UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

Reply to:

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Las Vegas, Nevada 89119
Tel: (702) 388-6125
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MEMORANDUM

DATE: December 15, 1989

FOR: John J. Linehan, Director, Repository Licensing Project Directorate, Division of High-Level Waste Management, M/S 4-H-3

FROM: John W. Gilray, Sr., OR YMP

SUBJECT: YMP Site Report for the month of November, 1989

The following report pertains to the QA, waste package and surface facility activities associated with the Yucca Mountain Project for the month of November, 1989.

I. GENERAL

As a result of YMP budget cuts the project is expected to lay off approximately 200 personnel. H&N, F&S, SAIC and LLNL will be most affected.

Essentially all ESF Title II design activities have been stopped. The major emphasis of ESF work is in developing alternatives to the ESF design which Sandia has the lead role.

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II. QUALITY ASSURANCE

A. Qualification of H&N Personnel

As a result of an H&N QA employee (Don Brown) questioning the qualifications of the H&N staff participating on the YMP, the YMP QA Director has requested H&N to expedite the resolutions of Don Brown's findings and to reevaluate the qualification records of all H&N QA and technical personnel to confirm that they meet current qualifications requirements. Don Brown will review the final result of this effort to determine if he is satisfied with the overall conclusions and resolutions to his concerns. The results of this evaluation and the resolutions to the concerns are scheduled to be ready for the YMP QA review by December 19, 1989. This onsite resident office will be briefed by the YMPO on the outcome of these activities the week of December 19 and in turn will report the findings back to NRC.

B. Actions Underway to Improve the YMP QA Program

The dedicated YMPO staff efforts in reviewing current flow down requirements and management and QA procedures implementing these requirements has slowed down due to uncertainties in the DOE management structure and policies on how the program is to be managed and carried out. This slow down is expected to impact the schedule for conducting an audit of the YMP QA program.

C. LANL

The Los Alamos Lab has self-imposed a stop work order until their QA implementing procedures are properly established and personnel trained to these procedures.

D. USGS

USGS is awaiting YMP approval of the quality plan designating the QA grading of proposed activities before starting work. This YMP approval is expected by February 1990.

E. Sandia

Sandia is actively working on alternative studies for the ESF with assistance from the other participants as requested.

F. SAIC

As a consequence of the YMP requesting SAIC to be a participant to the project, SAIC is now developing their own QA Program Plan which will be reviewed and approved by the YMPO prior to being submitted to NRC. The YMP is expected to receive a draft of the plan by December 29, 1989 for review.

G. Software QA Programs

The USGS software QA program is approved and the other participants are nearing completion and approval of their programs.

H. Sample Management Facility (SMF)

Procedural controls are under development by the YMPO to evaluate the USGS core samples and associated documentation to determine if they can be qualified to meet licensing requirements. Implementation of these procedures is expected to start in February.

Experimental dry core drilling for sample core specimens is expected to take place in mid-January in Arizona by the YMP using the SMF quality procedures to control the processes for retrieval, identification, storage and evaluation of the core specimens. This will afford the YMP the opportunity to check out the effectiveness of the SMF procedures prior to working on 10 CFR 50 Appendix B quality related activities.

I. QA Classification of Items and Activities

The YMP QA organization is finalizing the development of the two procedures (AP 5.28Q "Assignment of QA Levels, QA criteria Requirements and Grading" and AP 6.17Q "Determination of the Importance of Items and Activities") for classifying and grading Q-list items and activities. Implementation of these procedures is expected to be in March.

J. YMP QA Concerns with the Study Plan Assessment

The YMP QA staff has conducted a surveillance (Report #YMP-SR-90-003) of the ESF Study Plan Assessment documented packages and concluded that the QA concerns have been acceptably resolved. The closure of this issue has been documented in a YMP letter from the YMP QA and technical offices to C. Gertz dated November 22, 1989 (Enclosure 1).

III. WASTE PACKAGE

The NWTRB will be given a presentation and tour of the LLNL YMP activities at the California facilities January 17 thru 19. This office expects to attend this meeting to keep abreast of the current status of the overall LLNL YMP activities.

The LLNL August/September, October and November monthly status reports have been issued in November and are enclosed (Enclosure 2, 3, & 4 respectively). It is encouraged that comments and or questions regarding the contents of these reports be directed through this office for action and resolution in order to minimize impact on the YMP.

cc: With encs: J. Kennedy, M/S 4 H3; J. Bunting, M/S 4 H3;
J. Latz
Without encs: R. Adler, C. P. Gertz, R. R. Loux, M. Glora, G. Cook, D. M. Kunihiro, R. E. Browning, M/S 4 H3; K. Turner, S. Gagner, M/S 2 G5; L. Kovach, M/S NLS260; H. Thompson, M/S 17 G21; H. Denton, M/S 17 F2; R. Bernero, M/S 6 A4; K. Stablein, M/S 4 H3

Enclosures: Closure of the QA Concerns with the SPA, 11/22/89; August/September 1989 and October and November Monthly Reports, LLNL

Enclosure #1

Originated by: M. Pendleton, SAIC

NOV 22 1989

WBS 1.2.5.2.5
QA

Carl P. Gertz, Project Manager, YMP, NV

CLOSURE OF THE QUALITY ASSURANCE (QA) CONCERNS WITH THE STUDY PLAN ASSESSMENT (SPA)

In response to the concerns expressed by the QA Division with the SPA, the following actions have been completed:

1. The Regulatory and Site Evaluation Division has responded to all outstanding Standard Deficiency Reports (SDRs) that were generated during Yucca Mountain Project Office surveillances of the Study Plan preparation, review, and approval process.

2. The QA Division has responded to the Deficiency Report issued by the Office of Civilian Radioactive Waste Management after their surveillance of the Study Plan preparation, review, and approval process.

3. Records packages for the five construction-phase Exploratory Shaft Facility Study Plans have been submitted to the Local Records Center. The QA Division has completed a surveillance of these records packages. This surveillance did not result in any SDRs.

Completion of these activities resolves the QA concerns with respect to the SPA. We agree that the SPA correctly concludes that the content of the Study Plans would not have been changed in any substantive way if the plans had been developed under a fully qualified QA program.

ORIGINAL SIGNED BY
for UEL S. CLANTON

Maxwell B. Blanchard, Director
Regulatory and Site Evaluation Division
Yucca Mountain Project Office

YMP:MBB-944

Approved/Disapproved

Approved/Disapproved

Donald G. Horton, Director
Quality Assurance Division
Yucca Mountain Project Office

Edwin L. Wilmot, Deputy Project Manager
Yucca Mountain Project Office

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Enclosure #2

Lawrence Livermore National Laboratory

LLYMP8911126
November 17, 1989

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"QA: NA"

ACTION Ymeo
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AMA
AMCDH
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OER

Carl Gertz, Project Manager
Department of Energy
Nevada Operations Office
Yucca Mountain Project Office
P.O. Box 98518
Las Vegas, Nevada 89193-8518

Attention: L. Little

SUBJECT: August and September 1989 Monthly Report – LLNL

Attached are LLNL's Project Status Reports for the months of August and September 1989. A Project Status Report has been completed for each WBS.

If you need further information, please contact Deborah A. Kiraly of my staff at FTS 543-4571.

Sincerely,

Leslie Jardine
LLNL Technical Project Officer
for YMP

LJJ/DK/dk

Enclosures
xc:
YMPO, M. Cloninger
SAIC, B. McKinnon
SAIC, D. Morrissette

DISCLAIMER

QA checks on data contained here have only been performed to determine that the data has been obtained and documented properly. The LLNL Waste Management Project cautions that any information is preliminary and subject to change as further analyses are performed or as an enlarged and perhaps more representative data base is accumulated. These data and interpretations should be used accordingly.

LAWRENCE LIVERMORE NATIONAL LABORATORY
YUCCA MOUNTAIN PROJECT

MONTHLY TECHNICAL HIGHLIGHTS AND STATUS REPORT
AUGUST 1989

TABLE OF CONTENTS

1.2.1 Systems
WBS 1.2.1.2.4. Systems Engineering (Revelli)

1.2.2 Waste Package
Near Field Environment Modeling and Testing (Wilder)
WBS 1.2.2.2.1 Geochemistry and Mineralogy (Glassley)
WBS 1.2.2.2.2 Near Field Hydrology & Transport (Wilder)
WBS 1.2.2.2.3 Man Made Materials Effects (Glassley)
WBS 1.2.2.2.4 EBS Prototype Testing (Ramirez)
WBS 1.2.2.2.5 ESF EBS Testing (Ramirez)

Waste Form Modeling and Testing (Shaw)
WBS 1.2.2.3.1.1 Spent Fuel (Stout/Leider)
WBS 1.2.2.3.1.2 Glass (Ryerson)
WBS 1.2.2.3.4.1 Integrated Testing (Shaw)

Container Materials Modeling and Testing (Clarke)
WBS 1.2.2.3.2 Metal Barriers (McCright)
WBS 1.2.2.4.2 Fabrication and Closure (Russell)

Geochemical Modeling (Aines)
WBS 1.2.2.5.2 Model Development (Aines)
WBS 1.2.2.3.4.2 Thermodynamic Data Development (Silva)

Performance Assessment (O'Connell)
WBS 1.2.2.5.1 Performance Assessment (O'Connell)

Special Studies (Ballou)
WBS 1.2.2.4.1 Design and Analysis (Ballou)

1.2.5 Regulatory Interactions
WBS 1.2.5.2.1 Regulatory Interactions (Emerson)
WBS 1.2.5.2.2 SCP (Emerson)
WBS 1.2.5.2.3 Regulatory Compliance Documentation (Emerson)
WBS 1.2.5.2.5 Study Plan Coordination (Emerson)
WBS 1.2.5.2.6 SCP Progress Reports (Emerson)

1.2.9 Project Management
WBS 1.2.9.1.1 Project Management (Jardine)
WBS 1.2.9.1.4 Records Management (Bryan)
WBS 1.2.9.2 Project Control (Podobnik)
WBS 1.2.9.3 Quality Assurance (Short)

1.2.1 SYSTEMS

WBS 1.2.1.2.4 SYSTEMS ENGINEERING
M. Revelli, PI

OBJECTIVE

The Systems Engineering task will coordinate the integration of LLNL technical activities into the Yucca Mountain Project Technical Baseline to support the development of a Yucca Mountain Mined Geologic Disposal System that meets DOE and regulatory requirements. This task also supports the Project-wide development and implementation of a Yucca Mountain Systems Engineering Management Plan (SEMP) that contains detailed site-specific systems engineering procedures used to meet the unique needs of the Project, as well as the requirements established in the OGR SEMP.

