing.						
SNF age (yr)	Peak temperature during indicated time period (°C)			Relative humidity corresponding to peak temperature (%)		
	0-30 yr	30-100 yr	100-1000 yr	0-30 yr	30-100 yr	100-1000 yr
41	105	103	94	44	51	65
12	171	166	137	11	13	27
Table 1c: AML = 55.3 MTU/acre; 43.4-m drift spacing.						
SNF age (yr)	Peak temperature during indicated time period (°C)			Relative humidity corresponding to peak temperature (%)		
	0-30 yr	30-100 yr	100-1000 yr	0-30 yr	30-100 yr	100-1000 yr
41	112	112	109	55	56	63
12	182	180	150	9	10	20
Table 1d: AML = 110.5 MTU/acre; 21.7-m drift spacing.						
SNF age (yr)	Peak temperature during indicated time period (°C)			Relative humidity corresponding to peak temperature (%)		
	0-30 yr	30-100 yr	100-1000 yr	0-30 yr	30-100 yr	100-1000 yr
41	136	143	154	29	25	19
12	240	248	238	4	3	4

The repository-scale model predicts a peak temperature T_{peak} = 66°C and no reduction in *RH* for the 24.2-MTU/acre repository. However, for 12-yr-old SNF, the drift-scale model predicts T_{peak} = 170°C on the WP surface (Table 1a), and *RH* is relatively low for hundreds of years (Table 2a). For 41-yr-old SNF, T_{peak} is only 104°C; however, *RH* is reduced to 43% (Table 1a) and below-ambient *RH* persists for hundreds of years (Table 2a). To avoid boiling conditions for low AMLs, a combination of some of the following will be required:

1) SNF aging,
2) closely spaced drifts (and widely spaced WPs),
3) WPs with fewer assemblies, and
4) drift ventilation schemes.

The repository-scale model predicts T_{peak} = 110°C and *RH* < 70% for 670 yr for the inner 50% of the 55.3-MTU/acre repository. However, for 12-yr-old SNF, the drift-scale model predicts T_{peak} = 182°C on the WP surface (Table 1c) and *RH* < 70% for 8890 yr (Table 2c). For 41-yr-old SNF, T_{peak} = 112°C and *RH* < 70% for only 580 yr. In general, *T-RH* behavior on the WP surface is very sensitive to SNF age for low to intermediate AMLs. For high AMLs (e.g., 110.5 MTU/acre), this behavior is much less sensitive to SNF age (Table 2d).

Table 1 shows the very strong dependence that peak WP temperature has on SNF age. For the first 30 yr, the difference in WP temperature between the 12- and 41-yr-old SNF is 67, 66, 70, and 104°C for AMLs of 24.2, 35.9, 55.3 and 110.5 MTU/acre, respectively. During the first 100 yr, the peak WP temperature for 41-yr-old SNF in a 110.5-MTU/acre repository is lower (143°C) than for 12-yr-old SNF in a 24.2-MTU/acre repository (170°C). For 12-yr-old SNF, the range of minimum *RH* is relatively small (3 to 11%), while for 41-yr-old SNF it is larger (19 to 55%). The minimum *RH* is quite sensitive to SNF age for low to intermediate AMLs (24.2 to 55.3 MTU/acre) and less sensitive to SNF age for 110.5 MTU/acre.

Table 2: Binary gas-phase diffusion tortuosiy factor $\tau_{eff} = 0.2$
Time to rewet to indicated relative humidity *RH* on the WP surfaces, and the WP temperature when that *RH* is attained for different AMLs, based on the drift-scale model. The heat generation is for a composite of 21-PWR Wps and 40-BWR WPs with 12 m WP spacing. Also, applicable to 12-PWR and 21-BWR WPs with 6.86 m WP spacing.

Table 2a: AML = 24.2 MTU/acre; 99.0-m drift spacing.

SNF age (yr)	Time to rewet to indicated relative humidity (yr)				Temperature when indicated relative humidity is attained (°C)			
	60%	70%	80%	90%	60%	70%	80%	90%
41	90	220	640	2,110	88	77	70	54
12	220	300	600	2,320	117	109	102	95

Table 2b: AML = 35.9 MTU/acre; 66.8-m drift spacing.

SNF age (yr)	Time to rewet to indicated relative humidity (yr)				Temperature when indicated relative humidity is attained (°C)			
	60%	70%	80%	90%	60%	70%	80%	90%
41	70	150	420	1,440	99	91	86	73
12	590	880	1,180	1,740	110	104	95	85

Table 2c: AML = 55.3 MTU/acre; 43.4-m drift spacing.

SNF age (yr)	Time to rewet to indicated relative humidity (yr)				Temperature when indicated relative humidity is attained (°C)			
	60%	70%	80%	90%	60%	70%	80%	90%
41	90	580	1,010	1,550	111	106	101	92
12	1,710	8,890	16,800	27,600	112	62	46	36

Table 2d: AML = 110.5 MTU/acre; 21.7-m drift spacing.

SNF age (yr)	Time to rewet to indicated relative humidity (yr)				Temperature when indicated relative humidity is attained (°C)			
	60%	70%	80%	90%	60%	70%	80%	90%
41	17,200	23,200	28,700	34,300	52	46	42	38
12	20,100	23,100	26,100	29,100	53	50	48	45

Table 3: Binary gas-phase diffusion tortuosiy factor $\tau_{eff} = 0.2$
Time to rewet to indicated relative humidity *RH* on the WP surface, and the WP temperature when that *RH* is attained for different AMLs, based on the drift-scale model. The heat generation is for a composite of 21-PWR WPs and 40-BWR WPs with 12m WP spacing. Also, applicable to 12-PWR and 21-BWR WPs with 6.86m WP spacing.

Table 3a AML = 24.2 MTU/acre; 99.0-m drift spacing.

SNF age (yr)	Time to rewet to indicated relative humidity (yr)				Temperature when indicated relative humidity is attained (°C)			
	60%	70%	80%	90%	60%	70%	80%	90%
41	210	440	760	2,250	78	72	65	52
12	580	970	1,710	3,290	87	78	68	53

Table 3b AML = 35.9 MTU/acre; 66.8-m drift spacing.

SNF age (yr)	Time to rewet to indicated relative humidity (yr)				Temperature when indicated relative humidity is attained (°C)			
	60%	70%	80%	90%	60%	70%	80%	90%
41	230	490	990	1,890	88	83	77	65
12	710	1,160	2,280	6,720	105	94	76	48

Table 3c AML = 55.3 MTU/acre; 43.4-m drift spacing.

SNF age (yr)	Time to rewet to indicated relative humidity (yr)				Temperature when indicated relative humidity is attained (°C)			
	60%	70%	80%	90%	60%	70%	80%	90%
41	300	800	1,550	5,920	106	103	90	54
12	1,900	6,360	17,300	38,600	103	57	40	28

Table 3d AML = 110.5 MTU/acre; 21.7-m drift spacing.

SNF age (yr)	Time to rewet to indicated relative humidity (yr)				Temperature when indicated relative humidity is attained (°C)			
	60%	70%	80%	90%	60%	70%	80%	90%
41	7,360	14,300	24,900	42,100	70	56	45	36
12	15,100	21,600	29,500	38,400	62	52	45	37

A comparison of Tables 2 and 3 shows the importance of whether binary gas-phase diffusion is enhanced. For low to intermediate AMLs (24.2 to 55.3 MTU/acre) there is a substantial difference in the duration of reduced-*RH* conditions. Depending on the SNF age and value of τ_{eff} assumed, the relationship between *T* and *RH* varies substantially for low to intermediate AMLs. For 12-yr-old SNF in a 24.2-MTU/acre repository, the temperature associated with RH = 70% is 109°C for $\tau_{eff} = 0.2$, while it is only 78°C for $\tau_{eff} = 2.0$.

For 110.5-MTU/acre, *T-RH* behavior is less sensitive to value of τ_{eff}. For low to intermediate AMLs, enhanced binary gas-phase diffusion has the effect of extending the duration of reduced-*RH* conditions, while for the high-AML case (110.5 MTU/acre), enhanced binary gas-phase diffusion increases the rate of gas-phase re-wetting for $RH < 80\%$, thereby reducing the duration of reduced-*RH* conditions. For $RH > 80\%$, enhanced binary gas-phase diffusion begins to slow down gas-phase re-wetting, thereby increasing the duration of reduced-*RH* conditions.

1.2.1.6 Configuration Management

J. Blink reviewed reports from ICWG meetings and made verbal recommendations to the ICWG secretary.

1.2.2. WASTE PACKAGE

1.2.2.1 Waste Package Coordination and Planning

No significant activity.

1.2.2.4 Waste Form

1.2.2.4.1 Spent Fuel

Spent Fuel Dissolution

The ultimate objective of this activity is to generate analytical data on the dissolution rate of the UO_2 matrix of spent fuel for use in performance assessment modeling and for direct use in licensing. As part of this task, the flow-through tests on uranium oxides are designed to measure the dissolution rates of the oxides and to determine the rate dependence on several parameters, such as solution pH, temperature, oxygen fugacity, flow rate, and solution anions, particularly carbonate species. These tests are not intended to simulate the repository conditions but rather to provide parametric rate constant information.

The five room-temperature U_3O_8 dissolution experiments that were begun in early August were completed. As with the earlier dehydrated schoepite experiments, $UO_3 \cdot H_2O$, these were conducted at 8 ppm dissolved oxygen (20% oxygen in the gas phase) and initially at room temperature. The pH (8 to 10) and total carbonate concentration (2×10^{-4} to 2×10^{-2} molar) varied. Three of these runs were in the original test matrix. The other two were the room-temperature counterparts of 75°C matrix runs. Similar to the earlier dehydrated schoepite, runs the dissolution rates of the U_3O_8 experiments conducted at high carbonate concentrations were much higher [~20 mgU/(m^2·day)] than those conducted at low carbonate concentrations [~1-2 mgU/(m^2·day)], but far lower than the extremely rapid schoepite release rate in high carbonate solutions.

These five U_3O_8 room-temperature runs were continued at 75°C as another experimental series. Preliminary results indicate that this temperature increase causes the five dissolution rates to increase by factors of 2 to 5. The two remaining U_3O_8 room-temperature experiments were also started in another oven as a separate series.

At the end of September, thirteen of the original sixteen experiments in the UO_{2+x} test matrix were completed or are in progress. Of the eight additional experiments consisting of temperature pairs of the original sixteen, seven of those are either finished or in progress as well. This is a total of 20 of 24 planned UO_{2+x} dissolution experiments that are either finished or running.

The OCRWM technical audit 94-10 of LLNL was held during the third week of September. No significant problems were found in the Waste Form Characterization area. The efforts in this activity were described by the audit team as exemplary of the purposes of Quality Assurance and its implementation.

Two interim milestone reports were submitted in the areas of spent fuel and UO_2 dissolution and modeling.

A draft copy of a PNL progress report covering FY91 through FY94 was submitted to LLNL for review. This expanded, multi-year, report was written due to decreased staff time devoted to experimental activities resulting from suspension of radiological activities in Building 325. It is anticipated that this report will be issued as a PNL document after extensive reviews at PNL and LLNL.