ACTIVITIES AND ACCOMPLISHMENTS

L. Ballou and M. Revelli attended a meeting at Parsons-Brinkerhoff-Quade & Douglas (PBQD) in San Francisco on August 3, 1989, with representatives from YMP, SNL, PBQD and Weston. Two major topics were covered during the meeting: 1) A review of the basis for the quantities of excavated tuff that are being used in the current design studies and their impact on the Total System Life Cycle Cost (TSLCC) studies, and 2) A discussion of the status of an on-going SNL study aimed at revising the allowable Areal Power Density based on repository design constraints.

LLNL reviewed the July 1989 Draft of AP-5.1, "Management and Development of Technical Data on the Yucca Mountain Project", and provided comments to the Project Office. Because of serious flaws, it was necessary to recommend that this draft of AP-5.1 be withdrawn. Nevertheless, LLNL remains committed to working with DOE and Project Participants to develop a process that can satisfy both the need for timely/efficient access to data and the concerns of the technical staff.

Final revisions were made to the Draft A Waste Package Design Requirements (WPDR) document to incorporate the QMP-06-03 comment resolutions. A copy of the resulting Draft B WPDR was delivered to the Project Office on August 29, 1989, for a Technical Assessment Review. This submittal completed LLNL Milestone T-480.

Preliminary results from LLNL's expanded Spent Fuel Receipt Scenarios Study were presented at the OCRWM (Task 8) Meeting, "Technical Working Group on Acceptance of Spent Fuel of Various Characteristics". This study examines the thermal effects of an oldest fuel first receipt scenarios versus a uniform energy distribution scenario at four locations in a simplified repository layout. M. Revelli and L. Ballou attended the OCRWM Task 8 Meeting in Washington, D.C., on August 22 and discussed this work with representatives from DOE (HQ & YMPO) and contractors from major elements in the program. Later this year, this study will be documented in an LLNL report and the results will be included in the Task 8 Final Report for OCRWM.

Final revisions were made to the Waste Package Postclosure Regulatory Compliance Strategy document to incorporate changes agreed upon at the QMP-06-03 Comment Resolution Meeting (August 26-27, 1989, in Las Vegas). The revised draft (dated August 18, 1989) was transmitted to the Project Office on August 25, 1989.

MAJOR ACTIVITIES UPCOMING NEXT THREE MONTHS

LLNL will continue to work with the Project Office and other participants to revise the draft YMP/AP-5.1Q for the Management and Development of Technical Data.

Analysis of the expanded Spent Fuel Receipt Scenarios study will be completed and the results will be documented.

The Yucca Mountain Mined Geologic Disposal System Requirements (SR) Document will be reviewed to verify that the agreed upon comment resolutions have been incorporated.

MILESTONE PROGRESS

Milestone T-480 completed.

WBS 1.2.2.2.1 GEOCHEMISTRY AND MINERALOGY
W. Glassley, PI

OBJECTIVE

The objective of this task is to develop a model of the geochemical and mineralogical behavior that may occur in the vicinity of high level waste packages emplaced in Topopah Spring tuff at the proposed repository at Yucca Mountain. Once developed, the model will be used to predict the chemical environment waste packages may experience for a range of possible scenarios, and to provide information necessary for establishing the source term to be used in calculations of travel times and release rates for those scenarios concerned with release of radionuclides.

Development of this model requires detailed information regarding the chemical and mineralogical consequences of liquid and vapor phase water interacting with tuff at elevated temperatures and radiation levels. Obtaining rates of chemical reactions, identification of reaction products, and description of initial rock and water conditions are the principal goals of this task. To accomplish these goals activities have been designed and undertaken to determine experimentally the nature of tuff/water interaction at elevated temperature, the rates at which reactions occur through dissolution and precipitation, the composition of water that exists in pores in the unsaturated tuff, and the nature of reaction processes in aqueous systems subjected to elevated radiation levels. The data resulting from these activities are incorporated into numerical simulations that will be used to generate models of the long term behavior of the near field environment.

ACTIVITIES AND ACCOMPLISHMENTS

Rock-Water Interaction
The experiments are progressing normally. The purpose of these runs is to determine how a steady-state tuff-water system responds to perturbations in fluid composition. The approach to this problem has been to allow tuff and fluid to approach equilibrium and then inject into the reaction vessel an aliquot of fluid, which perturbs the steady state system. Sampling of fluid after perturbation allows monitoring of the approach to a new steady state. The current runs replace those that were prematurely terminated by a power outage.

The experiment is progressing normally. Solutions samples have been obtained through 90 days after injection of fluid and have been submitted for analysis If the solution compositions are the same as those from the previous sampling, it will be assumed that steady state has been achieved and the run will be terminated. Analysis of the solid phases and the analytical results will be accomplished when the run is terminated.

A backup power supply is being obtained to prevent loss of experiments during power outages. Ordering of the equipment should take place in August or September.

Vadose Water Extraction
Work continues to be delayed because of the absence of appropriate sample material. Arrangements are nevertheless being made to begin reconnaissance experiments with high G centrifuges.

Single-Phase Dissolution
Dissolution and precipitation kinetics experiments of kaolinite at 80°C and low pH, and dissolution and precipitation of gibbsite at low pH and 80°C continued. The experiments are progressing normally.

Study of the dissolution and precipitation kinetics of cristobalite at 200°C continued. Steady state concentrations of silica were achieved in the dissolution experiments that were consistent with predictions from other studies. Precipitation experiments proceeded normally. However, amorphous silica, rather than cristobalite has appeared in the run products. Investigation of this material continues.

MAJOR ACTIVITIES UPCOMING NEXT THREE MONTHS

Samples will be taken of the perturbed rock-water system to monitor the resulting steady-state composition of the solution after it has been disturbed.

Dissolution and precipitation experiments will continue on the clays, cristobalites and zeolites. Expanding the experiments to cover a broader range of pH values is expected.

PROBLEMS/ISSUES

The absence of rock material continues to delay the vadose water extraction activity.

MILESTONE PROGRESS

No milestones in this reporting period.

WBS 1.2.2.2.2 NEAR-FIELD HYDROLOGY & TRANSPORT
D. Wilder, PI

OBJECTIVE

The objective is to provide a detailed conceptual and quantitative understanding of the flow and transport processes active in the near-field waste package environment. Activities will provide a basis for the near-field flow and transport submodel to be included in the waste package performance assessment system model.

ACTIVITIES AND ACCOMPLISHMENTS

Work continued on building the models for the vertical prototype heater test, using the latest version of the TOUGH code to model both the large and the small diameter heater borehole options.

Work continued on some discrete fracture/matrix modeling of hydrothermal flow around the prototype heater. In our latest modeling effort, we are examining the impact of gridblock spacing transverse to the fracture.

John Nitao and Tom Buscheck attended an informal workshop on performance assessment at Lawrence Berkeley Laboratory on August 15-16, 1989. The emphasis was fracture-matrix flow interaction as it affects infiltration events and contaminant transport. It was decided to continue to hold these workshops on a regular basis as a method to produce more effective

integration of performance assessment at the respective organizations. (Organizations represented were SNL, LBL, USGS and LLNL).

The paper, "On the Infiltration of a Liquid Front in an Unsaturated, Fractured Porous Medium" was completed and submitted to the Focus '89 Conference to be held in Las Vegas, NV, Sept. 18-21, 1989.

The paper "Laboratory Study of Fracture Healing in Topopah Spring Tuff-Implications for Near Field Hydrology" by Wunan Lin was sent to the Project Office for review and release and will also be given at Focus '89.

The paper "Laboratory Determined Suction Potential of Topopah Spring Tuff" by William Daily was sent to the Project Office for review and release and will be published in Water Resources Research.

Dale Wilder presented the paper "Waste Package Interaction with Unsaturated Welded Tuff Environment" at SMiRT 10, Anaheim, CA. on August 21, 1989.

MAJOR ACTIVITIES UPCOMING NEXT THREE MONTHS

Work continued reviewing the Study Plan for the Hydrologic Properties of the Near Field Environment (1.2.2.2.1). Sixty review comments on this study plan were received from SAIC, SNL, LANL, and USGS. As a result, a large block of time will be required to address these comments.

Several USGS Hydrology Study plans will be reviewed during the next three months.

PROBLEMS/ISSUES

Interviews continue to fill the position of Task Leader for the Hydrology task. Until that position is filled, the work will be covered by the present staff.

MILESTONE PROGRESS

No milestones this reporting period.

WBS 1.2.2.2.3 MAN-MADE MATERIALS EFFECTS
W. Glassley, PI

OBJECTIVE

The objective of this task is to determine the chemical, physical, and mineralogical consequences that result from the presence in the proposed repository of man-made materials. These materials have the potential of affecting the properties of the environment waste packages must survive, and may therefore influence the performance lifetime of waste containers and waste-form leach rates. To achieve the objective of this task, activities will address the interaction of man-made materials with the host tuff, and evaluate the extent to which synergistic effects may occur among various man-made materials.

ACTIVITIES AND ACCOMPLISHMENTS

Because of the absence of funding for the remainder of FY89, no work was conducted on this task. Interviews for a prospective task leader in this area are continuing.

MAJOR ACTIVITIES UPCOMING NEXT THREE MONTHS

Because of the absence of funding for the remainder of FY89, no work was conducted on this task. It is expected that a task leader will be available by the beginning of FY90, at which time scientific investigation plans will be developed.

PROBLEMS/ISSUES

The absence of funding has prevented further work.

MILESTONE PROGRESS

No milestones this reporting period.

WBS 1.2.2.2.4 ENGINEERED BARRIER SYSTEM PROTOTYPE TESTING
A. Ramirez, PI

OBJECTIVE

This activity includes planning and implementation of prototype in situ tests of the waste package environment to test hardware, methods and procedures. The results of these tests will be used to evaluate candidate hardware and methods that will subsequently be used in the ESF (Exploratory Shaft Facility) and to provide data for preliminary assessment of model performance.

ACTIVITIES AND ACCOMPLISHMENTS

The overcoring operation started in G-Tunnel on August 29 with the drilling of Hole P-1, 6 ft per day is expected.

The field calibration of the moisture collection gauge was completed.

After the completion of the heating cycle, the TV camera was used to look for new fractures and these fractures were then re-mapped.

Our scoping calculations of the vertical prototype test continued by considering the impact of heater heat generation rate on the fraction of energy available for boiling.

Work is progressing on the Activity Plan for the vertical Prototype Test.

The Scientific Investigation Plan for the test is also being revised.

Alan Russell, Don Towse and Don Emerson attended the Sampling Class AP6.2, at NTS on August 9, 1989.

Abe Ramirez attended the Geophysical Coordination Workshop at NTS on August 29-30, 1989.

Ernie Majer of LBL gave a presentation to the Prototype Testing Group on how acoustic emission (High frequency seismic experiments) information could be used on the upcoming prototype test or later tests.