W. Gray (PNL) participated in the International Spent Fuel Workshop held August 22-24 in Montebello, Quebec.

<u>D-20-43, Unsaturated Dissolution Tests with Spent Fuel</u>

Tests under unsaturated conditions at 90°C are in progress at Argonne National Laboratory (ANL) to evaluate the long-term performance of spent fuel in the potential Yucca Mountain repository. These tests examine the leach/dissolution behavior of two types of well-characterized irradiated PWR fuels, ATM-103 and ATM-106, in three types of tests: two with a saturated water vapor atmosphere, two with a drip rate of 0.075 mL/3.5 d, and two with a higher drip rate of 0.75 mL/3.5 d. A control test without fuel but with the lower drip rate is also included. EJ-13 water for the tests came from well J-13 and was equilibrated with volcanic tuff for approximately 80 days at 90°C.

The seven tests have undergone 25 months of testing at 90°C. Effort this month was devoted to two areas:

1) Writing a paper "Alteration of Spent Fuel Matrix Under Unsaturated Water Conditions" for the 1995 International High-Level Radioactive Waste Mgmt. Conference, May 1-5, 1995, which was submitted for LLNL review;
2) Estimating the uranium reaction rate; and
3) Examining the two high drip rate tests after 748 days of reaction. The remainder of this status report addresses items 2 and 3.

Estimating the Uranium Reaction Rate

Most models assume that release of the individual radionuclides is congruent with that of the spent fuel matrix. The two limiting cases[1,2] are then bulk flow, which is solubility limited, and water saturation, which is diffusion limited. Such models predict the yearly fractional release rate for water saturation to be three orders of magnitude greater than that for bulk flow. The fractional release that has been observed at ANL at 120 days for ATM-103 is an order of magnitude higher and that at 275 days for ATM-106 is two orders of magnitude higher than that calculated for the water saturation case. If the uranium release at 748 days is two orders of magnitude higher than the former values, then current models are not estimating the magnitude of the potential source term in an unsaturated repository. Our tests, which simulate the unsaturated environment, appear to indicate that current models for the reaction of spent fuel and the subsequent release of actinides and other radionuclides do not result in conservative limits.

Fuel Alteration

The initial results from the two high drip-rate tests indicate that significant fuel alteration has occurred. Striking evidence of a physical change in the visual appearance of the ATM-103 fuel after 748 days of reaction was observed. Edges of all fuel fragments were rounded; all surfaces were covered by an ~100 μm thick white coating. The coating probably is comprised of different types of uranyl oxide hydrates, and possibly uranyl silicate phases. Six months earlier, a few white dots along the edge of a fragment may have been evidence of the presence of nucleation sites. The short time, six months, required for the dramatic change demonstrates that spent fuel reaction rates can be quite rapid. This observation suggests that oxidation of the fuel in the repository will occur essentially immediately upon contact between the fuel and liquid. It also suggests that any oxidation that occurs prior to contact by liquid water will be insignificant in the overall performance assessment of the repository.

For the ATM-106 fuel, a different type of phenomena was noted, this time in the leachate. A yellow stratified liquid layer was found in the base of the test vessel when the vessel was opened. A yellow to yellow-brown material then crystallized within two days in the storage vessel into which the leachate was transferred. We plan to characterize this material. The observations made in both of these test activities have profound ramifications for the performance of waste in the engineered barrier system (EBS), the design of the EBS, and the performance of the repository.

D-20-49.1. Unsaturated Dissolution Tests with Spent Fuel and UO_2

The objective of this Activity is to evaluate the reaction of UO_2 pellets after exposure to dripping EJ-13 water at 90°C using the Unsaturated Test Method. More specifically, these tests are designed to examine the dissolution behavior of UO_2, formation of alteration phases, release rates, and mechanisms of uranium release, and to serve as a pilot study for similar tests with spent nuclear fuel.

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[1] M. J. Apted et al., *Preliminary Calculation of Release Rates of Tc-99, I-129, and Np-237 from Spent Fuel in a Potential Repository in Tuff*, Lawrence Berkeley Laboratory Report LBL-31069 (1990).

[2] W. W.-L. Lee et al., Waste-Package Release Rates for Site Suitability Studies, Lawrence Berkeley Laboratory Report LBL-30707 (1991).

There was no sampling of the tests at ANL this month. Efforts were focused on preparing the annual report.

D-20-53(a), Flow-Through Dissolution Testing of UO_2

Flow-through tests will be started at PNL, as previously planned, on oxidized (U_4O_{9+x}) and unoxidized ATM-104 spent fuel specimens after resumption of radiological activities and replacement of the liquid waste tank in Building 325. Other flow-through tests will be started on ATM-103 spent fuel at low pH (3 to 6) for comparison with results from drip tests being conducted at Argonne National Laboratory.

Spent Fuel Oxidation

A letter report documenting FY94 progress at PNL was drafted and sent to LLNL for review. Comments are now being incorporated.

Implementation of the requirements of DOE Order 5480.6, Radiological Control (RadCon) requires that all radiation work permits (RWPs) be revised to incorporate the applicable portions of the Order. Thus, nearly all RWPs at PNL are in the process of revision. This revision process has affected the restart of the drybath oxidation tests because new RWPs for the transmission electron microscopy (TEM) sample preparation lab and 327 Canyon have not yet been approved. This approval is expected in late October, after the submission date of this report input.

RadCon requirements have also required a revisit of the radiological controls implemented for the operation of the thermogravimetric apparatus (TGA). An ALARA review committee has recommended that a variance be given for conduct of the TGA tests in the radiation fume hoods. This is positive news because, if the waiver could not be justified, these tests would have been required to be moved to a hot cell which would have added significant cost and complexity to the TGA testing.

A drybath interim examination was conducted. Nothing unusual was noted in the 110, 130, and 175°C tests. The rapid weight gain in the 255°C tests continues even though an oxygen-to-metal ratio (O/M) of 2.6 has been reached. There is a hint that the O/M curves in the 255°C and 195°C tests may be starting to accelerate (i.e. d(O/M)/dt is increasing). Samples are being taken for X-ray diffraction (XRD) and TEM examination. Difficulty in preparation of satisfactory TEM samples of irradiated powder continues. This hampers a positive identification of a possible ingrowth of amorphous U_3O_8.

The closure of Building 325 continues to hamper the project. Both the TGA and XRD are out of service until the building is reopened. Steps are being taken to get a variance so SNF powdered samples can be handled in a fume hood under the new procedure (same as the old procedure but with a radiological hold point). This is necessary to operate the TGA.

R. Einziger, L. Thomas, and B. Hanson (PNL) attended the Spent Fuel Workshop in Canada.

MCC Hot Cell Activity

Argonne National Laboratory spent fuel ATM shipments were halted by DOE-NV in FY94. This activity will be restarted in FY95.

1.2.2.4.2 Borosilicate Glass

The current Integrated Contractor Order (ICO), which supports the work in the glass and spent fuel testing tasks at ANL, is in place and describes work that can be done through March 1995. However, the funding in the ICO was not augmented in October so there was no support available to perform work or charge effort. For October, ANL continued the ongoing testing, but performed no analysis or work not essential to preservation of the test environment.

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

The N2 (Defense Waste Production Facility, DWPF, actinide-doped glass) tests continued as scheduled and have reached 105 months in length. For the N2 tests that were sampled on 6/20/94, all data have been received and will be incorporated into the data spreadsheets.

The N3 tests on West Valley actinide-doped ATM-10 glass continue as scheduled; 87 months of testing have elapsed. The tests were last sampled in July 1994. Solution analyses from these tests are completed and have been entered into the data tracking system.

The paper, "Reaction Progress Pathways for Glass and Spent Fuel under Unsaturated Conditions," was submitted to LLNL for review and input. This paper is intended for presentation at the High-Level Waste Management Conference in Las Vegas in May 1995.

D-20-70, Parametric Studies of WVDP and DWPF Glass

Sixteen tests continue with some in progress for up to 8 years. The samples collected during the June sampling have been analyzed. It is intended that these tests can be brought up to the Quality Affecting level. To do this, the Activity Plan governing the work will have to be amended.

Tests on a variety of glasses exposed to 60 and 95% relative humidity (RH) at 70°C continue. No test terminations have been done for several years and none are planned for this year.

1.2.2.5 Waste Package Materials Testing and Modeling

Engineered Materials Characterization Report—EMCR

The purpose of preparing the materials characterization report is to compile and synthesize information on the cogent properties of the candidate materials for the Waste Package and other Engineered Barrier System components. This report is planned to incorporate information on the important physical, mechanical, and chemical properties of the candidate materials, plus an outline of the long range and short range testing planned during ACD. Much of the long range testing plans are discussed in the Planning Documents section of WBS 1.2.2.5.1. The Engineered Materials Characterization Report (EMCR) will serve as input to the Basis For Design document for Waste Package design and will provide a great deal of useful information.

The updated "Engineered Barrier Materials Candidate List" was prepared and forwarded to YMSCO to meet the requirements of milestone MOL01. The list included a definitive compilation of the container materials discussed at length during the Materials Workshop (Metallic Barriers, WBS 1.2.2.5.1) and a less inclusive list of materials that should be further evaluated (Basket, Filler, Packing, Backfill and Non-Metallic Barrier Materials, WBS 1.2.2.5.2 through 1.2.2.5.6) in the coming years. Appropriate parts of the updated candidate list will appear in the "Engineering Materials Characterization Report."

On September 27, D. Stahl and T. Doering of the M&O met with W. Clarke, D. McCright, E. Dalder, and R. Van Konynenburg to discuss the Engineered Materials Characterization Report. R. Van Konynenburg showed the extensive amount of text and tabulated data already prepared. During the meeting, it was agreed that some restructuring of the report will better serve the project needs. The report will be divided into three volumes;

1) Introduction, History, and Current Candidates,
2) Design Data, and
3) Corrosion Data and Modeling.

An annotated outline of the full report was prepared and forwarded to YMSCO as a partial fulfillment of Milestone MOL94. The remainder of the milestone was rebaselined in FY95.

1.2.2.5.1 Metallic Barriers

The purpose of the metallic barrier task is to characterize the behavior and determine the corrosion rates and corrosion mechanisms of metallic barriers, including the interaction with the surrounding environment. Tests and modeling are performed to determine this behavior. Conceptual models of corrosion processes are developed for use in evaluating waste package performance. This task provides considerable input on materials properties to the waste package and repository design tasks and to the performance assessment task.

Task Management and Quality Assurance (PACS OL251JCE)

Status reports on Air/Steam TGA Corrosion Testing (MOL48), Corrsion Model Development (MOL49), Pitting Corrosion Testing (MOL50) and Crack Propagation Testing (MOL51) were completed and forwarded to YMSCO to complete the respective milestones.

Ralph Moeller (Nickel Development Institute) met with metallic barrier staff members on October 28 to discuss issues on use of nickel base alloys as corrosion-resistant barriers. Candidate materials were discussed, as well as methods to fabricate and join them. Practical limits on the dimensions of containers fabricable from a single heat of material were discussed. Plans continue to evolve on holding a 2-3 day workshop on uses of Ni in waste package containers. The workshop will be held in the Spring of 1995. Present plans are to invite many of the same YMP participants from the Materials Workshop held in May 1994, as well as technical representatives from the Canadian AECL, the NWTRB, and the NRC (and sub-contractors).

D. McCright discussed "Materials R&D Efforts for the Yucca Mountain Project" before the LLNL Chemistry and Materials Science Department Materials Review Committee on October 26. The review committee consists of representatives from universities and other national laboratories.

S. Nesbit from the M&O is organizing the DOE/NRC Technical Exchange on Substantially Complete Containment. The exchange is scheduled for December 7 in the Washington, D.C. area. He asked D. McCright to make a presentation on container materials and the status of the testing activities. A "dry run" of the presentations is planned to be held in Las Vegas on November 8.