Wunan Lin attended the ESTC Meeting held in Denver, CO on August 23, 1989.

The paper, "Microwave Measurements of Water Vapor Partial Pressure at Temperatures up to 350°C", by Robert Latorre was sent to the Project Office for review and release and will be given at Focus '89 Sept. 18-21, 1989 in Las Vegas, NV:

MAJOR ACTIVITIES UPCOMING NEXT THREE MONTHS

Work will continue on the draft activity plan and the revising of the SIP.

Work will continue on the Criteria Letter that is being prepared for the Vertical Prototype Test.

PROBLEMS/ISSUES

The overcoring operation is experiencing problems with the drill bits and the drilling has been slower than expected because of this.

MILESTONE PROGRESS

No milestones this reporting period.

WBS 1.2.2.2.5 EXPLORATORY SHAFT FACILITY ENGINEERED BARRIER SYSTEM TESTING
A. Ramirez, PI

OBJECTIVE

This activity includes planning and implementation of in situ tests of the waste package environment. The results of these tests will be used in defining the waste package environment and will aid in validating models used in performance assessment of the waste package system. This task also includes the preparation and certification of LLNL input to the Exploratory Shaft design documents.

ACTIVITIES AND ACCOMPLISHMENTS

Don Towse attended the ESF/TPO Status meeting in Las Vegas, August 31, 1989.

MAJOR ACTIVITIES UPCOMING NEXT THREE MONTHS

Continue work on Long Range Planning Exercise.

PROBLEMS/ISSUES

No problems/issues this reporting period.

MILESTONE PROGRESS

No milestones this reporting period.

WBS 1.2.2.3.1.1.WASTE FORM TESTING - SPENT FUEL
R. Stout/H. Leider,

OBJECTIVE

This task involves the measurement of the radionuclide release rate from spent fuel, the oxidation rate of irradiated UO_2, and the corrosion rate of spent fuel cladding. The data obtained from the testing program are to be used as input for performance modeling of the long-term radionuclide release rates from the waste package.

ACTIVITIES AND ACCOMPLISHMENTS

Spent Fuel Leaching/Dissolution Tests (H. Leider, P.I.) Argonne National Laboratory

YMP Series 5 Spent Fuel Leach (SFL) Tests

A revised version of the Task Plan has been completed. The purpose of these revisions was (1) to accommodate new QA level I formatting rules under the guidance of the generic QA Plan YMP-02-001, Rev. 0; (2) to incorporate the comments, submitted by reviewers H. F. Shaw and C. N. Wilson; and (3) to include new knowledge gained during the recently completed study on the dissolution of UO_2 powder in J-13 water. Copies of the reviewed Task Plan were submitted to LLNL for an additional review and approval.

Saturated Tests with Unirradiated UO_2

The acquisition of a UO_2 specimen suitable for this task is still in progress. LLNL has issued a request to MCC to supply ANL with approximately 500 g of "single crystal UO_2," available from special material vaults at PNL. According to MCC, the delivery will be made upon the completion of requisite transfer documents. Any additional characterization of the crystals will be made at ANL. Among them are: the crushing of crystalline clusters in a mortar and pestle, separation of -4 +80 mesh fraction for the tests, determination of U/O ratio, and measurement of uranium isotope distribution.

Unsaturated Tests with Unirradiated UO_2

Current activities in this task are limited to experiments with four Zircaloy-clad UO_2 specimens that are supported by perforated stainless steel plates and contained in stainless steel vessels. EJ-13 water is dripped on top of UO_2 surfaces at a rate of 0.075 mL every 3.5 days. The first solution sampling/specimen inspection date is scheduled in mid-October.

Two additional alloys are under consideration by the YMP as potential materials for nuclear waste containers: CDA-715 and Incoloy-825. To investigate their performance under present test conditions, we will fabricate specimen support plates from these alloys and use them in the same manner as stainless steel plates in the present tests. Procurement sources for the alloys have been identified and fabrication arrangements are underway.

Electrochemistry of UO_2 Dissolution (Lawrence Berkeley Laboratory)

No activity to report this month.

Static and Flow-Through Dissolution Tests (Pacific Northwest Laboratories)

Work on flow-through experiments using depleted UO_2 pellet fragments to investigate the effects of water chemistry and other test parameters on the dissolution rate of UO_2 continued. Calcium and silicon in the water appear to cause substantial reductions (i.e., orders of magnitude) in uranium concentrations measured in flow-through experiments in comparison to measurements using deionized water or $NaHCO_3$ (171 mg/L) solution that do not contain calcium or silicon. It appears that a thin secondary phase or adsorbed layer forms at the UO_2 surface in the experiments using J-13 water or $NaHCO_3$ plus calcium and silicon, forming a barrier to UO_2 dissolution. Uranium concentrations measured in 25°C flow-through experiments (using either J-13 water or the $NaHCO_3$/calcium/silicon solution at constant flow rates) decreased over a period of several weeks as the indicated surface layer was forming. The rate at which the surface layer formed appeared to be accelerated when the temperature was raised to 85°C.

The surfaces of UO_2 particles that were removed from flow-through columns at various times have been examined using an Auger microprobe. Auger examination of particles from columns where uranium concentrations had dropped to the detection limit (~0.1 ng/mL) showed silicon and calcium to be present with uranium to a depth of ~100 Å. This thin surface layer was not visible during a scanning electron microscopy examination. This thin surface layer was not visible during a scanning electron microscopy examination.

Remote precipitation of uranium-bearing phases may also be occurring in flow-through columns run with calcium/silicon-containing water compositions, making it difficult to directly relate UO_2 dissolution rates to the uranium concentrations measured in these tests. Dark stains and clear, gelatinous-appearing phases have been observed on fritted, porous, stainless steel disks used at the exit of the flow-through columns. Analysis of nitric acid used to strip a disk from a column operated for several weeks in $NaHCO_3$/calcium/silicon solution indicated the presence of a significant quantity of uranium. The uranium may have originated from a few UO_2 grains trapped by the disk or from uranium-bearing secondary phases that were apparently stable at uranium concentrations of 0.1 ng/mL or less, which is much lower than the steady-state uranium concentrations of ~700 ng/mL measured in stainless steel vessels and J-13 water under static conditions. If flow-through methods are to be used to measure fuel matrix dissolution rates and the degree of preferential dissolution of soluble nuclides, it will be necessary to establish conditions for these tests under which remote precipitation of uranium-bearing phases does not occur.

A flow-through column that had reached very low uranium concentrations in $NaHCO_3$/calcium/silicon solution was switched to deionized water; after several days the uranium concentration approached a higher steady-state level than was previously measured in deionized water. Uranium concentration in a similar column that was switched back to $NaHCO_3$ solution rapidly increased to levels previously measured in the same $NaHCO_3$ solution. Auger examination of particles from these two columns suggested partial dissolution of the calcium/silicon/uranium surface phase in the column switched to deionized water and complete dissolution of the calcium/silicon/uranium surface phase in the column switched to NaHCO3 solution.

Development of a negative ion mass spectrometry procedure for ^{99}Tc (as TcO_4^-) appears promising. Runs using a ^{99}Tc standard indicate that the detection limit may be on the order of 10^7 atoms of ^{99}Tc and concentrations in samples from flow-through tests with spent fuel are expected to be on the order of 10^{10} atoms/mL. A ^{97}Tc spike needs to be calibrated and measurements need to be made using actual samples from spent fuel dissolution to check for interferences.

Zircaloy Cladding Corrosion (R. Stout, P.L.)

Stress Analysis of an Oxide Film on a Zircaloy Cladding (LLNL)

An analysis to model the elastic plus creep material response of a Zircaloy tube surrounded by a thin oxide film continued. The model provides for a coupling between Zircaloy creep deformation and oxide film fracture response. An analytic solution has been derived for the partial differential equations of the model. Because the Zircaloy fuel rods have a distribution of initial conditions (i.e., oxide film thickness, cladding dimensions, internal fission gas pressure, irradiation damage) and different rods of the same kind may potentially have different repository temperature histories, the solution procedure is being formulated with methods from stochastic differential equations. This will permit, in a probabilistic sense, a conservative model for Zircaloy cladding failure rate that would result from stress corrosion cracking. The conservatism is established by equating the cladding failure time to the time at which the oxide film first fractures. The rationale for this shorter failure time is because the fracture of the oxide film surrounding the Zircaloy is being observed at PNL as the critical step for the initiation of the stress corrosion cracking response in Zircaloy cladding.

Zircaloy Hydride Modeling (LLNL)

A write-up of a simplified deformation-thermodynamic model for hydride precipitation kinetics continued. The model considers the deformation from the formation of zirconium hydride platelets as a discontinuity displacement in the lattice structure. This means that the deformation response due to hydride platelets of various orientations can be coupled into the thermodynamics of hydride precipitation by a stress work term. In the thermodynamics, a thermodynamic chemical potential is a functional, and according to existing experimental evidence, it has different values for different sizes and orientations of the hydride platelets.

For Zircaloy cladding, the two commonly observed orientations for hydride platelets are circumferential and radial. A model and experimental data to describe the kinetics of transitions from one orientation to the other are necessary to predict cladding failure rates due to hydride platelet precipitation and growth.

Zircaloy Modeling of C - Ring Experiments (Bryan Chin, Auburn University
Conceptual model development to predict the anticipated damage to the Zircaloy cladding during storage in a Tuff repository is continuing. Work involved determining the sensitivity of the predicted oxide stress to temperature of formation, internal fission gas pressure, thickness of oxide formed and conditions under which stress relaxation occurs. Preliminary results indicate that internal pressure of the fission gas was the variable that affects the stress in the oxide film the most. Temperature of formation and conditions of relaxation were found to only slightly affect the predicted stress in the oxide film. The hoop stress in the oxide film decreases by less than 10% as the temperature decreases during storage by 250°C. The oxide stress was found to be a function of oxide film thickness. The thinner the layer of oxide the higher the predicted stress. Oxide film stresses were all found to be compressive in nature.

Zircaloy Cladding Corrosion Degradation (Pacific Northwest Laboratories)
C-Ring Experiments
Review comments are being incorporated into a draft of a paper, An Interpretation of the High-Stress, Low-Temperature Cracking of Zircaloy-4 Spent Fuel Cladding. It is reported in the paper that the data fall on a straight line on a log(t) vs. % yield stress plot, where t is the time to failure of the C-ring.

Pressurized Cladding Stress Corrosion Cracking Test
The experiment to establish a correlation between strain and fracture of oxide on the surface of Zircaloy will be performed in early September. During the experiment, strain gauges will be used to measure the hoop strain of the internally pressurized, oxidized cladding. To detect oxide fracture, the electrical resistance between the specimen and the synthetic J-13 well water will be measured. Polymeric insulation will be used to electrically isolate all but the oxidized cladding surface, so that the electrical resistance between the specimen and water, originally high, will drop suddenly when the oxide fractures. Acoustic emission monitoring will be performed during the experiments as a complimentary method to resistance change. After the tests, the methods will be compared to see which gives the clearest indication of failure for the effort involved.