E. Dalder was named Metallic Barrier Task Leader, effective October 1.

Prepare Planning Documents (PACS OL251LGH)

The purpose of this activity is to update the planning documents for this task, particularly the Scientific Investigation Plan (SIP) and any subsumed activity plans, to account for changes in the multipurpose container, waste package, and repository designs.

An annotated outline of the revised Metallic Barrier Scientific Investigation Plan (SIP) was prepared and forwarded to YMSCO as partial fulfillment of Milestone MOL45. The remainder of the milestone was rebaselined in FY95.

Several iterations of the PACS workscopes, budget forecasts, and deliverable descriptions were made during October as part of a finalization of the FY-95 budget process.

Degradation Mode Surveys (PACS OL251LGI, Activity E-20-13)

The purpose of the degradation mode surveys is to amass previously published information about a candidate material and its performance in a number of environments and to interpret this body of information in the context of a potential repository in Yucca Mountain. In many cases, the degradation mode survey indicates the ways in which a material can degrade and serves to indicate the rate and kind of degradation in environments that have some similarity to what a metal barrier may experience in the Yucca Mountain setting. The lack of information in other cases suggests what work will be required to determine the behavior of the candidate material in Yucca Mountain environments.

A procurement-package for the conduct of a Degradation Modes Survey on monel-class Ni-Cu alloys has been prepared and is going through the approval process.

Performance Tests and Model Development (PACS OL251LGK, Activity E-20-16)

The purpose of the model development activity is to derive predictive tools that will enable using experimental data and analyses to draw long-term assessments of the performance of candidate container materials under Yucca Mountain conditions. This work will ultimately describe the performance of the multiple barrier waste package container, but as a first step in that direction, the modeling work has focused on the pitting corrosion of a corrosion resistant barrier, such as one of the nickel-base or titanium-base candidate materials. While pitting corrosion is usually governed by electrochemical, chemical, and occasionally metallurgical parameters, an important aspect of pitting is "stochastic". Much of the modeling work is aimed at developing the stochastic aspect of pitting within the electrochemical and chemical parameters.

G. Henshall was a member of the YMP team sent to Japan for a series of meetings. At a meeting with PNC company personnel in Tokai, he presented an overview of the YMP container materials effort. This presentation, "Plans for Materials Testing," was prepared by D. McCright. G. Henshall also attended the NWTRB meeting on Engineered Barrier System design. At this meeting he presented (again for D. McCright) "Plans, Status, and Objectives of the U.S. Waste Package Materials Research Program." Finally, he attended the *XVIII International Symposium on the Scientific Basis for Nuclear Waste Management* (MRS'94). At this meeting, he presented the poster entitled, "Stochastic Modeling of the Influence of Environment on Pitting Corrosion Damage of Radioactive-Waste Containers." Details of these meetings will be available in the foreign trip report current being prepared.

Integrated Corrosion Facility (ICF) (OL251LGJ)

A conceptual design for the Integrated Corrosion Facility continues to be developed with emphasis on reviewing and finalizing the System Design Document (SDD). G. Gdowski has drafted the SDD which is being evaluated in weekly meetings. The current SDD describes the general requirements for the data acquisition and control of the parameters of interest, e.g., pH, dissolved O_2, water level, temperature, and agitation. This document is under review by Electronics Engineering, which is putting together the comprehensive hardware requirements document for data acquisition and control of the 22 vessel array.

A conceptual design of a typical vessel and components has been completed by J. Estill. Elucidation of the test-matrix and specimen-geometry will drive the final dimension of the vessel, since the total surface area of all the specimens determines the required electrolyte volume.

Use of a C-ring specimen for a screening evaluation of stress corrosion resistance of candidate materials has been recommended. Budget, ease of sampling, and a defined stress are reasons cited for its value. Follow-up tests using WOL (Wedge-Opening Load) or other fracture-mechanics specimens may be warranted after the field of alloys has been thinned.

A literature review of crevice corrosion testing was completed by J. Estill. He found that a critical crevice gap (1 μm) and depth (1 mm) may exist, and that values above this gap may not be sufficient to deplete oxygen in a crevice. Since the repository crevice conditions are undefined, we will endeavor to create a very aggressive crevice as a conservative bound. One of the precursors to an aggressive crevice is oxygen-depletion in the crevice. Preliminary work with metal to metal crevices consisting of 2" x 2" plates held in contact with about 4 bolts torqued to 15 ft-lb, reveals about 200 μm crevice gaps. Subsequent work with multiple crevice assemblies (MCA) employing a ceramic to metal interface resulted in crevice gaps on the order of 1 μm with fracturing of the ceramic at the metal-ceramic interface. Teflon will be tested to determine the minimum crevice gap attainable. The relative ease of use of the MCA makes it well suited for use in the evaluation of crevice corrosion susceptibility.

J. Estill submitted a paper for the May 1-5, 1995 ANS meeting, entitled "Integrated Corrosion Facility for Long-Term Testing of Candidate Materials for High-Level Radioactive Waste Containment". E. Dalder, G. Gdowski, and D. McCright are co-authors.

Parameter Tests and Metal Degradation (PACS OL251LGM, Activity E-20-17)

There are currently two active parametric studies, one on thermogravimetric analysis and the other on corrosion sensor development, including support to the Large Block Test.

Thermogravimetric Analysis

The purpose of this work is determination of the conditions under which aqueous corrosion processes occur after emplacement of the waste package. These conditions have special significance in an unsaturated zone repository, because the extent of degradation of the candidate materials becomes much greater when aqueous corrosion processes initiate. The key parameters appear to be humidity, temperature, and surface condition; the experimental work aims to determine the interrelationship among these parameters. Thermogravimetric analysis (TGA) is a particularly sensitive technique for using a micro-analytical balance to measure very small changes in weight gain as a material reacts with the environment.

G. Gdowski presented a talk entitled "Water Vapor Effects on the Corrosion of Copper and Iron at 70-200°C", at the ASM/TMS Meeting, October 3-7, in Rosemont, Illinois. J. Estill is a co-author.

A cooling shell is being designed for use with the band heaters on the Thermogravimetric analyzer (TGA) reaction tube. The original furnace supplied by Cahn is inadequate, and a re-design of the heating/cooling capabilities is needed. Although the band heaters do well for a constant temperature soak, they do not work well for heat-up and cool-down ramps. A cooling shell is being evaluated that produces the required temperature profile in the reaction tube. We have received two 1" band heaters and will install them in November. These heaters will supplement the existing 4" band heater and will be placed above and below it. With the increased power-density of the 1" heaters, and a cooling shell placed about the 4" band heater, the appropriate temperature profiles will be obtainable.

Corrosion Sensor Development—Support to the Large Block Test

The purpose of this activity is to develop sensors and methods to monitor atmospheric corrosion phenomena for prospective container materials, and also to investigate the rates and mechanisms of microbiologically induced corrosion (MIC). Past work has centered on measurements in the liquid phase. Relatively little work has been done, relevant to the Yucca Mountain Site Characterization Project, on the application of electrochemical methods (and other sensors) in the gas phase, which is a more realistic corrosion environment for the repository. Our current efforts center around the development of microelectrode arrays for corrosion potential/rate measurements in the gas phase, initially to be used in the Large Block Test, and the use of the quartz crystal microbalance for studying MIC processes.

pH Sensing Electrode

No significant activity.

Corrosion Potential Measurements

No significant activity.

Crack Growth Tests (PACS OL251LGO, Activity E-20-18F and E-20-55)

The purpose of this work is to determine the stress corrosion cracking (SCC) susceptibility of candidate container materials under a variety of environmental, metallurgical, and mechanical stress conditions relevant to the repository. Stress corrosion is an important degradation mode that can affect both corrosion-allowance and corrosion-resistant materials. A sensitive crack growth measurement apparatus, which operates under the principle of measuring minute changes in the electrical resistance of the test specimen as a crack propagates, is in use at Argonne National Laboratory (ANL) to measure crack growth on pre-cracked compact tension fracture mechanics type of specimens. A similar unit is being commissioned at LLNL. Research activities deal with fracture mechanics crack-growth-rate determinations on Incoloy 825, Titanium Grade 12, Hastelloy C-4, and Hastelloy C-22. Crack growth rate (CGR) tests using standard compact tension (CT) fracture mechanics specimens have been conducted on Incoloy 825 in an earlier phase of the program. Additional tests were initiated on Ti Grade 12, Hastelloy C-4, Hastelloy C-22, and on a new heat of Incoloy 825 in FY94.

Crack growth rate tests are continuing for standard Titanium Grade 12 (Specimen No. T16-01), Hastelloy C-22 (Specimen No. 227-01) and Hastelloy C-4 (Specimen No. 245-02) in a simulated J-13 well water environment at 93°C. The simulated J-13 well water was prepared from deionized high-purity water and reagent-grade-purity salts of $CaSO_4$, $Ca(NO_3)_2$, $CaCl_2$, $FeCl_2$, Li_2SO_4, $MgSO_4$, $MnSO_4$, $MnSO_4$, $AlCl_3$, Na_2CO_3, NaHCO3, $KHCO_3$, Na_2AlO_3, and HF. High-purity mixed gas containing 20% O_2 12% CO_2 and 68% N_2 is used as a cover gas at 3-5 psig to maintain the desired dissolved O_2 and HCO_3 concentrations. The pH value of the feed water is in a range of 6-8. The specimens have been fatigue-cracked in air at room temperature for a precrack length of 1.9 mm under a cyclic load with triangular load shape, load ratio of $R = 0.1$ to 0.25 and a loading-frequency 1 Hz, to introduce a sharp-starter crack before crack growth-rate tests.

1.2.2.5.2 Basket

The objective of the Basket Materials task is to assemble properties data on candidate materials for use in the support baskets for spent fuel in waste containers and to aid in the selection of materials for this purpose. The baskets must provide mechanical support, must assist in heat transfer, and must absorb neutrons to provide long-term criticality control.

The task is currently in the planning stage. R. VanKonynenburg was named task leader, effective October 1. His background is in materials engineering, particularly the nuclear properties of materials and the effects of radiation damage on materials. He is also knowledgeable about nuclear chemistry and the effects of radiation on chemical changes in the environment. R. Van Konynenburg has worked on the Yucca Mountain Project in various assignments over the past 12 years, many of these assignments involving the Metal Barriers Task. He therefore brings a great deal of interdisciplinary experience to this task.

LLNL staff are examining the requirements for basket materials and identifying the significant properties. Data needs and available property data on possible candidates are being collected. When collection is completed, LLNL staff will decide on a candidate list, devise tests and testing environments that are appropriate for producing the remaining necessary data, and perform these tests. Close interaction with the waste package design team will be maintained.

Manufacturers are being contacted to obtain data. As reported earlier, LLNL staff met with representatives of SCM Metal Products, Inc., in August, and plan to meet with a representative of AAR Advanced Structures, Inc. in early November.

1.2.2.5.3 Filler

This WBS element is not funded in FY95.

1.2.2.5.4 Packing

This WBS element is not funded in FY95.

1.2.2.5.5 Backfill/Invert

This WBS element is not funded in FY95.

1.2.2.5.6 Non-Metallic Barriers

The purpose of the non-metallic barriers task is to characterize the behavior of non-metallic materials, such as ceramics, and to determine degradation rates and mechanisms, including the interaction between the barrier and the surrounding environment. The work in the non-metallic barriers task parallels that in the metallic barriers task. One of the multiple barriers of the waste package container may be fabricated from a non-metallic material. A primary objective of this task is determination of the feasibility of making a non-metallic barrier as part of a waste package.

The Non-Metallic Barrier Materials Survey (Milestone MOL57) was completed and forwarded to YMSCO. The survey covers the kinds of ceramic materials that should be considered, the ways in which they can be employed as barrier materials (as a "stand alone" barrier or as a plasma or flame sprayed coating on a metallic barrier), and the kinds of degradation modes that can potentially affect ceramic barriers. Because this WBS element is not forecast to be funded in FY95 in the current budget plan, work in this area was suspended upon the issuance of the survey report.

1.2.3 SITE INVESTIGATIONS

1.2.3.1 Site Investigations Coordination and Planning

1.2.3.1.2 Participant Management and Integration

D. Chesnut attended a THRET meeting on October 14. He also provided input to the OCRWM Progress Report 11 on his log-normal distribution approach to PA and presented that material to an M&O group.

J. Blink met with R. Rogers (M&O) to discuss the 3-D stratigraphy and property database that will be developed by the M&O and EG&G. Three LLNL interfaces were identified:

1) Some LLNL PI data may be appropriate for inclusion in the database.
2) LLNL modelers will be users of the database.
3) LLNL has had a similar project ongoing for the last year under environmental funding, and there may be an opportunity to accelerate the YMP database development if this group is included in the database team.

1.2.3.2 Geology

1.2.3.2.1.2.1 Natural Analog of Hydrothermal Systems in Tuff

This WBS element is not funded in FY95. The Study Plan will be deleted from the technical baseline, and its objective will be incorporated into Study Plans 8.3.4.2.4.1 and 8.3.1.20.1.1.

1.2.3.2.8.3.6 Probabilistic Seismic Hazards Analysis

This WBS element is not funded in FY95. Funding based on a CSCR is expected in January.

1.2.3.4 Geochemistry

1.2.3.4.2 Geochemical Modeling

1.2.3.4.2.1 EQ3/6 Code

This subtask is developing geochemical modeling software (EQ3/6) for analysis and simulation of interactions among water, rock, nuclear waste, and other repository components in the near-field environment, the altered zone, and the far-field environment.

In FY94, LLNL maintained the Version 7 series of the software. The independent V&V (verification and validation) activity for Version 7 was completed, and Version 7.2a became the first version of EQ3/6 to be certified for use in quality-affecting work. LLNL staff continued the development of Version 8.0 by adding new capabilities for thermodynamic pressure corrections and ion-exchange modeling (incorporating the Gapon and Vanselow models). In FY95, LLNL is maintaining the software, conducting an independent V&V activity leading to the certification of version 8.0, and further developing the software by adding capabilities with an emphasis on phenomena related to boiling. These new capabilities will be applied in other WBS elements, principally those dealing with the geochemistry of the altered zone and the near-field zone. Consequently, the software is being extended to deal with a gas (vapor) phase and its interaction with a liquid phase, including boiling and condensation processes. Additionally, enthalpy and volume calculations are being included in the software for the first time. Some improvements are also being made to the software to deal with the possibility of formation of concentrated solutions due to boiling. As time permits, we may also make some further additions to the ion-exchange modeling capability, such as the addition of the Gaines-Thomas model and a general site-mixing model.

An Individual Software Plan (ISP) for the independent V&V of Version 8.0 was drafted and is being reviewed. Version 8.0 is being prepared for in-house beta testing, which may last all or part of the V&V period.

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

Incorporation of the CHEMVAL4 and CHEMVAL5 thermodynamic databases, as well as modification of the JEWEL software to facilitate generation of CHEMVAL-based EQ3/6 datafiles into GEMBOCHS was completed. CHEMVAL contains approximately 1000 chemical species and is commonly used for comparative radiological assessment calculations in Europe.

Work continued on incorporating the comprehensive NIST database of critical stability constants for metal complexes (over 4,000 species) into GEMBOCHS. New data were also added for approximately 50 Zinc, Cadmium, and Nitrogen species; these data were needed for local modeling efforts.

JEWEL was modified to eliminate several minor bugs associated with generation of thermodynamic datafiles for use with the geochemical modeling code REACT.

A new Individual Software Plan (ISP) for GEMBOCHS software was completed and submitted for formal review. New software category forms for GEMBOCHS were completed. The GEMBOCHS Configuration Item list was completed and comments resolved. A new Software

Configuration Management system was initiated and Configuration Management Records were submitted to the LRC. A new GEMBOCHS Development Log was created.

S. Lundeen attended the National Ingres User's Association's annual meeting. Following the recent takeover by INGRES of Computer Associates, Inc., this meeting was particularly information regarding future direction of the INGRES products on which GEMBOCHS is critically dependent.

1.2.3.5 Drilling

1.2.3.5.2.2 Engineering, Design, and Drilling Support

This work is reported in WBS element 1.2.3.11.2

1.2.3.9 Site Investigations - Special Studies

1.2.3.9.9 Study Plan Preparation, Coordination & Review

Comment resolutions for draft study Plans 8.3.4.2.4.2 and 8.3.4.2.4.5 continued. The M&O Study Plan coordinator distributed a revised draft of Study Plan 8.3.4.2.4.4 to reviewers and requested they indicate any remaining unresolved comments.

1.2.3.9.10 Special Studies: Project Peer Review

This activity has not been funded in FY95.

1.2.3.10 Altered Zone Characterization

1.2.3.10.1 Characterization Techniques for the Altered Zone

No significant activity.

1.2.3.10.2 Characterization of Thermal Effects on the Altered Zone Performance

Experiments to examine rock-water interaction in relevant lithologic units continue.

1.2.3.10.3 Integrated Testing

1.2.3.10.3.1 Integrated Radionuclide Release: Tests and Models

Activity will be discussed in a future status report.

1.2.3.10.3.2 Thermodynamic Data Determination

J. Johnson attended the 5th YMP-SOLWOG meeting in Las Vegas on October 3.

1.2.3.11 Integrated Geophysical Testing for Site Characterization

1.2.3.11.1 Systematic Acquisition of Surface Based Borehole Geophysical Logging Data

Activity will be discussed in a future status report.

1.2.3.11.2 Surface-Based Geophysical Testing

LLNL and the M&O/SAIC reviewed the LLNL-NTS logging capabilities to support construction logging and gravity logging.

Eight logging operations, to perform photo inspections of drill holes, were accomplished during the months of September and October 1994. Five drill hole photo inspections were conducted at USW NRG-7A, and one photo inspection was conducted at each of three boreholes: USW SD-9, USW NRG-6 and USW NRG-7.

1.2.3.11.3 Geophysics—ESF Support, Subsurface Geophysical Testing

The capital and non-capital procurement for the caliper, camera and neutron logging system was completed. All tools and depth system passed the acceptance tests.

1.2.3.12 Waste Package Environment Testing and Modeling

1.2.3.12.1 Chemical and Mineralogical Properties of the Waste Package Environment

Activity will be discussed in a future status report.

1.2.3.12.2 Hydrologic Properties of the Waste Package Environment

The draft Study Plan for the laboratory testing of hydrological properties of the near-field environment (8.3.4.2.4.2) has been revised in response to reviewer comments.

A progress report by J. Roberts and W. Lin, summarizing the hydrological properties of Topopah Spring tuff obtained from laboratory measurements thus far, is undergoing LLNL review.

<u>Modeling Results: Analysis of the Impact of an Optimized AML Distribution and Overburden Thickness on Temperature and Relative Humidity Conditions in the Repository</u>

In order to augment the thermo-hydrological calculational support of the thermal loading systems study, LLNL has been conducting the calculations in the near-field/altered zone hydrology task with the same set of thermal loading assumptions. We assume a Youngest Fuel First Spent Nuclear Fuel (SNF) receipt scenario with a 10-yr cut-off for the youngest fuel [referred to as YFF(10)] and account for the emplacement of BWR waste packages (WPs) containing 40 assemblies per WP, and PWR WP containing 21 assemblies per WP. The waste receipt schedule was supplied by the M&O. Areal Mass Loadings (AMLs) of 24.2, 35.9, 55.3, 70, 83.4, 100, 110.5, and 150 MTU/acre have been analyzed assuming the matrix hydrological properties given in the Reference Information Base (RIB) and Klavetter and Peters (1986).

This month, we investigated

1) the impact of an optimized, nonuniform-AML distribution on generating more uniform sub-ambient relative humidity conditions,
2) the impact of overburden thickness on these optimized-AML cases, and
3) the impact of SNF aging and overburden thickness on minimizing the duration of above-ambient repository temperatures.

In section 1.2.1.5 we discuss the impact of enhanced binary gas-phase diffusion on drift-scale thermo-hydrological behavior.

In past progress reports we have described the temperature *T* and relative humidity *RH* conditions throughout the repository (center to edge) for cases with a uniform-AML distribution and for cases with an nonuniform, optimized-AML distribution. For the optimized-AML cases, the AML in the inner 75% of the repository is uniform, while for the outer 25%, it is nonuniform, increasing as the outer perimeter is approached, with an average AML that is 63% greater than for the inner 75%. Table 4 summarizes *T-RH* conditions for the nominal overburden case (343.1 m) and "nominal" binary gas-phase diffusion, where the binary, gas-phase diffusion tortuosity factor τ_{eff} is 0.2.

Table 5 summaries *T-RH* conditions for the same suite of optimized-AMLs for a 200-m-thick overburden. This case was chosen because it is the shallowest overburden thickness allowed by regulation. For the nominal overburden case, the repository is 225 m above the water table, while in the shallow-overburden (200 m) case, it is 330 m above the water table. Because of the additional 105 m standoff from the water table, the liquid saturation at the repository horizon in the shallow-overburden case is about 10% less than in the nominal-overburden case. Therefore, some of the following observations concerning *RH* behavior may be influenced by that factor.

A comparison of Tables 4, 5 and 6 shows that decreasing the overburden thickness from 343.1 to 200 m for the 62.4-MTU/acre case modestly increases the duration of reduced-*RH* conditions and modestly decreases the temperature associated with a given *RH*, particularly for *RH* > 80%. For AMLs of 83.1, 96.9, and 128.4 MTU/acre, the duration of reduced- *RH* conditions is not strongly influenced by overburden thickness, except at the repository edge where the duration is generally increased for the shallow-overburden cases. Temperatures associated with a given *RH* are generally less for the shallow-overburden cases, particularly for *RH* < 80%. The relative insensitivity of the duration of reduced- *RH* conditions to overburden thickness stems from the fact that most of the dry-out occurs during the first 1000 yr. For cases where boiling effects (both convective and diffusive) dominate net moisture movement away from the dry-out zone, we find that about 95% of the cumulative dry-out occurs during the first 1000 yr. Because the reduction in the insulating effect of the overburden does not begin to reduce repository temperatures until after 1000 yr, it does not significantly reduce the cumulative dry-out effects. Consequently, we find in comparing Tables 4 and 5, that the duration of reduced-*RH* conditions at the repository is generally the same for the nominal and shallow-overburden cases. The lower temperatures associated with a given *RH* for the shallow-overburden case arise from the more rapid decline in repository temperatures. For an AML of 174.3 MTU/acre and aged SNF we observe a dramatic increase in the duration of reduced *RH* conditions for the inner 75% of the shallow overburden repository. We also observe a dramatic reduction in the temperature associated with a given *RH* throughout the entire shallow overburden repository.