Work is under way on the pressurized tube test plan for the pressurization experiments of actual spent fuel sections immersed in J-13 water to simulate the tuff repository environment. The plan is expected to be completed in September.

Fluoride/Cladding Interaction Test Development
Work continued on an activity plan for the Fluoride/Cladding Interaction Test.

Carbon-14 Release and Concentration Profiling for Spent Fuel Cladding
Work continued on an activity plan for the carbon-14 thermal release work. The procedure, "Thermal Release Rate Measurements for Carbon-14 and Tritium from Irradiated Materials", will be incorporated into that plan.

SPENT FUEL OXIDATION (Pacific Northwest Laboratories)
TGA Tests
Both TGA systems are undergoing long-term stability tests. Preliminary investigations confirmed by pressure measurements and short-term gas samples indicate that the system leaks have been eliminated. No further reports will be made on the activity until the stop work order is lifted.

Dry Bath Test

An interim weighing was conducted at the end of August. Preliminary evaluation of the weights indicated nothing unusual. The O-ring seals on the sample protectors were changed as a precaution against sample contamination caused by cracking due to radiation embrittlement.

If hydration can be ruled out by future x-ray diffraction and transmission electron microscopy examinations, it appears that there is a small average increase in the weight gain when the spent fuel is oxidized in a moist atmosphere. BWR fuel also appears to initially oxidize faster than PWR fuel, but this appears to be just a grain size effect and may have nothing to do with the type of fuel.

Oxidation Model Development (LLNL)

Statistical model development for oxidation kinetics of UO_2 spent fuel continued. The important physical mechanisms currently being observed during the initial oxidation process appear to strongly depend on grain boundary oxidation and grain volume oxidation phenomena. Thus, the species density of grain boundaries and their associated relationship to the grain volume is being represented in terms of statistical mechanics concepts. This statistical approach is well suited for describing dual rate kinetics where the magnitudes of the rates for the individual kinetics of grain boundaries and grain volumes are different. In addition, a statistical description based on observable physical attributes should be easier to relate to other physical mechanisms and states of UO_2 oxidation for the distribution of spent fuel that will be stored in a repository. Preliminary analysis was completed on the oxidation problem for different sizes of UO_2 fragments from fractured spent fuel pellets in a fuel rod.

MAJOR ACTIVITIES UPCOMING NEXT THREE MONTHS

Readiness Reviews of Activities D-20-44 and D-20-45 for TGA and Oven Bath oxidation Testing will be held in September, 1989.

Complete oxidation and hydride modeling papers for MRS meeting during November, 1989.

A procedure TIP-YM-2 entitled "Collect, Store, and Distribute Water from Well J-13" will be submitted for review and approval in September, 1989.

Test plans for pressurized cladding testing, fluoride-Zircaloy testing, carbon-14 release testing, and a revision of a test plan for Series 5 dissolution testing from PNL are being written and should be completed by September/October (89).

PROBLEM ISSUES

Redirection of staff to meet new QA requirements has delayed conceptual model development.

MILESTONE PROGRESS

Milestone R205,(9/89), a report on the results of spent fuel leaching at 85°C has been returned to the author for revision at PNL.

Milestone P111 (10/89), initiation of dissolution testing of partially oxidized spent fuel will not be conducted as part of the LLNL program supported at PNL. It is being funded at PNL by RTP (Chicago).

Milestone P250 (10/89), initiation of parametric dissolution tests of spent fuel (Series 5 tests at ANL), is on schedule; however, issues that may arise from planned readiness review could result in a delay.

The new Scientific Investigation Plan (SIP) for YMP WBS Element 1.2.2.3.1.1 (1989) Rev. 1, was approved at LLNL and is at YMPO for approval. The SIP was written to comply with the

existing Quality Assurance requirements and QA Level assignments of the activities being planned and conducted in the Spent Fuel Waste Form Modeling and Testing technical area.

Activity Plans D-20-44 and D-20-45 for oxidation testing were written and distributed for comments. All comments that have been received have been addressed. The spent fuel oxidation testing will be performed at Pacific Northwest Laboratories.

W.B.S. 1.2.2.3.1.2 WASTE FORM TESTING & MODELING - GLASS
F.J. Ryerson, P.I. (acting)

OBJECTIVE

This task involves the measurement of the radionuclide release from borosilicate glass; these are to be used as input for the performance modeling of long-term radionuclide release from the waste package.

ACTIVITIES AND ACCOMPLISHMENTS

D-20-27 Unsaturated Testing
The N2 tests (SRL-165 glass) continued as scheduled with no sampling periods occurring this month. The N3 tests (ATM-10 glass) continued as scheduled with no sampling periods occurring this month.

No analyses of the test components form the ATM-10 test components have been conducted due to the reduced work order. This will cause a delay in the delivery of the report describing this work.

D-20-28 Static leach testing of DWPF and WVDP glass
The Study Plan describing the methodology to perform vapor phase hydration in support of static leaching testing has been completed and is under review.

The Study Plan describing the methodology to perform static leaching tests is undergoing revision. Upon approval, static leach testing can be initiated once glasses of average and bounding compositions have been received. These glasses were requested from WSRC on 11/88, we expect to receive these glasses in the October-November '89 time frame.

D-20-29 Parametric studies of DWPF and WVDP glasses based on the unsaturated test
The parametric tests are ongoing, and a study plan to continue these tests is being prepared. A paper describing the parametric experiments has been submitted for the MRS meeting in November.

D-20-30 Parametric studies of DWPF and WVDP glass
To support the development of a study plan for the vapor phase hydration/leach tests a preliminary set of experiments was continued 7/28/89. SRL-165A and ATM-10 glasses, both of which contain transuranics, had been subjected to vapor phase hydration at 90-200°C, over time periods from a few days to over half a year. These glasses had been in dry storage until recently when they were examined to determine the extent of hydration. The examination was done using a stereomicroscope and the extent of hydration ranged from minimal in the 90°C samples to heavy in the 200°C samples.

Twenty-eight day MCC-1 leach tests were conducted on all glasses except those that were most heavily hydrated (these glasses were reserved for further surface characterization). The 28-day test was completed on 8/25/89. At termination, the following aliquots were extracted for analysis. Samples were taken for pH, anions, cations, U and transuranics. An additional aliquot was taken for the most heavily hydrated samples for filtering through a 1.8 nm filter. After these aliquots were taken, all of the solution had been consumed. The vessels were then subjected to an acid strip which was analyzed for U and transuranics. the glass samples were removed from the vessels, dried, and weighed.

Results to date indicate that the total transuranic release for the most heavily hydrated samples is 200-500 times larger that for non-hydrated samples. SRL glass showed greater release after 28 days than did the ATM glass because the SRL hydrated layer lacked structural stability and separated from

the surface during leaching. pH values closely tracked the extent of leaching, with the most highly hydrated samples attaining a ph of ≈9.2. These results indicate that a large release pulse is generated when vapor phase aged glasses are exposed to liquid water.

D-20-31 Studies of glass surface layers and precipitation
As was reported last month, the newly installed Kratos quadropole looks promising, but has not operated properly. The spectrometer was not properly configured during installation, and Kratos staff people are continuing to look into the problem.

D-20-32 Geochemical Interactions
Flow-through experiments on a simple analogue glass have been completed and the solution data reduced. This work forms the basis of an MRS paper this Fall. Characterization (by FTIR, XRD, SEM and nuclear reaction depth profiling) of the recovered glass from these experiments is underway. The rate constant for dissolution is a strong function of solution pH reaching a minimum for a given temperature near neutral pH's. Similarly, the release of elements from the glass is also pH dependent. At pH's below 7 elemental release can be incongruent with alkalis being released faster than silicon; as such, a thick gel layer is formed. At pH higher than 7, leaching is congruent. This suggests that leaching under proposed repository conditions may be modeled as congruent dissolution.

A series of static leaching experiments on the simple analogue glass in Dickson autoclaves has also been completed and the data are being analyzed. Characterization of the reacted glasses is underway.

MAJOR ACTIVITIES UPCOMING NEXT THREE MONTHS

Revision of the SIP will continue. Activity plans for D-20-27, D-20-28, D-20-32 will be drafted and submitted for approval. Flow-through tests on SRL-165 will commence. Static leach testing of vapor-phase aged glasses will commence.

PROBLEMS/ISSUES

DWPF glass samples are needed before testing can begin

MILESTONE PROGRESS

2R32 Preliminary leaching database

Level I batch mode unsaturated tests are completed, and awaiting final QA readiness review before analysis of solids can begin.

2R22 Preliminary glass kinetics models

A report "Geochemical Modeling of Radioactive Waste Glasses Dissolution Using EQ3/6: Preliminary Results and Data Needs" has been submitted to YMPO for approval. An improved model has been developed and the results will be presented at the Fall MRS meeting. New flow through data will be used in future models.

2R31 Glass leaching database

Activity plans for saturated testing have been completed.

WBS 1.2.2.3.4.1 WASTE FORM MODELING & TESTING - INTEGRATED TESTING
M. ten Brink, Acting P.I.

OBJECTIVE

The purpose of this task is to conduct tests and experiments that will yield an understanding of the performance of the waste package system in the repository environment. Emphasis is placed on multi-component tests and on examination of natural analogs.

ACTIVITIES AND ACCOMPLISHMENTS

Tuff wafer experiment
Experimental and analytical efforts continued towards determining 1) the heterogeneity of the tuff pore structure 2) the major element and mineral distribution on the same scale as U measurements and 3) the size distribution of colloidal and dissolved U in the doped groundwater. A Coulter Electronics acutocorrelated photon spectrometer was brought in for demonstration and attempts made to determine the size of colloidal particles in a number of actinide/J-13 water solutions. Further information was also gathered about the composition of colloidal material present in glass leachate and in NTS well waters.

Core flow through experiment
Discussion, information exchange, and collaboration between integrated testing and other geochemical efforts at LLNL and LANL were increased following the visit of M. ten Brink to LANL late in July. Reports and SIPS received from LANL were read and circulated. Changes in the emphasis of Integrated Testing that could take advantage of the LANL expertise were discussed. The design for a diffusion cell was also finalized and fabrication began at LLNL.

Planning and test development
The ion microscope was disassembled this month for major maintenance. A significant improvement of depth profiling abilities was noted after re-assembly. Delivery of a duplicate copy of the operating system's software was finally obtained from Hewlett Packard for the HP9000. The HP9000 was obtained from YMP surplus. Bringing the entire system on line will greatly increase the data reduction and graphics ability of the ion microscope. James Wong, also began learning the software and hardware of the ion microscope.