Table 4: Repository depth = 343.1m

Time to rewet to indicated relative humidity *RH* at various repository locations, and temperature when that *RH* is attained for 22.5-yr-old SNF, an optimized-AML distribution with the indicated average AML, k_b = 280 millidarcy and a gas-phase diffusion tortusity factor τ_{eff} = 0.2. Locations are identified as the percentage of the repository area enclosed, with 0% corresponding to the repository center, and 100% corresponding to the edge.

Table 4a: AML = 62.4 MTU/acre.

Repository area enclosed (%)	Time to rewet to indicated relative humidity (yr)				Temperature when indicated relative humidity is attained (°C)			
	70%	80%	90%	95%	70%	80%	90%	95%
50	980	2,160	4,720	6,650	106	95	75	69
75	1,420	3,150	6,990	10,000	102	80	65	60
90	1,690	3,160	5,920	8,350	92	76	66	61
97	1,030	1,520	2,400	3,380	98	88	77	70

Table 4b: AML = 83.1 MTU/acre.

Repository area enclosed (%)	Time to rewet to indicated relative humidity (yr)				Temperature when indicated relative humidity is attained (°C)			
	70%	80%	90%	95%	70%	80%	90%	95%
50	4,140	11,300	21,900	30,800	89	66	52	46
75	4,050	10,200	18,600	28,400	85	66	53	46
90	3,220	5,870	9,320	12,200	85	73	65	60
97	1,720	2,490	3,770	4,830	98	87	77	73

Table 4c: AML = 96.9 MTU/acre.

Repository area enclosed (%)	Time to rewet to indicated relative humidity (yr)				Temperature when indicated relative humidity is attained (°C)			
	70%	80%	90%	95%	70%	80%	90%	95%
50	10,400	22,200	36,200	46,500	73	55	45	40
75	8,420	17,700	29,300	37,600	75	58	48	43
90	5,400	9,200	13,900	18,700	81	70	61	55
97	2,710	4,060	6,030	7,950	93	83	75	70

Table 4d: AML = 128.4 MTU/acre.

Repository area enclosed (%)	Time to rewet to indicated relative humidity (yr)				Temperature when indicated relative humidity is attained (°C)			
	70%	80%	90%	95%	70%	80%	90%	95%
50	17,900	32,300	49,100	61,000	67	51	49	39
75	14,800	25,500	37,800	44,300	69	55	47	44
90	10,500	15,300	21,000	28,100	76	66	58	51
97	6,330	8,830	11,700	14,400	85	77	70	65

Table 4e: AML = 174.3 MTU/acre; 40-yr-old SNF.

Repository area enclosed (%)	Time to rewet to indicated relative humidity (yr)				Temperature when indicated relative humidity is attained (°C)			
	70%	80%	90%	95%	70%	80%	90%	95%
50	19,200	33,200	49,400	60,400	73	55	46	42
75	17,600	26,500	37,400	44,700	73	61	51	47
90	14,200	18,800	26,700	31,200	77	68	58	54
97	10,700	13,600	17,200	19,400	82	75	68	64

Table 5: Repository depth = 200 m

Time to rewet to indicated relative humidity *RH* at various repository locations, and temperature when that *RH* is attained for 22.5-yr-old SNF, an optimized-AML distribution with the indicated average AML, k_b = 280 millidarcy and a gas-phase diffusion tortusity factor τ_{eff} = 0.2. Locations are identified as the percentage of the repository area enclosed, with 0% corresponding to the repository center, and 100% corresponding to the edge.

Table 5a: AML = 62.4 MTU/acre.

Repository area enclosed (%)	Time to rewet to indicated relative humidity (yr)				Temperature when indicated relative humidity is attained (°C)			
	70%	80%	90%	95%	70%	80%	90%	95%
50	1,070	2,060	4,720	6,780	105	86	61	55
75	1,900	5,570	9,960	15,200	86	57	50	44
90	2,590	5,710	9,590	14,600	70	55	49	44
97	1,110	1,810	3,090	4,620	95	78	61	55

Table 5b: AML = 83.1 MTU/acre.

Repository area enclosed (%)	Time to rewet to indicated relative humidity (yr)				Temperature when indicated relative humidity is attained (°C)			
	70%	80%	90%	95%	70%	80%	90%	95%
50	4,260	9,350	14,200	19,400	72	57	50	45
75	6,950	13,600	22,100	32,000	60	50	42	37
90	6,380	11,100	17,000	26,000	59	52	45	40
97	2,490	4,280	6,720	9,820	75	62	56	51

Table 5c: AML = 96.9 MTU/acre.

Repository area enclosed (%)	Time to rewet to indicated relative humidity (yr)				Temperature when indicated relative humidity is attained (°C)			
	70%	80%	90%	95%	70%	80%	90%	95%
50	7,900	14,000	19,700	29,000	65	54	47	41
75	11,400	19,800	29,000	41,600	56	46	40	36
90	8,760	13,200	18,400	26,300	59	52	47	41
97	4,360	6,630	9,270	12,100	67	61	56	52

Table 5d: AML = 128.4 MTU/acre.

Repository area enclosed (%)	Time to rewet to indicated relative humidity (yr)				Temperature when indicated relative humidity is attained (°C)			
	70%	80%	90%	95%	70%	80%	90%	95%
50	18,700	29,300	42,400	62,900	54	46	38	34
75	16,400	24,500	33,100	44,800	56	48	42	37
90	11,600	15,300	19,200	27,500	61	55	50	44
97	7,490	9,740	11,900	14,100	67	62	58	55

Table 5e: AML = 174.3 MTU/acre.

Repository area enclosed (%)	Time to rewet to indicated relative humidity (yr)				Temperature when indicated relative humidity is attained (°C)			
	70%	80%	90%	95%	70%	80%	90%	95%
50	36,400	56,000	85,300	136,000	46	38	33	30
75	25,600	35,300	47,800	66,500	52	45	40	35
90	16,400	21,200	28,300	31,800	61	54	48	45
97	11,700	14,200	17,800	19,900	66	62	56	53

Table 6: Duration of Boiling Period Duration of boiling period at various repository locations and relative humidity attained at the end of the boiling period for 22.5-yr-old SNF and various optimized AML distributions with the indicated average AML, a gas-phase diffusion tortuosity factor t_{eff} = 0.2, and k_b = 280 millidarcy. Locations are identified as the percentage of the repository area enclosed, with 0% corresponding to the repository center, and 100% corresponding to the edge.										
Table 6a: Repository depth = 343.1 m.										
Repository area enclosed (%)	Duration of boiling period (yr) and relative humidity (%) at end of boiling period for indicated AMLs									
	62.4 MTU/acre		83.1 MTU/acre		96.9 MTU/acre		128.4 MTU/acre		174.3 MTU/acre	
50	1810 yr	77%	2860 yr	62%	3660 yr	49%	5530 yr	39%	9240 yr	41%
75	1590 yr	71%	2470 yr	60%	3210 yr	50%	4740 yr	39%	7990 yr	40%
90	1350 yr	63%	2130 yr	60%	2730 yr	54%	4030 yr	42%	6770 yr	41%
97	1060 yr	65%	1770 yr	64%	2330 yr	60%	3520 yr	48%	5740 yr	43%
Table 6b: Repository depth = 200.0 m.										
Repository area enclosed (%)	Duration of boiling period (yr) and relative humidity (%) at end of boiling period for indicated AMLs									
	62.4 MTU/acre		83.1 MTU/acre		96.9 MTU/acre		128.4 MTU/acre		174.3 MTU/acre	
50	1530 yr	77%	2140 yr	63%	2470 yr	56%	4050 yr	40%	6610 yr	25%
75	1460 yr	67%	1930 yr	57%	2470 yr	49%	3510 yr	40%	5510 yr	28%
90	1310 yr	60%	1710 yr	52%	2140 yr	45%	2930 yr	41%	4580 yr	33%
97	1070 yr	69%	1470 yr	59%	1850 yr	53%	2570 yr	46%	4000 yr	39%

Table 7: Dependence on Depth and Age Time required to decline to indicated temperature at various repository locations for a gas-phase diffusion factor, τ_{eff}, = 0.2, k_b = 280 millidarcy, and the indicated repository depth; the locations are identified as the percentage of the repository area enclosed, with 0% corresponsding to the respository center, and 100% corresponding to the outer perimeter.									
Table 7a: AML = 24.2 MTU/acre; 22.5-yr-old SNF.									
Repository area enclosed (%)	Time required to decline to indicated temperature for 200-m repository depth (yr)			Time required to decline to indicated temperature for 343.1-m repository depth (yr)			Time required to decline to indicated temperature for 430-m repository depth (yr)		
	60°C	50°C	40°C	60°C	50°C	40°C	60°C	50°C	40°C
50	1,170	2,320	5,440	1,430	3,790	15,500	1,990	7,760	28,700
75	1,020	2,000	4,220	1,140	2,790	14,100	1,440	4,610	27,900
90	420	1,370	2,850	430	1,660	10,600	710	2,150	23,900
97	NA	720	2,120	NA	760	3,590	150	1,120	19,600

Table 7b: AML = 55.3 MTU/acre; 343.1-m repository depth.								
Repository area enclosed (%)	Time required to decline to indicated temperature for 22.5-yr-old SNF (yr)				Time required to decline to indicated temperature for 80-yr-old SNF (yr)			
	80°C	70°C	60°C	50°C	80°C	70°C	60°C	50°C
50	3,310	5,330	9,930	18,000	2,530	4,360	9,400	17,700
75	2,340	3,710	7,500	15,400	1,700	2,850	6,510	14,800
90	1,290	2,200	4,360	11,900	590	1,560	3,190	11,500
97	530	1,310	2,780	9,320	NA	NA	1,850	8,390

Table 7a summarizes the time to decline to the indicated temperature for an AML of 24.2 MTU/acre and overburden thicknesses of 200, 343, and 430 m. The time to decline to the indicated temperature is a very strong function of overburden thickness, with this dependency increasing with decreasing temperature. Relative to the nominal overburden case, the time to decline to 60°C is reduced by 18% for the shallow-overburden case, while the time to decline to 40°C is reduced by a factor of three. Relative to the nominal overburden case, the time to decline to 60°C is increased by 40% for the deep-overburden case, while the time to decline to 40°C is nearly doubled.

Table 7 clearly shows the role of the overburden thickness in containing the repository heat in Yucca Mountain. Effectively, the overburden acts like a thermal insulator or blanket, governing the time required for repository heat to eventually be dissipated to the atmosphere. Therefore, we find that removing 143.1 m of this "thermal blanket" (Table 6) has the effect of reducing the duration of the boiling period t_{bp}, especially in the center of the repository. In general, removing 143.1 m of the overburden has the following effects:

1) substantially reducing t_{bp} in areas that are associated with large t_{bp}, such as in the entire 83.1, 96.9, 128.4- and 174.3-MTU/acre repositories.
2) modestly reducing t_{bp} in areas that are associated with moderate t_{bp}, such as in the inner 50% of the 62.4-MTU/acre repository,
3) negligibly affecting t_{bp} in areas that are associated with small t_{bp}, such as in the outer 50% of the 62.4-MTU/acre repository,

In general, edge cooling effects influence t_{bp} at the repository perimeter more than the impact of overburden thickness. We also observe for the 174.3 MTU/acre thermal load, a reduction in *RH* associated with the end of the boiling period for the shallow-overburden case.