MAJOR ACTIVITIES UPCOMING NEXT THREE MONTHS

During the next few months, a new SIP for the Integrated Testing activities will be written. Tuff samples will also be prepared for ion implantation in order to calibrate the sensitivity factor on the ion microscope for elements of interest.

PROBLEMS/ISSUES

None

MILESTONE PROGRESS

No near-term milestones.

WBS 1.2.2.3.2 METAL BARRIER SELECTION AND TESTING TASK,
R. D. McCright, PI

OBJECTIVE

The goal is selection of a metallic material for fabrication of waste containers and characterization of the material behavior under expected conditions and environments. Test data derived from this work will be used in performance assessment modeling and for licensing. Current emphasis is on two alloy systems: (1) Fe to Ni-base austenitic alloys, and (2) Cu and Cu-base alloys.

ACTIVITIES AND ACCOMPLISHMENTS

Task Management

The Metal Barrier Task members participated in two inter-technical area meetings to discuss the interplay of various activities in the technical areas as they input into Performance Assessment Technical Area. In particular, information feeds on model developments as they occur were encouraged rather than waiting until the model development and integration are complete in each technical area before passing this information on to performance assessment. The Metal Barrier task therefore defined some intermediate milestones for information transfer between the tasks.

Metal Barrier staff were invited to participate in the August 30 meeting of the Performance Assessment Technical Integration Group PATIG) at Las Vegas. Three presentations were made: (1) Overview and organization of Container Modeling and Development (Will Clarke), (2) Status of Container Material Selection (Bill Halsey), and (3) Status of Container Performance Modeling (Joe Farmer).

W. G. Halsey attended a meeting of the OCRWM Graduate Fellows at Las Vegas, NV on August 15. He made a presentation on the waste package and container work conducted at LLNL.

Task Quality Assurance

At the request of the TPO, the Metal Barrier Selection and Testing Scientific Investigation Plan (SIP) was revised (Rev 1) to reflect the changes in QA level assignments made in April 1989 in accordance with the new Quality Assurance Program Plan (QAPP) and new Quality Procedures (QPs). The original SIP (Rev 0) was written in early 1987 and approved by the Project office in November 1987. The designations and technical scopes of activities in Rev 1 remain the same as in Rev 0. Some revisions in the descriptions for Degradation Mode Surveys and for Establishment of Criteria for Metal Barrier Selection were made to be consistent with details of the work accomplished in the last two years. The revised SIP is in internal technical review. Approval of activity plans and readiness reviews is contingent on completion of the revised SIP.

The Metal Barrier task staff participated in the training session for QP 12.0 Rev 1 on Calibration of Measurement and Testing Equipment and the session on AP 15.3Q on Readiness Reviews. These sessions were held August 31.

Degradation Mode Surveys

All nine volumes of the degradation mode surveys covering discussion of the possible degradation modes that can affect the six candidate materials under Yucca Mountain repository environmental conditions have been typeset in anticipation of Project office approval.

Work continues on extending the survey to include other materials that may be considered for more robust waste package designs, either as thin-walled single metal containers or as two-metal configurations.

Coordination with Design, Fabrication and Prototype Testing Task
Metal Barrier task and Design task staff met with representatives from Babcock and Wilcox (B&W) on August 3 to plan the portion of the B&W effort that will support meeting the container material selection milestone in the spring of 1990. This work will involve producing friction welds on three of the candidate materials, as well as some other fabrication and closure work aimed at minimizing the amounts of alloy constituent segregation in the weld region.

Metal Barrier task also participated in discussions involving the container cost estimate study (to be undertaken in part by B&W), since this information will also be used in evaluating and comparing the container materials for the selection activity.

Metal Barrier task staff met with James A. Vaughn and Jerry Van Tillburg, AMAX Corporation, on August 7. AMAX produces low-oxygen, phosphorus-deoxided coppers that offer some combined advantages of CDA 102 and CDA 122. These materials may be considered in some of the fabrication and closure process evaluation studies because of improved weldability.

Selection Criteria
W. G. Halsey presented a talk on the container material selection process to the PATIG meeting on August 30. His talk included the background on the candidate materials, the degradation mode surveys, drafts of the selection criteria, and the peer review panel report. He outlined the future work and schedule for this activity. Formal re-start of this activity at QALA I is awaiting approval from the TPO and YMPO.

Model Development
J. C. Farmer presented a paper entitled "Models for Predicting Performance of Waste Package Containers" at the Structural Mechanics and Material Properties in Radioactive Waste Repository Technology (SMiRT) Conference in Anaheim, CA on August 22. The conference contained contributions from the USA, Switzerland, Federal Republic of Germany, Finland, Belgium, Japan, Canada and other countries.

Work continues to complete an activity plan for model development. The first part of the work will be a survey of existing models for localized corrosion (includes pitting and crevice attack) and for environmentally assisted cracking (includes hydrogen embrittlement and stress corrosion cracking) and determining their applicability to Yucca Mountain conditions. Emphasis will be placed on models that have successfully predicted service lifetimes over decades of years (e.g. marine structures, light water reactor components). This work was outlined in J. C. Farmer's presentation to the PATIG on August 30.

Technique Development
Technical implementing procedures (TIPs) are being developed for experimental work that will be performed on some of the new equipment discussed under parametric studies (next section). These TIPs include preparation and testing of compact tension specimens for crack propagation studies under plane strain conditions.

Parametric Studies
Approval of the start-up of some new work (at QALA II) in this activity is awaiting TPO sign-off. Metal Barrier staff are awaiting delivery on a reversing direct current crack propagation monitoring system, built by the GE corporation of San Jose, CA. This system will permit simultaneous monitoring of growing stress corrosion cracks in six different specimens. Two test chambers, each containing three specimens, are included in the system, so that different environments can be specified or different families of alloys can be tested. (It is imprudent to test copper-base and Fe-Cr-Ni "stainless" types of materials in the same vessel because of cross contamination.)

Work is continuing under subcontract at Argonne National Laboratory in two areas: (1) stress corrosion crack initiation and propagation studies using sensitive techniques to discern differences in behaviors among the candidate materials, and (2) radiation enhanced corrosion and oxidation studies on the candidate materials with emphasis on understanding the radiolysis mechanisms and radiolysis products that are formed. Both studies will support the container materials selection activity. Because these studies are currently being upgraded from QALA Level III to Level II, a considerable amount of effort has gone into preparing a QAPP at ANL. A QA surveillance of the ANL work is planned. Activity plans for the Metal Barrier portion of the work will be prepared upon receipt of Statements of Work from the ANL principal investigators for work proposed in FY-1990.

Container Material Selection
There is no progress to report this month since the start of this activity is linked to completion of the selection criteria document.

MAJOR ACTIVITIES UPCOMING IN NEXT THREE MONTHS

Metal Barrier task will continue to write activity plans for QALA Level I and II activities and conduct readiness reviews of these activities as appropriate.

PROBLEMS/ISSUES

Multiple activities are awaiting readiness reviews and approvals before start up.

MILESTONE PROGRESS

Milestones are on schedule.

WBS 1.2.2.4.2. CONTAINER MATERIALS, FABRICATION AND CLOSURE
E. Russell, P.I.

OBJECTIVE

To develop, analyze, fabricate and test waste package designs that incorporate qualified materials and that are fully compatible with the repository design in order to support license application by demonstrating conformance with requirements for safe handling emplacement, possible retrieval, and credible accident conditions per 10 CFR 60 and 40 CFR 191, in a cost efficient manner.

ACTIVITIES AND ACCOMPLISHMENTS

Container Fabrication/Closure Process Development Activities: A Progress Review of these activities, subcontracted to Babcock and Wilcox, was held on August 3 at LLNL. This meeting consisted of three sessions, and the major discussion/action items are as follows:

1) Container Cost Estimate Study: Out of twenty vendors identified as potential suppliers of data for this study, the three vendors chosen are WELDCO,Youngstown,OH; Joseph Oat Corporation, Camden,NJ; and B&W Commercial Nuclear Nuclear Division, Lynchburg,VA. A package was sent to the above vendors, consisting of detailed drawings, specifications, and and QA requirements, for the purpose of supplying the necessary container information for the study. A methodology developed by B&W and approved by LLNL will insure that the data is presented in sufficient detail and uniformity so that it can be compared from one vendor to another. Receipt of the data at B&W is expected by 8/31/89.

2) Accelerated Friction Welding and Cold Work feasibility Studies: The FY89 deliverables associated with these activities are prerequisite to FY90 activities that will be conducted to support the Metal Selection milestone of April, 1990. The subject activities are on schedule, with deliverables expected by 9/29/89.

3) Discussion of B&W FY90 Work Scope and Budget: Activities that must be completed by the Metal Selection milestone were identified. Follow-up activities for the completion of phase 2 of the container fabrication/closure process development in FY90 were also identified.

Container Closure Nondestructive Evaluation Activity:
This activity is not in work due to curtailment of funding.

Parametric Studies:
1) A report, "Preclosure Criticality Safety Analysis for the Yucca Mountain Repository", SAND-7010, was reviewed, and discussed at a meeting at BNI on 8/25.

2) A Preclosure Criticality Safety Analysis meeting in San Francisco was attended by Ed Russell on August 25.

MAJOR ACTIVITIES UPCOMING IN NEXT THREE MONTHS

Container Fabrication/Closure Process Development Activities:
1) Container Cost Estimate Study: Delivery of container cost estimates with cover letter to DOE/HQ by 10/2, with a schedule for completion of the formal report.

2) Phase 2 Container Fabrication/Closure Process Development FY90 activities: Commitment of funds for ordering long-lead hardware necessary for delivery of timely data in support of Metal Selection Milestone by 9/25; and development of scope and budget by 9/29.

Container Closure Nondestructive Evaluation Activity:
Development of an Activity Plan per QP 3.0 requirements by mid-October.

Parametric Studies:
Development of scope and budget required for FY90 studies in criticality, thermal, and structural analysis in September.

PROBLEMS/ISSUES

None

MILESTONE PROGRESS:

See discussion above for support of the Metal Selection Milestone (4/90), under Container Fabrication/Closure Process Development Activities.

WBS 1.2.1.4.5.L GEOCHEMICAL MODELING - MODEL DEVELOPMENT
K. Jackson/J. Johnson

OBJECTIVE

This task is the development of advance calculational capabilities for modeling geochemical processes in the repository environment. The work is being carried out by extending the capabilities of the existing EQ3/6 software. The applications objective is to support site, waste package, and performance assessment through calculations of solubilities, rock/water interactions, etc., leading to long-term predictions of geochemical behavior necessary for the DEIS and license application.