The three overburden thicknesses in Table 7a were provided by the Thermal Loading Systems Study and represent the actual range of overburden thickness for repository designs currently being considered. A more realistic thermal analysis that represented the actual variable overburden thickness across the repository footprint would show temperature decline for the 24.2-MTU/acre varying quite widely from one region of the repository to another. Table 7a clearly indicates that the low-AML thermal management strategy (that is, based on minimizing the duration of temperature buildup) would be significantly benefited if the repository could be placed at a shallower depth. A comparison of Tables 4e and 5e also indicates that a high-AML extended-dry thermal management strategy (that is, based on maintaining dry *RH* conditions in the repository until repository temperatures have cooled) is also benefited if the repository could be placed at a shallower depth. This second observation stems from the fact that a shallower overburden thickness does not appear to reduce the duration of reduced-*RH* conditions; however, the shallower depth substantially increases the rate of temperature decline in the repository. Of course, there are other considerations such as thermo-hydrological-mechanical (T-H-M) coupling that may be impacted by a shallower overburden. The impact of overburden depth on other coupled T-H-M-C effects is being investigated in the Altered Zone Characterization Task.

Figure 7b summarizes the time to decline to the indicated temperature for an AML of 55.3 MTU/acre for 22.5- and 80-yr-old SNF. Except for early time and the outer edge of the repository, the impact of SNF aging on reducing the duration of repository temperature buildup is relatively small, especially when compared to the impact of overburden thickness. The times to decline to 60 and 50°C are virtually unaffected by SNF age. The thermal effect of older SNF is similar to emplacing younger SNF and aggressively ventilating heat out of the repository area until repository closure. Both the case of emplacing older-age SNF and the case of emplacing younger-age SNF with drift ventilation during the retrieval period result in a substantial delay for the WPs to reach peak temperatures.

An aggressive thermal management strategy to minimize the magnitude and duration of repository temperature buildup would incorporate:

1) SNF aging and/or drift ventilation to reduce repository temperature buildup during the first 1000 yr and
2) a shallow overburden thickness which would reduce repository temperature buildup for later times ($t > 1000$ yr).

This approach could also be useful if the decision were made to increase the AML of portions (or all) of the repository area prior to closure in order to enhance moisture removal and the duration of reduced-*RH* conditions. The use of either older-age SNF and/or long-term ventilation of heat and moisture from the repository result in a substantial delay for the WPs to reach peak temperatures. Increasing the time required to reach peak temperature greatly facilitates how effectively we can apply a nonuniform, optimized-AML distribution to levelizing the *T-RH* conditions throughout the repository.

Software Development

J. Nitao ported the NUFT code to the NERSC CRAY UNICOS operating system at LLNL. He also developed a suite of benchmark problems for V-TOUGH in accordance with the Individual Software Plan (ISP) for V-TOUGH. J. Nitao and R. Bradford worked on the report "Modeling the Heterogeneity of Condensate Flux through a Heated Repository."

Laboratory Experiments

Electrical Impedance as a Function of Moisture Content

LLNL staff completed the preparation of more samples from the G-4 hole and the LBT cores to complete the measurements at 95°C. Gold electrodes were deposited on the samples and they are ready for measurement. Previous impedance data have been modeled using a complex nonlinear least square (CNLS) routine to fit the frequency dependent response. Approximately 90 fits on 60 experiments have been performed. The parameters derived from these fits are being analyzed.

Characteristic Curves of Tuff

For the experiment of determining the moisture retention curve and one-dimensional imbibition using G-4 core, we continued the moisture retention experiments at high temperatures. Measurements at 95°C in the drying phase are nearly complete. The samples were at 95°C and 40% relative humidity for September and 95°C and 20% relative humidity for October.

The Effect of Confining Pressure on Fracture Healing

The experiment to determine the effect of confining pressure on fracture healing, as observed previously by Lin and Daily, continued. A fractured Topopah Spring tuff sample from the G-4 hole is being used. During September, the sample was at an effective pressure of 2.5 MPa (3.0 MPa confining pressure and 0.5 MPa pore pressure), heated to 150°C and then cooled down to 25°C. The permeability did not change very much during the cool-down phase at 2.5 MPa effective pressure. The data are being analyzed. In October, the sample was at an effective pressure of 4.5 MPa (5.0 MPa confining pressure and 0.5 MPa pore pressure) and 156°C. The permeability decreased to about 2.6 millidarcy (md), from about 3.4 md at an effective pressure of 2.5 MPa.

Resonant Cavity

A feasibility study of using the resonant cavity for measuring relative humidity in a rock block continues. The resonant cavity is probably too sensitive to small drops of water condensate within it.

Meetings

T. Buscheck attended the Materials Research Society (MRS) XVIII International Symposium on the Scientific Basis for Nuclear Waste Management in Kyoto, Japan from October 23 to 27 where he made the presentation "The Importance of Thermal Loading Conditions to Waste Package Performance at Yucca Mountain". He attended a field trip at the Tono Uranium Mine of PNC, where extensive geoscience studies such as regional hydrology, shaft excavation effects, and natural analogues related to radionuclide migration are being carried out. The Tono Mine is located at Toki, 50 km north of Nagoya.

1.2.3.12.3 Mechanical Attributes of the Waste Package Environment

The objective of this task is to characterize the geomechanical response of the rock in the near-field to the changing conditions expected to occur over the lifetime of the repository. This includes providing data from laboratory, field and modeling investigations that can be used to support technical site suitability and a high level finding for rock properties. Particular emphasis is on coupled processes and behavior at elevated temperatures and at long times.

Work conducted on this task during August, September and October is described below.

Management & Integration

Milestone reports MOL74 and MOL76 describing progress on laboratory tests on 0.5m blocks and simulation of the LBT respectively, were prepared and submitted to YMSCO.

An abstract describing geomechanical studies on the Large Block Test was accepted for the second international conference on Mechanics of Jointed and Faulted Rock (MJFR-II) to be held in Vienna in April, 1995. A second abstract describing laboratory tests on 0.5 m scale blocks was prepared for the 1995 IHLRWM meeting.

S. Blair attended the Workshop sponsored by the NRC on Rock Mechanics Issues for Nuclear Waste Disposal, and he participated as a panel member for a session on Rock Mechanics and Performance Assessment Issues. He also visited the Civil and Geological Engineering Department at Notre Dame University and presented a seminar describing the geomechanics studies planned for the LBT. The purpose of this seminar was to educate colleagues and obtain their input on the design of the test. He also prepared for and participated in the dry run for the NRC technical exchange on coupled processes and a meeting between LLNL and LBL research staff to identify areas of possible collaboration between these laboratories. Development of collaborative activities in geomechanics with L. Myer at LBL is underway. B. Boyle (YMSCO) and R. Datta (M&O) visited the geomechanics laboratory facilities at LLNL, and several members of the OCRWM staff also toured the laboratory.

Laboratory

LLNL made significant progress in setting up the laboratory scale block experiments to aid in determining mechanical behavior of fractured Topopah Spring Tuff. A safety note for the 300 ton test frame to be used for these tests was prepared and approved. Fabrication/assembly of several of the component loading and diagnostic systems is nearing completion. A sample block 64 x 33 x 25 cm has been prepared for testing.

Image processing analysis to quantitatively characterize the microstructure of samples of Topopah Spring Tuff from several of the drill holes at the site was started. This analysis will assist in characterizing the geomechanical, hydrologic and geochemical properties of the potential repository horizon. This work is a continuation of the analysis done during the summer of 1993 for this task.

Modeling

A simulation was conducted to evaluate the stress field that will be created in the Large Block Test if lateral confining stress is applied to only the upper 3 m of the block. This calculation provides information on stress concentrations produced by the altered loading geometry.

Work continued on digitization of the map of the top surface of the large block for input into a discrete element code, and the map is approximately 80% digitized.

Support of the Large Block Test

Planning and preparation for the geomechanics measurements on the Large Block Test continued, including ordering of several types of transducers and associated instrumentation. Specific progress includes the following.

LLNL is developing a laser based instrument for precise measurement of small displacements in subsurface environments such as boreholes and drifts. Development of the Multipoint Borehole Laser Extensometer (MBLEX) has been underway for a few months, including completion of a design and a survey of available components. Several components have been received and tested on an optical table. These include a 91 m (300') optical cable and a fiber optic power meter. Recent work includes testing of techniques for collimating a laser beam after it is transmitted through an optical cable and then into the atmosphere. The system is based on a phase modulated laser measurement instrument; delivery of this instrument is expected in early November.

Elastic Wave Velocity System

P. Berge met with representatives from SAIC to evaluate a downhole acoustic wave source for use in the Large Block Test, and assessed that the source is appropriate for our purposes. A signal analysis system that can be used for both the laboratory and field block tests was leased and is being set-up in the laboratory.

Several tests to determine materials properties at elevated temperature and pressure and as a function of time were made on a variety of candidate engineering materials for the LBT. Results of these tests were reduced and presented to the LBT engineering team.

1.2.3.12.4 Engineered Barrier System (EBS) Field Tests

Revision of the draft Engineered Barrier System Field Tests Study Plan (8.3.4.2.4.4) has been completed in response to reviewer comments. Reviewers are being contacted by the M&O to determine if any comments remain to be resolved.

Large Block Test (LBT)

A Large Block Test milestone (MOL225) "Preliminary Report and Data on Construction, Experiments Started, and Characterization of Small and Large Blocks" has been completed and submitted to YMSCO

Matrix Bulk Porosity

The determination of porosity using the wet-dry method was completed. The average porosity is 10.9% $\pm$ 1.5%, which agrees well to the results obtained by the mercury porosimetry method..

Fracture Mapping

The fracture mapping on the surfaces of the large block was completed. The fracture distribution is essential for determining the location of some of the instrument holes. Therefore, the fracture data need to be analyzed as soon as possible.

Excavation

The excavation work was completed in September. The sampling of the small blocks to be used in the laboratory tests was also completed. Some of the blocks have been sent to Nevada Neanderthal Stone in Beatty, Nevada to be cut into smaller blocks, under the direction of LLNL, so that they can be machined in the sample preparation facility at LLNL.

Initial Moisture Content

The neutron logging data obtained from some of the Large Block Test vertical holes both before and after the sawing have been reduced, based on the LLNL calibration data of the neutron tool. The saturation levels of the block were between 60 and 80% at the time of the measurement. The data indicate that the sawing process did not significantly increase the saturation level of the block.

Small samples of the tuff, obtained from Fran Ridge for estimating the initial moisture content, are still in the saturating process.

Small Block Tests in the Laboratory

Tests on the performance of the Kapton heaters (to be used as guard heaters for the large block and as heaters for the small block experiments), the potential insulation materials, and the thermal controller for the guard heaters, under a 4.1 MPa stress, continue.

X-ray imaging to determine water saturation continues. A small block (2.5 x 10 x 10 cm) of Topopah Spring tuff from Fran Ridge, with a tensile fracture in the middle, was used to test the x-ray scanning capability. Water doped with KI was added to the top of the sample and radiographs are being taken as a function of time to try to determine the distribution of water content. Water was observed entering the fracture and the matrix. The images are being processed to determine saturation as a function of time, and the wetting front as a function of time.

Two new experiments are being planned and designed. One is to measure relative humidity in a rock sample with known moisture content. The other is to study one-dimensional vapor condensation along a fracture and the movement of the condensate water along the fracture.

The Load Retaining Frame

V. Brugman, J. Blink, M. Owens, and E. Dalder visited Aircraft Engineering Corporation (AEC) in Los Angeles on October 28. The four completed sections of the frame sides were assembled for a trial fitting, and the dome was placed on top of them. Non-destructive evaluation (NDE) results from AEC were reviewed, and a schedule for finish welding on the dome was discussed. AEC intends to ship the completed side sections to NTS during the week after Thanksgiving. The dome will be shipped on December 5, subject to oversize load permits.

Engineering analysis of the proposed modifications to retrofit the frame was completed. The load requirements for the anchor bolts have been determined. The results have been transmitted to RSN for designing the anchoring system. It was proposed that the frame can be retrofitted by moving the holes, which connect the sections together, closer to the wall of the frame. The bladder supporting structures will be welded to the inner side of the frame.

Eight (tacked) sections of the frame have been shipped to LLNL from Aircraft Engineering Corporation (AEC). LLNL has completed welding two sectors (at the time of issue of this report), and the other two sectors will be welded by REECo, providing the REECo cost estimates are acceptable. Aircraft Engineering Corporation (AEC) has completed welding one section (four sectors) of the cylindrical part of the frame. The four sectors were preliminary inspected by AEC using the ultrasonic method. AEC is working on the dome part of the frame. The dome and the four sectors will be shipped to Nevada by December 5, 1994.

Loading Devices

The engineering design of the bladder support/housing devices was completed.

Pre-test Calculations

A draft report, by K. Lee, on pre-test scoping calculation progress has been completed and is in the LLNL review process.

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

Activity will be discussed in a later status report.

1.2.5 REGULATORY

1.2.5.1 Regulatory Coordination and Planning

No significant activity.

1.2.5.2 Licensing

1.2.5.2.2 Site Characterization Program

W. Clarke, J. Blink, W. Halsey, and D. Wilder attended the NWTRB meeting in Las Vegas on October 12.

1.2.5.3 Technical Data Management

1.2.5.3.5 Technical Data Base Input

Nine LLNL TDIF's were entered into the ATDT in October.

1.2.5.4 Performance Assessment

1.2.5.4.2 Waste Package Performance Assessment

The objective of this task is to integrate physical process submodels and data into computational models for prediction of long-term waste package performance including single-package performance under local conditions, the net performance of the set of all waste packages in the repository, probabilistic distributions of net performance, and characterization of uncertainties. The task assesses whether the waste package subsystem will meet the performance objectives for the waste packages specified in 10CFR60.113. It also provides feedback to design optimization studies and provides a source term for the total system performance assessment.

Milestone MOL89 concerning the YMIM code was completed in September by transmittal of the Users Guide Report to YMSCO for programmatic review. YMIM combines summary models of many of the processes of the near-field environment and the engineered barrier system. The near-field processes are represented by their time-varying values at the waste package boundary. The resulting changes in the waste package containers, spent fuel cladding, and spent fuel waste form are evaluated. Radionuclide release rates as a function of time are calculated. Temperature-dependent effects were the focus for model enhancements as used in Total System Performance Assessment '93 (TSPA-93).

Milestone MOL87, "Progress Report: EBS Trade Studies" was completed in September by a statistical sensitivity study based on the TSPA-93 data. The TSPA analysis modeled the performance of four different repository designs differing in emplacement mode and thermal loading. The present study identified parameters that are important in predicting repository performance and studied the underlying reasons for the differing performance of the designs. The study was summarized in the August 1994 Monthly Progress Report. A follow-on paper is being prepared for submittal to the 1995 International High Level Radioactive Waste Management Conference.

Milestone MOL90, "Input to AREST II" was completed by transmittal to PNL of the then-draft YMIM Users Guide Report and a memo report on a glass waste form dissolution model. The YMIM manual describes container and spent fuel process models used in YMIM. The glass memo describes a glass waste form dissolution rate model developed by W. Bourcier of LLNL.

Work on cladding creep strain prediction under storage or disposal conditions continued. The present work compares predictions from experiments reported in the literature and incorporates an estimate of gas volume changes and their effect. The spent fuel temperature limits on design for disposal may be limited by the cladding creep and creep rupture phenomena, although other barriers will be engineered to contain the radioactive waste. A paper, "Creep Strains Predicted from Constitutive Equations for Zircaloy-Clad Spent Fuel Rods" by R. Rosen and W. O'Connell was prepared for submittal to the 1995 International High Level Radioactive Waste Conference. This is additional documentation of work presented to the Nuclear Waste Technical Review Board meeting on March 10-11, 1994.

The YMIM model was analyzed using an object-oriented program development approach. Such an approach will aid in the software QA process by allowing the recording of design-stage developments in progress and by providing complementary views of the model structure. The analysis was done in parallel with the testing of a commercial software package for object-oriented modeling which includes diagramming, database, and internal consistency checking features. The test was a two-week trial-basis test of the package. The test application on YMIM resulted in some proposed streamlining of the code operation and some streamlining of the higher-level structure so that it is easier to communicate the model structure and assumptions to the engineering and earth science subject-matter experts.

1.2.5.4.9 Development and Verification of Flow & Transport Codes

This WBS has not been funded in FY95.

1.2.5.5. Special Projects

1.2.5.5.1 Integrated Test Evaluation (ITE)

No significant activity.

1.2.9 PROJECT MANAGEMENT

1.2.9.1 Management and Coordination

1.2.9.1.2.1 Participant Technical Project Office Management

C.K. Chou and J. Blink attended the Project Management Review in Las Vegas on October 26.

J. Blink participated in the 90% design review of the Integrated Data and Control System. He also attended an Infrastructure Reduction Assessment Team meeting on October 7 and a Quality Integration Group meeting on October 12.

J. Blink presented hands-on science lessons entitled "waves" to 75 students (grades 3-5) at Las Vegas Day School on October 5. He also presented the "speed of light" lesson to 100 sixth graders in Pahrump on October 6. He participated in the DOE-NV Science Now day on October 18 presenting the "speed of light" lesson to two groups of top level high school students and their faculty mentors.

1.2.9.2 Project Control

1.2.9.2.2 Participant Project Control

Actual schedule progress and costs were submitted to the PACS reporting system via the PACS workstation. Variance analysis explanations were developed.

LLNL requested guidance from the YMSCO Deputy Project Manager (DPM) in regards to the underfunding of WBS 1.2.9 during FY95. The issue was whether LLNL should immediately reduce its management and project control staff and work scope to fit the allocated budget, or whether LLNL should front-load the resources in anticipation of additional funding prior to the middle of the fiscal year. The DPI decided that the funding level would be restored to the FY94 level, probably in December or January. Therefore, the existing resources were front-loaded, and the work scope was not reduced.

Affected document notices were completed for CRs 94/273, 329, 336, 356, 365, 367, 370, 372, 373, 382, 383, 384, 387, 388, 400, 414 and 334M1. No LLNL documents were affected.

1.2.11 QUALITY ASSURANCE

1.2.11.1 Quality Assurance Coordination and Planning

The LLNL-YMP FY Quality Assurance Audit Schedule, Rev. 3, and Surveillance Schedule, Rev. 2, were completed and distributed on October 28, 1994. LLNL-YMP FY95 Quality Assurance Audit Schedule, Rev. 0, was completed and distributed on October 28, 1994.

1.2.11.2 Quality Assurance Program Development

LLNL-YMP QA is still involved in the on-going process of updating and verifying the RTN Matrix with the assistance of S. Harris (QATSS).

1.2.11.3.1 Quality Assurance Verification - Audits

Audit 94-05, LLNL-YMP Near-Field Environment Characterization was conducted May 3 - September 12, 1994. Two adverse findings were identified, and two CARs, LLNL-035 and LLNL-036, were issued as a result of this audit.

Audit 94-12, LLNL-YMP Audit of Argonne National Laboratory, was conducted September 8-9, 1994. One adverse finding was identified. No CARs were generated during this audit.

LLNL responded to CAR YM-94-102, generated as a result of OCRWM Audit YMP-94-10. All actions have been completed and verified.

Corrective action for CARs LLNL-031 and LLNL-036 was completed and verified, and both CARs were closed on October 25, 1994.

1.2.11.3.2 Quality Assurance Verification - Surveillance

No significant activity.

1.2.11.4 Field Quality Assurance /Quality Control

No significant activity.

1.2.11.5 Quality Assurance - Quality Engineering

No significant activity.

1.2.12 INFORMATION MANAGEMENT

1.2.12.2 Records Management

1.2.12.2.2 Local Records Center Operations (LRC)

LLNL-YMP Document Control issued eleven revisions and twenty-three change notices during the month of September and one revision and no change notices in October. Files are in the yearly updating and clean out process. Assistance in the preparation of technical publications records packages continues, with three packages sent to the LRC in October.

Follow up continues on previously distributed documents.

1.2.12.2.3 Affected Organizations Records Management Activity

A total of 211 items were logged into the LLNL-YMP tracking system in September and 188 in October. A total of 22 records/records packages were processed through to the CRF in September and 23 in October. Seventeen action items were closed in the month of September. Eight action items were closed in October

LLNL records management staff received positive feedback following the DOE audit performed in September.

1.2.12.2.5 Document Control

LLNL received no funding under this WBS element for FY95. Work performed to complete LLNL's obligation in this WBS element is funded under WBS 1.2.12.2.2.

1.2.13.2 SAFETY AND OCCUPATIONAL HEALTH

1.2.13.2.5 Occupational Safety and Health

The YMSCO ES&H audit of LLNL-YMP activities at NTS was completed. Immediate action was taken on items identified during the audit or the outbriefing that could impact the environment or worker safety. Items requiring formal planning documents and procedures will be addressed during the first half of FY95.

1.2.15 SUPPORT SERVICES

1.2.15.2 Administrative Support

1.2.15.2.3 Support/Personnel Services

LLNL-YMP input for Progress Report 11 was compiled and edited during the months of September and October. LLNL-YMP input was completed and submitted to the M&O.

1.2.15.3 Yucca Mountain Site Characterization Project Support for Training Mission

In September, there were 111 people on the project. For the month of October there were 110 people to be trained and/or tracked on the project. Two new participants were initiated in September. One participant terminated and three became inactive.

The new training data base program has been completed and installed. Data entry remains to be accomplished and the projected completion date for this activity is November 30.

LLNL training staff received positive feedback following the DOE audit performed in September.

The annual Management Recertification process was completed ahead of schedule.

B. Bryan instructed a training class on QP 17.0, Rev. 6. The returned class evaluations rated the class and the instructor as excellent.

LLNL PROJECT STATUS REPORT EXTERNAL DISTRIBUTION
October 1994

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NOV 28 1994

Richard L. Craun, Assistant Manager, for Engineering and Field Operations, YMSCO, NV

YUCCA MOUNTAIN SITE OFFICE (YMSO) ACTIVITIES REPORT (SCPB: N/A)

The following are the significant activities from October 29, 1994 through November 11, 1994:

1. FIELD OPERATIONS CENTER

A. Management and Administration

1. Provided administration, operational, logistical support during this period to the following tours: Nuclear Environment Management Center, Korea; USGS Instrumentation Committee; DOE/NV Employees; Sons of Utah Pioneers; Nuclear Regulatory Commission; Korea Atomic Energy Research Institute; American Planning Association and a Public Open House.
2. Processed 18 work order and 36 photographic services requests.
3. Prepared 60 badging requests for site visits and daily field work.
4. Coordinated with Northern Geophysical regarding USGS seismic study, completed request to store explosives on NTS. Coordinated with REECo in escorting Northern Geophysical in escorting property off NTS.
5. Provided Underground Visitors Training for personnel requiring access to the Starter Tunnel.
6. Submitted SP 1.3, "Occurrence Reporting and Processing of Operations Information" for approval and final signature.
7. Prepared and transmitted Daily Operations Reports to NORSOC, and biweekly Reports to HQ OCRWM.
8. Provided operations, administrative, and security support to the Yucca Mountain Site Manager and his DOE staff, including support and escort of tours.
9. Provided logistical support by issuing vehicles, first aid kits, fire extinguisher, and other necessary equipment to personnel performing field duty in the YMP area of operations.
10. Provided operational and administrative support for Site Characterization activities in the field.
11. Supported Saturday and shift coverage of FOC for Area 25 activities.