ACTIVITIES AND ACCOMPLISHMENTS

Code and Development

Work delayed pending approval of the Software Quality Assurance Plan (SQAP). A meeting was held on August 8-10, 1989, with representatives of the Yucca Mountain Project Office (YMPO) to discuss informal comments by YMPO on the LLNL SQAP. Agreement was reached on the direction to proceed and LLNL personnel proceeded to make detail changes to the SQAP. Completion of change effort is expected in the first part of September, with approval by YMPO to follow shortly thereafter.

Data Base Development

James W. Johnson became the Task Leader for this effort on August 1, 1989.

Hands-on development of the SUPCRT software package was continued in collaboration with Dr. H. C. Helgeson, U.C.-Berkeley. The associated SUPCRT data base, an essential subset of the LLNL thermochemical data base, has just been augmented by Dr. D. A. Sverjensky, Johns Hopkins, to include a large number of important organic and inorganic aqueous complexes previously unavailable. Updated versions of selected SUPCRT routines and the augmented SUPCRT data base will be incorporated into LLNL's capabilities in the near future.

Interaction coefficients were input into the AQBDOT table in the MDAIN data base, and DATAØ files with an alternate activity coefficient formalism were tested and run through EQ3NR and EQ6.

A data base requirements document was prepared based upon a review of the CHEMVAL project report. The consolidation of logk values in MDAIN data base will add flexibility to the DBAPP/OUTPUT options. This activity will allow LLNL to compare other thermodynamic data bases directly with the LLNL ones using multiple formats, yet not be subject to the limitations that the CHEMVAL project has.

Work continues on the preparation for publication of the data base manual.

Mirror programming actions were completed to allow the data base and the codes to be transferred from the Vax to the Sun computers.

Most of the difficult routines from the NIST CATCH program were coded and debugged. The entire program should be working in September, 1989. This will assist in completion of the data base.

Work continued on the new site-mixing models. Thirty-four new materials were added to the dataØ data base with the new format. Dimensioning problems with the new minerals were solved, and new data1 file was made to run EQ3NR test problems.

Code Maintenance, Documentation, and Release

A draft requirements scoping document was prepared for the possibility of adding a surface complexation model to the EQ3/6 codes. Planning was begun for the addition of this model to the EQ3/6 codes. Began reading in data for surface complexation mineral blocks from the input file and extracting data from a new file for surface species.

Work continued on incorporating ion exchange capability into EQ3/6. This capability was tested by running EQ3 jobs that exercise ion exchange options.

EQ6 runs were finished for Paul Cloke (SAIC) and Lynda Stabler (University of Florida) on the effects of metal container materials on the solubility limits of secondary phases of radionuclide concentrations predicted for J-13 water-wasteform interactions.

The new input file was changed so that gas fugacities can be specified, and the input file document was updated. Also added five tolerances and one debug option to the new input file. These parameters will be used with the new routines that process non-ideal solid solutions.

The requirements documented for GEODATA was completed and distributed for review. The end product of GEODATA will be the multiple column ascii file. Future plans will target the development of a "geochemists analysis program" that will be totally interactive and will not require any knowledge of individual applications.

MAJOR ACTIVITIES UPCOMING NEXT THREE MONTHS

Continuing work on validation and verification of the data base.

Complete changes to the SQAP to achieve its approval as soon as possible.

Preparation and approval of the necessary Scientific Investigation Plan (SIP), Activity Plans, and TIPs.

Successful completion of the Readiness Reviews.

Continuing work on code documentation and verification and validation projects.

Release of version 3245.0889 of the EQ3/6 code. (Ingress-based data base release.)

PROBLEMS/ISSUES

Code development work on the Quality Level 1 EQ3/6 code is delayed pending approval of the SQAP, Activity Plans, and TIPs, the preparation of revised SIP, and conducting successful Readiness Reviews.

MILESTONE PROGRESS

Internal technical reviews of the draft EQ6 User's Manual have begun. Subsequent to the review cycle, an updated version of the user's guide will be submitted to YMP to comprise completion of Milestone P314. **Code development milestones (e.g., L078, L084, L091, L092, and C395) will slip on a day for day basis during the stop work action.**

WBS 1.2.2.3.4.2 GEOCHEMICAL MODELING - THERMODYNAMIC DATA DEVELOPMENT
R. Silva, PI.

OBJECTIVE

The purpose of this task is to experimentally evaluate the thermodynamic properties of solids and solution species needed for geochemical modeling of waste form performance.

ACTIVITIES AND ACCOMPLISHMENTS

Hydrolysis and Carbonate Complexation of Pu(V)

The photoacoustic spectra of Pu(V) as a function of pH have been analyzed and the logarithm of the value of the first hydrolysis constant of Pu(V) was calculated to be 9.84 ±0.09. The inert atmosphere box is being converted to a CO_2 box for measurements of the carbonate complexation of Pu(V).

High-temperature Calorimetry and Spectroscopy (LLNL)

The new variable temperature titration calorimeter has been successfully operated at 50 and 65°C. It is in the process of being calibrated via the determination of the heat of protonation of tris (hydroxymethyl) aminomethane (TRIS). Replicate runs at 50°C yield a value about 9% higher than literature values with a reproducibility of 5–7%. The reason for the discrepancy

with the literature value is not known but is being sought. Cross check with the FSU calorimeter will be made with TRIS at 50°C next month. TRIS titrations at 65°C will be initiated next month.

High-temperature Calorimetry (Florida State University)
Water-water titrations have been performed as part of the calibration of the variable temperature calorimeter. The uncertainty in the measurements was ± 2 mjoules; the best achieved to date with this calorimeter. Calibration of the calorimeter via titrations of TRIS at 45°C has been initiated.

Solubility Studies
The equipment for the computer control of the pH and temperature of the solutions involved in the solubility measurements have been obtained and are being assembled and tested for installation in the new inert atmosphere boxes.

MAJOR ACTIVITIES UPCOMING NEXT THREE MONTHS

Complete all TIP's and Activity Plans.

Complete calibrations of calorimeters.

PROBLEMS/ISSUES

Awaiting completion of TIP's, Activity Plans, and Readiness Review.

MILESTONE PROGRESS

None due this period.

WBS 1.2.2.5.1 PERFORMANCE ASSESSMENT
W. O'Connell, P.I.

OBJECTIVE

The objective for performance assessment is to provide predictions of post-closure waste package performance in order to assess compliance with EPA and NRC regulations (40 CFR 191 and 10 CFR 60, respectively). These assessments will consist of deterministic and probabilistic analyses. A source term necessary for total system performance assessment will also be provided.

ACTIVITIES AND ACCOMPLISHMENTS

Review comments on NRC's draft GTP on the use of tectonic models were sent to YMPO on August 9th.

W. O'Connell attended a YMP meeting on starting a YMP Performance Assessment Implementation Plan, Aug. 24 in Albuquerque.

W. O'Connell and A. McIntyre attended the joint HQ/YMP Performance Assessment meeting in Las Vegas Aug. 30-31. Three members of the Metal Barriers Technical Area, W. Clarke, W. Halsey, and J. Farmer gave presentation. on the metal barrier selection process and on corrosion modeling.

MAJOR ACTIVITIES UPCOMING NEXT THREE MONTHS

Further activities in establishing readiness to start QA Level I work will include SIP revision, Activity Plan draft, establishment of procedures and training needs, and finalization of the LLNL Software QA Plan.

Long range planning network logic, interconnects, and resource loading will be ongoing.

Issuance of draft report M260 on performance assessment of WP conceptual design.

Finalization of enhancements to uncertainty methods model and revision of draft report.

PROBLEMS/ISSUES

The reduced budget this FY combined with a redirection of effort to meet QA program and long-range planning requirements have left little resources for the originally planned technical work and technical milestones. Schedules are being revised in light of available resources for technical work.

WBS 1.2.2.4.1 SPECIAL STUDIES - DESIGN AND ANALYSIS
L. Ballou, PI

OBJECTIVE

The objective for package design is to develop and analyze waste package designs that incorporate Yucca Mountain Project qualified materials and that are compatible with the repository design. The designs and analyses are needed to support license application by documenting conformance with NRC requirements for safe handling, emplacement, retrieval, containment, and release rate.

ACTIVITIES AND ACCOMPLISHMENTS:

None to report this period.

MAJOR ACTIVITIES UPCOMING NEXT THREE MONTHS

None to report this period.

PROBLEMS/ISSUES

None to report this period.

MILESTONE PROGRESS

None to report this period.

WBS 1.2.5.2.1 NRC INTERACTION SUPPORT
D. Emerson, PI

OBJECTIVE:

Support DOE interactions on the site program with NRC by providing information, coordination and support within the Project.

ACTIVITIES

L. Ballou attended a DOE/NRC meeting in Washington, D.C. on August 29 to discuss the term "substantially complete containment" as it relates to the 10 CFR 60 performance criteria.

WBS 1.2.5.2.2 SITE CHARACTERIZATION PROGRAM
D. Emerson, PI

OBJECTIVE

Support the DOE in the completion of the Site Characterization Plan. Provide ongoing technical planning and support of site characterization activities. Integrate results into site characterization activities and programs as appropriate, monitor each site program, serve as the interface between the principle investigator and the DOE/HQ.

ACTIVITIES

None to report during this period.

WBS 1.2.5.2.3 REGULATORY REVIEW
D. Emerson, PI

OBJECTIVE

Support DOE/HQ in the review of site aspects of proposed NRC regulatory changes. Review Project technical products to determine relationship and compliance with site-related requirements. Review DOE licensing positions and related technical reports.

ACTIVITIES

Review comments on NRC's Draft Generic Technical Position on Tectonic Models were sent to YMPO on August 10.

WBS 1.2.5.2.5 STUDY PLAN REVIEW AND APPROVAL
D. Emerson, PI

OBJECTIVE

Coordinate the Project and Headquarters reviews of Study Plans.

ACTIVITIES

LLNL Study Plans
Work is continuing to resolve the YMP comments on LLNL-SP-8.3.4.2.4.2, Hydrologic Properties of the Waste Package Environment. Revision of the Mechanical Attributes Study Plan 8.3.4.2.4.3 continues with the incorporation of comments received from the SAIC screening review.

Other Participant's Study Plans
Technical review of the study plan, LANL-SP-8.3.1.3.4.2.R1, Biological Sorption and Transport was sent to YMPO.

> LANL-SP-8.3.1.3.6.1, R0 "Dynamic Transport Column Experiments and LANL-SP-8.3.1.3.6.2, R0 "Diffusion" were received for technical review.

WBS 1.2.5.2.6 SEMI-ANNUAL PROGRESS REPORTS
D. Emerson, P.I.

OBJECTIVE

Provide support to DOE/HQ for the development and preparation of the Site Characterization Semi-Annual Progress Reports.

ACTIVITIES

None to report during this period.

WBS 1.2.9.1 PROJECT MANAGEMENT
L. Jardine, TPO

OBJECTIVE

Provide overall management of the LLNL Yucca Mountain Project activities including budgeting and financial analysis, progress reporting, support to YMPO and HQ management activities, training, and overall Project integration.

ACTIVITIES AND ACCOMPLISHMENTS

A meeting was held with YMPO, DOE-HQ, LLNL and subcontractor staff to develop summary level schedules based on the LLNL detailed long range planning networks. The results were developed that were to be used as input into a DOE-HQ OCRWM summary schedule.

L. Jardine presented the paper "Evaluation of Site-Generated Radioactive Waste Treatment and Disposal Methods for the Prospective Yucca Mountain Repository" at SMiRT 10, Anaheim, CA on August 17, 1989.

L. Jardine presented the paper "Preclosure Safety Aspects of a Geologic Repository" at SMiRT 10, Anaheim, CA on August 21, 1989.

L. Jardine attended a meeting on August 24, 1989 with YMPO, DOE-HQ and subcontractor staff to review and discuss a draft approach for developing a waste package program plan.

MAJOR ACTIVITIES UPCOMING NEXT THREE MONTHS

None to report this period.

PROBLEMS/ISSUES

None to report this period.

MILESTONE PROGRESS

No LLNL milestones on this WBS

WBS 1.2.9.1.4 RECORDS MANAGEMENT
B. Bryan, P.I.

OBJECTIVE

Establish and operate and LLNL Local Records Center that meets the requirements of the Quality Assurance Program Plan and other Project-level requirements, including receipt, retention, and protection of all records, issue of controlled documents, and operations of correspondence, logging, tracking, and distribution systems.

ACTIVITIES AND ACCOMPLISHMENTS

In the month of August, the Records staff continued processing all backlogged LLNL records through to the Central Records Facility. Our internal records database has been upgraded and all new capabilities have been used with success. We are continuing our task of acquiring fire cabinets for areas other than Records and Document Control.

The Quality Procedures for Records and Document Control have been revised and are in final typing to go for final review and approval.

LLNL comments on the Records Management Plan were sent to Carl Gertz from Les Jardine on August 24, 1989 (LLYMP8908217).

Document Control issued four change notices to the QA Plan. Follow-up for receipt acknowledgements continued.

MAJOR ACTIVITIES UPCOMING NEXT THREE MONTHS

Efforts will continue to refine our daily procedures in handling records. Acquisition of fire cabinets should be completed by the end of September. Efforts will be directed to upgrading the Document Control database, creating menu driven items. No other major activities are scheduled.

PROBLEMS/ISSUES

None.

MILESTONE PROGRESS

This activity does not produce milestones

WBS 1.2.9.2 PROJECT CONTROL
J. Podobnik P.I.

OBJECTIVE

This task manages and coordinates all LLNL Yucca Mountain Project activities to be consistent with the goals and objectives of the overall DOE Yucca Mountain Project, including planning, technical direction, cost, and schedule control.

ACTIVITIES AND ACCOMPLISHMENTS

Completed first phase of long range planning effort. Products consist of Summary Schedules, Intermediate Summary Schedule, and detailed Long Range Plan.

Reviewed three candidate software systems for integrated cost/schedule control. Selected Prima Vera with PrimaVision, and Parade modules.

Completed on-site PACs training and developed interim procedures for generating input.

Completed first draft of Information Technology Report - Short Range Plan.

Initiated processing capital equipment requests.

MAJOR ACTIVITIES UPCOMING NEXT THREE MONTHS

Complete FY 89 accounting close.

Develop first edition of PACs input.

Convert existing scheduling database to Prima Vera.

Re-configure existing computer systems to support Prima Vera and PACs systems.

Develop FY90 working budget.

PROBLEMS/ISSUES

None

MILESTONE PROGRESS

No milestones for this WBS activity.

WBS 1.2.9.3 Quality Assurance
D. Short, P.I.

OBJECTIVE

The objective of Quality Assurance is to develop, implement, and maintain a Quality Assurance Program Plan in accordance with requirements set forth in the YMP QA Plan, NVO-196-17, and the Project Administrative Procedures.

ACTIVITIES AND ACCOMPLISHMENTS

QA Audit Finding 87-7 No. 6 was closed on August 1,1989.

The report of LLNL-YMP QA Audit 89-10, Procurement Document Control, Document Control and QA Records which was conducted July 25-28, was transmitted to NVO on August 2. No nonconforming conditions were identified during the audit; however, several Observations were included in the report and are being reviewed by cognizant LLNL-YMP personnel.

Procedure QP 2.9 Revision 1, Indoctrination and Training, incorporating Change Notices 2.9-0-1 to 2.9-0-3, was transmitted on August 4, 1989 for internal review.

Procedure QP 2.10 Revision 1, Qualification of Personnel, incorporating Change Notices 2.10-0-1 to 2.10-0-2, was transmitted on August 4, 1989 for internal review.

LLNL-YMP completed the review of Draft Interim Change Notice No. 1 to Administrative Procedure AP-1.1Q and advised SAIC that we had no comments.

A draft of a proposed procedure for Special Studies, QP 2.12, Special Scientific Studies and Other Projects, was transmitted for internal review on August 11, 1989.

LLNL responded on August 11, 1989 to NRC comments on the LLNL-YMP QAPP. Change Notices were initiated to affected section of LLNL's QAPP and recommended changes were incorporated. For NRC Comment No. 1, clarifications were introduced into the wording to make the recommended changes implementable with the LLNL QAPP.

QA Surveillance S89-16, Procurement of Materials for Activity E-20-18, was completed with no nonconforming conditions identified.

A Letter of Agreement between the LLNL Electronic Services Group and LLNL-YMP, addressing QA Program implementation for instrument calibration services, was finalized on August 22, 1989.

The draft of proposed QP 16.3, Quality Concerns and Exit Interviews, prepared in response to a recent change in our QAPP and the forthcoming YMPO AP 5.8Q, was distributed for internal review on August 24, 1989.

A draft of proposed Readiness Review Dates was distributed internally on August 22, 1989 in preparation for the coordination of Readiness Reviews and the training of LLNL participants to AP 5.13Q.

LAWRENCE LIVERMORE NATIONAL LABORATORY
YUCCA MOUNTAIN PROJECT

MONTHLY TECHNICAL HIGHLIGHTS AND STATUS REPORT
SEPTEMBER 1989

TABLE OF CONTENTS

1.2.1 Systems
WBS 1.2.1.2.4. Systems Engineering (Revelli)

1.2.2 Waste Package
Near Field Environment Modeling and Testing (Wilder)
WBS 1.2.2.2.1 Geochemistry and Mineralogy (Glassley)
WBS 1.2.2.2.2 Near Field Hydrology & Transport (Wilder)
WBS 1.2.2.2.3 Man Made Materials Effects (Wilder)
WBS 1.2.2.2.4 EBS Prototype Testing (Ramirez)
WBS 1.2.2.2.5 ESF EBS Testing (Ramirez)

Waste Form Modeling and Testing (Shaw)
WBS 1.2.2.3.1.1 Spent Fuel (Stout)
WBS 1.2.2.3.1.2 Glass (Ryerson)
WBS 1.2.2.3.4.1 Integrated Testing (ten Brink)

Container Materials Modeling and Testing (Clarke)
WBS 1.2.2.3.2 Metal Barriers (McCright)
WBS 1.2.2.4.2 Fabrication and Closure (Russell)

Geochemical Modeling (Aines)
WBS 1.2.2.5.2 Model Development (Jackson/Johnson)
WBS 1.2.2.3.4.2 Thermodynamic Data Development (Silva)

Performance Assessment (O'Connell)
WBS 1.2.2.5.1 Performance Assessment (O'Connell)

Special Studies (Ballou)
WBS 1.2.2.4.1 Design and Analysis (Ballou)

1.2.5 Regulatory Interactions
WBS 1.2.5.2.1 Regulatory Interactions (Emerson)
WBS 1.2.5.2.2 SCP (Emerson)
WBS 1.2.5.2.3 Regulatory Compliance Documentation (Emerson)
WBS 1.2.5.2.5 Study Plan Coordination (Emerson)
WBS 1.2.5.2.6 SCP Progress Reports (Emerson)

1.2.9 Project Management
WBS 1.2.9.1.1 Project Management (Jardine)
WBS 1.2.9.1.4 Records Management (Bryan)
WBS 1.2.9.2 Project Control (Podobnik)
WBS 1.2.9.3 Quality Assurance (Short)

1.2.1 SYSTEMS

WBS 1.2.1.2.4 SYSTEMS ENGINEERING
M. Revelli, P.I.

OBJECTIVE

The Systems Engineering task will coordinate the integration of LLNL technical activities into the Yucca Mountain Project Technical Baseline to support the development of a Yucca Mountain Mined Geologic Disposal System that meets DOE and regulatory requirements. This task also supports the Project-wide development and implementation of a Yucca Mountain Systems Engineering Management Plan (SEMP) that contains detailed site-specific systems engineering procedures used to meet the unique needs of the Project, as well as the requirements established in the OGR SEMP.

ACTIVITIES AND ACCOMPLISHMENTS

LLNL completed a review of the final (August 1989) draft of OCRWM's Transportation System Data Base for the Civilian Radioactive Waste Management Program. This review was conducted in accordance with QMP-06-03 and Document Review Sheets, with LLNL comments, were forwarded to YMPO.

Proposed responses to LLNL's AP-5.1Q comments and a revised draft of the procedure were received from SAIC. LLNL is currently reviewing this material to assess the impact of the data transfer requirements on LLNL's existing Quality Procedures. Disposition of these comments will be completed next month.

LLNL staff initiated a review of the draft Waste Package/Repository Interface Control Drawings proposed by SNL. This information will be checked against reference and alternate waste container concepts, waste canister specifications, and inertial welding closure and NDE concepts. Review comments will be forwarded to SNL in October and the proposed changes should be discussed at the next Design Integration Group meeting.

Verification of the Yucca Mountain Mined Geologic Disposal System Requirements (SR) document is in progress to assure that LLNL comments were adequately addressed. During this review, a number of other significant changes to Waste Package sections of the SR document were also identified. LLNL has advised the Project Office of its plan to complete this verification review and evaluate the other changes to assess their appropriateness.

MAJOR ACTIVITIES UPCOMING NEXT THREE MONTHS

LLNL will continue to work with the Project Office and other participants to revise the draft YMP/AP-5.1.Q for the "Control and Transfer of Technical Data on the Yucca Mountain Project".

Comments on the draft Waste Package/Repository Interface Control Drawings will be forwarded to SNL.

The verification review of the Yucca Mountain SR document will be completed.

Analysis of the expanded Spent Fuel Receipt Scenarios study will be completed and the results will be documented.