QA: N/A

Richard L. Craun, Assistant Manager, for Engineering and Field Operations, YMSCO, NV

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10. Provided operational and administrative support for Site Characterization activities in the field.
11. Supported Saturday and shift coverage of FOC for Area 25 activities.

12. Provided Weekly Activity Report of YMP construction to Site Manager.
13. Issued Operations Permit 95-06 for JP 94-19, "Rework and testing of NRG-6".
14. Created Notebook for tracking Environmental Compliance Surveillance Reports and issued weekly report on these items. Completed FOC's portion of four (4) Environmental Compliance Surveillance Reports. Closed out Reports 94-0107 and 94-0213.
15. Investigated a brush fire started by lightning in a remote area 15 miles north of the ESF.
16. Worked on space allocation planning for Bldg. 4015.
17. Coordinated physical inventory of all items in bldg. 4015 to be transitioned to M&O Property.
18. Coordinated a field trip into Air Force land with OCC to support SAIC field study activities.
19. Investigated an oil leak at the SMF and contacted REECo maintenance for repair.
20. Continued work on FOC Duty Officer Training Course being developed.
21. Site Manager prepared a Job Package Letter of Authorization for Job Package 94-19, "Borehole Workover, Testing, and Instrumentation of NRG-6". Field Controlled copies were distributed from the YMSO Document Records Center.
22. Site Manager prepared and issued two Letters of Authorization to REECo, M&O/TRW, USGS and M&O/SAIC. These were for replacement of transducers at the C-Well Complex and for the recovery of the materials left in borehole UE-25 UZ-16.

B. Field Safety & Health

1. Resurvey of Mercury spill area in USGS building.
2. Met with Drilling Support Geologist and USGS representatives regarding possible health hazards from Erionite found in some previous core samples.
3. Conducted daily monitoring and weekly surveillance of field activities.
4. Measured air quality during confined space entry into drum of 8 yard transit mix truck.
5. Attended special Safety and Health meeting called by AMESH to discuss Erionite. Developed a protocol for handling erionite containing samples with necessary personal protective equipment.

2. RAYTHEON SERVICES NEVADA, (RSN)

A. Continuing to as-built the ESF utilities.
B. Continuing to support ESF Survey Control.

C. Lay-out of the utilities at the ESF.
D. Continuing to support Tunnel Alignment Control.
E. Continuing to support the qualifying of existing Drill Hole locations.
F. Construction lay-out of the Switchgear Building at the ESF.
G. Provided preliminary survey support for LBL Gravity Study.
H. Performed a topographic survey for Drill Pad WT-24.
J. Lay-out of Environmental Boundary for Drill Hole WT-24.

3. T&MSS QUALITY ASSURANCE, (SAIC)

A. Monitored the UZ-16 work over activities.
B. Monitored instrumenting and stemming of NRG-7/7A. Performed verification activities related to the cementing of the wellhead box.
C. Verified drilling and coring operations at SD-7.
D. Performed verification of instrumentation and stemming activities at NRG-6.
E. Commenced surveillance, SR-95-002, to verify implementation of the T&MSS QA Program at the Sample Management Facility.

4. SAMPLE MANAGEMENT FACILITY (SMG/SAIC)

A. Completed Stemming and grouting Downhole Instrumentation Station Apparatus in place at NRG 7/7A.
B. Resumed drilling activities on SD-7, sampled and processed core and cuttings to 69.7 feet. Currently drilling in the Tiva Canyon Middle non-lithophysal unit.
C. Procuring logging services and preparing for geophysical logging scheduled to begin on 11/14. Submitted Notification of Intent to precede with field logging activities.
D. Continued work on Sample Management Safety Action Plan for handling core and cuttings samples that may contain hazardous materials.
E. Conducted 12 core examinations at SMF for USGS, SNL and Drilling Support Section staff.
F. Created 104 specimens from core samples for analysis by PI's.
G. The SMF processed cuttings from previous drilling activities.
H. Completed work program 94-19 and Summary Cost estimate for NRG-4 Additional Work Activities - Nye County Support.
I. Completed work program 94-16 and Summary Cost estimate for NRG-6 Instrumentation and Stemming Program.
J. Completed revision to WI-FR-001, Drilling Work Instruction.

5. YMP HYDROLOGIC RESEARCH FACILITY, (USGS)

A. <u>Geologic Studies Program</u>

1. Performed field work on faults and trenches in Crater Flats.
2. Mapping and performing field work on Sundance Fault in Split Wash and on Whaleback Ridge.
3. Performed field work in the central area of the proposed repository block.
4. Logged core at the Sample Management Facility.
5. Collected soil samples for chemical analysis in the Amargosa Desert.
6. Performed field work in the new trenches in Split Wash.
7. Calibrated seismic stations and set up recorders to collect additional data from seismic reflection shots.
8. Mapped trenches on the Ghost Dance Fault.
9. Northern Geophysical crew continued collecting data on seismic reflections across Yucca Mountain. Data Quality on Line 2 was excellent with initial data showing a wealth of detail.
10. Tunnel mapping crew were at the ESF North Portal.

B. <u>Hydrologic Investigations Program</u>

1. Worked on water level monitoring.
2. Completed air permeability tests in NRG-6. Collected gas samples. Prepared instrumentation for NRG-6.
3. Preparing for upcoming testing in USW G-2.
4. Instrumented borehole NRG 7/7A.
5. Performed maintenance on stream gauge sites in Yucca Mountain area and in Fortymile wash.

6. REYNOLDS ELECTRICAL AND ENGINEERING CO., (REECo)

A. <u>Drilling</u>

1. NRG-7/7A; completed stemming operations, demobilized.
2. SRS 311; completed pulling ODEX casing, demobilized rig.
3. SD-7; completed rigging up, cored to 73 feet.
4. NRG-6; moved in platform, crane and equipment. Ran TV camera and three armed caliper. Ran AW casing to total depth, tagged bottom at 833.76 feet.
5. UZ-16; Ran overshot, tagged fill at 1626 feet. did not recover fish.
6. NRG-4 - Nye County Support; mobilized Joy 1 drill rig.

B. Logistics

1. Assisted in the conducting of tours which were being held during this time period, which included a Public Open House.
2. Requisitioned needed supplies and arranged for services needed in the operation of the Field Operation Center (FOC) and related facilities.

C. Construction

1. TBM Work

   a. TBM now at STA 2+51.6.
   b. Made modifications to Ring Erector, Propel Cylinders and changed steering pump.
   c. Installed 9 invert segments and 6 ring beams.

2. Precast Yard

   a. Modifying forms to facilitate seal.
   b. Fabricated rebar cages.
   c. Continued to pour invert segments.
   d. Installing fence on south side of yard.

3. North Portal Pad

   a. Surface construction continues with water, power and sewer being installed on the Pad.
   b. Continued Pad perimeter fencing.
   c. Worked on Switchgear Building forms and rebar.
   d. Worked on finish/hookup of modular units.
   e. Cuttings from TBM are being distributed and compacted on the ESF Pad extension.

4. Water Line/Tank

   a. Continued water line and tank work for service to Pad.
   b. Continued water line work "H" road to tank.
   c. Four load bearing plate tests completed, backfilling area and taking compaction tests on one foot lifts.

5. NRT-1 Trench

   REECo is backfilling trench, it is about 25 percent complete.

6. Seismic Line

Northern Geophysical continues with their surface surveys.

7. LOS ALAMOS NATIONAL LABORATORY, (LANL)

A. TBM advanced 18 meters (59 feet). SAIC resumed radon monitoring in the Test Alcove.
B. The total water usage in the north ramp, to date, is 38.4 kiloliters (10,145 gallons).
C. USBR on site to observe the advance of the TBM. The ground continues to be fractured, mapping is not practical at this time, but photographs have been taken.
D. SNL continues to monitor MPBX gauges, and rockbolt load cells. With TBM moved to the face SNL Field Team unable to measure convergence pins. The SNL field team concluded monitored the borehole pressure cells as the TBM operated.
E. USGS resumed Radial Borehole Testing.
F. Parts of the reaction frame arrived and REECo will perform final welding on the received sections.

8. FIELD CHANGE CONTROL, (CRWMS M & O)

A.	Total number of FCR's submitted during period:	5
B.	Total number of FCR's closed during period:	4
C.	Total number of FCR's remaining open:	1

9. DOCUMENTS AND RECORDS CENTER, (CRWMS M & O)

A. JOB PACKAGES

YMP/JP 92-03, Rev. 0	OBSOLETE
YMP/JP 94-19, Rev. 0	"Borehole Workover, Testing, and Instrumentation of NRG-6".

B. WORK PROGRAMS

YMP/WP/94-19, Rev. 0	"UE-25 NRG-4 Additional Work Activities - Nye County Support".

C. FCR's

FCR 94/408	OBSOLETE
FCR 95/038	"Redefine Testing Responsibilities for NRT-1 Backfill".

FCR 95/039	"Redefine Testing Equipment Specification for NRT-1 Backfill".
FCR 95/040	"Delete Specified Compaction Equipment for NRT-1 Backfill".
FCR 95/044	"Simplification of Pipe Concrete Encasement".
FCR 95/046	"Culvert Rebar Cover Change".
FCR 95/047	"Booster Pump Station MCC Details".
FCR 95/048	"Firewater Line Correction (Supersede Portion of FCR 95/030)".
FCR 95/049	"Change of SWW Meter Type at the Portal Entrance".

D. SPECIFICATIONS

YMP-025-9-SP08, Rev. 1 OBSOLETE

E. VENDOR DOCUMENTS

BAB000000-01717-6300-VD-75, Rev. 0
BAB000000-01717-6300-VD-76, Rev. 0
BAB000000-01717-6300-VD-77, Rev. 0
BAB000000-01717-6300-VD-78, Rev. 0

F. DRAWINGS

YMP-025-9-MING-MG211, Rev. 1, OBSOLETE
YMP-025-9-CIVL-PL104, Rev. 1, OBSOLETE
YMP-025-9-CIVL-GP104, Rev. 1, OBSOLETE
YMP-025-9-CIVL-PR104, Rev. 1, OBSOLETE

G. DOCUMENTS ISSUED:

1,014 controlled documents
- 364 FCR's
- 469 DRWG's
- 66 JP's
- 40 WP'S
- 21 SPEC's
- 54 VENDOR

424 uncontrolled documents

H. REPRODUCTION

19,336 Pages copied
1.004 Drawings copied

10. FIELD TRAINING (SAIC)

A. GET 1.5 Refresher Training; 9 students passed.

B. Conduct of Operations Class; 3 people attended.
C. Standard First Aid/CPR provided for 7 people.
D. GUT Training Conducted; 21 people attended.
E. ESF visitor briefing, 59 personnel attended.

Robt White for

Winfred A. Wilson, Site Manager for
Assistant Manager for Engineering
and Field Operations

AMEFO:WAW-95/036

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