1.2.2.2 WASTE PACKAGE

WBS 1.2.2.2.1 GEOCHEMISTRY AND MINERALOGY
W. Glassley, P.I.

OBJECTIVE

The objective of this task is to develop a model of the geochemical and mineralogical behavior that may occur in the vicinity of high level waste packages emplaced in Topopah Spring tuff at the proposed repository at Yucca Mountain. Once developed, the model will be used to predict the chemical environment waste packages may experience for a range of possible scenarios, and to provide information necessary for establishing the source term to be used in calculations of travel times and release rates for those scenarios concerned with release of radionuclides.

Development of this model requires detailed information regarding the chemical and mineralogical consequences of liquid and vapor phase water interacting with tuff at elevated temperatures and radiation levels. Obtaining rates of chemical reactions, identification of reaction products, and description of initial rock and water conditions are the principal goals of this task. To accomplish these goals activities have been designed and undertaken to determine experimentally the nature of tuff/water interaction at elevated temperature, the rates at which reactions occur through dissolution and precipitation, the composition of water that exists in pores in the unsaturated tuff, and the nature of reaction processes in aqueous systems subjected to elevated radiation levels. The data resulting from these activities are incorporated into numerical simulations that will be used to generate models of the long term behavior of the near field environment.

ACTIVITIES AND ACCOMPLISHMENTS

Rock-Water Interaction
The experiments begun nearly a year ago were terminated normally. The purpose of these runs was to determine how a steady-state tuff-water system responds to perturbations in fluid composition. The approach to this problem has been to allow tuff and fluid to approach equilibrium and then inject into the reaction vessel an aliquout of fluid, which perturbs the steady state system. Sampling of fluid after perturbation allowed monitoring of the approach to a new steady state. The current runs replaced those that were prematurely terminated by a power outage.

Solution samples were obtained through the 150th day after injection of new fluid. At the termination of the experiment, fluid samples were taken, the tuff wafers recovered, and precipitates on the gold bags were sampled. The solutions have been submitted for analysis. Analysis of the solid phases will be accomplished over the next few months.

The thermocouples and transducers used in the equipment were removed when the experiment was terminated, and have been submitted for calibration. When they are returned from the calibration laboratory, they will be reinstalled in the system, and a thorough system calibration will be performed.

A backup power supply will be obtained to prevent loss of experiments during power outages. The cost of this facility will be shared by those who also use the building in which the experiments are conducted.

Vadose Water Extraction
Work continues to be delayed because of the absence of appropriate sample material. Arrangements are nevertheless being made to begin reconnaissance experiments with high G centrifuges.

Single-Phase Dissolution
Dissolution and precipitation kinetics experiments of kaolinite at 80°C and low pH, and dissolution and precipitation of gibbsite at low pH and 80°C continued. The experiments are progressing normally.

Study of the dissolution and precipitation kinetics of cristobalite at 200°C continued. Steady state concentrations of silica were achieved in the dissolution experiments that were consistent with predictions from other studies. Precipitation experiments proceeded normally. However, amorphous silica, rather than cristobalite has appeared in the run products. Investigation of this material continues.

MAJOR ACTIVITIES UPCOMING NEXT THREE MONTHS

Analysis of the solid samples obtained in the hydrothermal studies will begin. Data reduction of the solution analysis will be initiated when the analyses are complete.

Dissolution and precipitation experiments will continue on the clays, cristobalites and zeolites. Expanding the experiments to cover a broader range of pH values is expected.

PROBLEMS/ISSUES

The absence of rock material continues to delay the vadose water extraction activity.

WBS 1.2.2.2.2 NEAR-FIELD HYDROLOGY & TRANSPORT
D. Wilder, P.I.

OBJECTIVE

This objective is to provide a detailed conceptual and quantitative understanding of the flow and transport processes active in the near-field waste package environment. Activities will provide a basis for the near-field flow and transport submodel to be included in the waste package performance assessment system model.

ACTIVITIES AND ACCOMPLISHMENTS

Work continued reviewing the Study Plan for the Hydrologic Properties of the Near Field Environment (1.2.2.2.1). Sixty review comments were addressed which resulted in a rewrite of the Study Plan.

Work continued on the final review of the Progress Report.

Input for the Site Characterization Plan 6 month progress report was completed.

Verification testing of the latest version of TOUGH is continuing.

Interviews were held for the Hydrology Task Leader position.

Tom Buscheck and John Nitao presented their paper, "On the Infiltration of a Liquid Front in an Unsaturated, Fractured Porous Medium" to the Focus 89 Conference held in Las Vegas, NV.

MAJOR ACTIVITIES UPCOMING NEXT THREE MONTHS

Completion of Study Plan.

Completion of analysis/modeling for data from horizontal test.

WBS 1.2.2.2.3 MAN-MADE MATERIALS EFFECTS
W. Glassley, P.I.

OBJECTIVE

The objective of this task is to determine the chemical, physical, and mineralogical consequences that result from the presence in the proposed repository of man-made materials. These materials have the potential of affecting the properties of the environment waste packages must survive, and may therefore influence the performance lifetime of waste containers and waste-form leach rates. To achieve the objective of this task, activities will address the interaction of man-made materials with the host tuff, and evaluate the extent to which synergistic effects may occur among various man-made materials.

ACTIVITIES AND ACCOMPLISHMENTS

Revision of the Mechanical Attributes Study Plan 8.3.4.2.4.3 continues with the incorporation of comments received from the SAIC screening review.

Planning documents for activities described in the above study plan have been started.

A task leader in this area has been hired and will begin work in December, 1989.

MAJOR ACTIVITIES UPCOMING NEXT THREE MONTHS

Because of the absence of funding for the remainder of FY89, no work was conducted in this task. The new task leader for this task will begin preparation of scientific investigation plans in January, 1990.

PROBLEMS/ISSUES

The absence of funding has prevented further work.

MILESTONE PROGRESS

Technical review of the report entitled Evaluation of Bentonite Packing Material in Waste Packages for a Proposed Repository in Tuff at Yucca Mountain, Nevada was completed. The paper was revised by the authors, edited by technical services, and figures are now being redrafted.

WBS 1.2.2.2.4 ENGINEERED BARRIER SYSTEM PROTOTYPE TESTING
A. Ramirez, P.I.

OBJECTIVE

This activity includes planning and implementation of prototype in situ tests of the waste package environment to test hardware, methods and procedures. The results of these tests will be used to evaluate candidate hardware and methods that will subsequently be used in the ESF (Exploratory Shaft Facility).

ACTIVITIES AND ACCOMPLISHMENTS

The first draft of the revision to the SIP was completed.

Scenarios were prepared on budget assumptions for FY90.

Input for the Site Characterization Plan six month progress report was completed.
Preparation of final reports for the horizontal prototype test has begun.

Three papers were presented at the Focus 89 Conference held in Las Vegas, NV: "Microwave Measurements of Water Vapor Partial Pressure at Temperatures Up to 350 degrees C. by V. Latorre, "High Frequency Electromagnetic Tomography", by W. Daily, and "Prototype Engineered Barrier System Field Tests-Progress Report" by A. Ramirez, et al.

Work is continuing on reviewing final technical comments for the Progress Report on Prototype Testing.

A briefing was given to Leo Little on the prototype testing.

Post-test overcoring drilling of the instrument boreholes used during the horizontal prototype test is continuing. Drilling of the second borehole was started but was temporarily halted because of money problems. REECo used incorrect drills bits originally and did not correct until a great deal of money had been spent. The financial problems were solved and the drilling continued. Pressure transducers have been recalibrated after test completion. Post-testing on heater was started in the laboratory.

MAJOR ACTIVITIES UPCOMING NEXT THREE MONTHS

Completion of the Progress Report On Prototype Testing.

Completion of Criteria Letter and Activity Plan for the vertical prototype test.

PROBLEMS/ISSUES

Budget uncertainties are making planning difficult for vertical prototype test.

WBS 1.2.2.2.5 EXPLORATORY SHAFT FACILITY ENGINEERED BARRIER SYSTEM TESTING
A. Ramirez, P.I.

OBJECTIVE

This activity includes planning and implementation of in situ tests of the waste package environment. The results of these tests will be used in defining the waste package environment and will aid in validating models used in performance assessment of the waste package system. This task also includes the preparation and certification of LLNL input to the Exploratory Shaft design documents.

ACTIVITIES AND ACCOMPLISHMENTS

Prepared input for the TSRD (Test Support Requirement Document).

Attended ESF Construction Alternative Meeting in Las Vegas, NV.

MAJOR ACTIVITIES UPCOMING NEXT THREE MONTHS

Will be updating the network charts for FY90.

WBS 1.2.2.3.1.1.L WASTE FORM TESTING - SPENT FUEL
R. Stout, Acting P.I.

OBJECTIVE

This task involves the measurement of the radionuclide release rate from spent fuel, the oxidation rate of irradiated UO_2, and the corrosion rate of spent fuel cladding. The data obtained from the testing program are to be used as input for performance modeling of the long-term radionuclide release rates from the waste package.

ACTIVITIES AND ACCOMPLISHMENTS

Spent Fuel Leaching/Dissolution Tests (H. Leider, P.I.) Argonne National Laboratory
YMP Series 5 Spent Fuel Leach (SFL) Tests
Analytical procedures, written for this task for the determination of α-emitting nuclides, are being reassessed to correct for possible flaws in the radionuclide separation steps. The three NNWSI-RNL procedures are: 05-006 for $^{238,240}Pu$, 05-007 for ^{241}Am and ^{244}Cm, and 05-008 for ^{237}Np. Suspected deficiencies are being identified, corrected, and tested in collaboration with the Analytical Chemistry Laboratory at ANL/CMT. Updated versions of the above procedures will be issued.

Saturated Tests with Unirradiated UO_2
All necessary DOE documents for transferring 500 g of "single crystal UO_2" from MCC to ANL have been completed. The remaining acquisition steps left are: (1) moving the material from the WHC site to PNL, (2) having Harlan Anderson (who crystallized the UO_2 melt in 1960) certify its identity, and (3) shipping the package to ANL. Estimated arrival time is one to two months.

Unsaturated Tests with Unirradiated UO_2
Ongoing work on this task consists of four experiments in which Zircaloy-clad UO_2 solid cylinders, hermetically sealed in 304L stainless steel vessels, are exposed at 90°C to EJ-13 water dripping on the top UO_2 surface at a rate of 0.075 mL every 3.5 days. The Zircaloy/UO_2 assemblage rests on a perforated 304L SS plate that is situated about 1-inch from the bottom. The resulting leachate solution is collected in the bottom portion of the vessel. The first solution sampling date for these experiments has been set for 10/23/89. The samples will be assayed for pH, uranium, carbon, anions, and cations depending on the amount of solution available. A detailed procedure has been written for the numerous steps during the sampling.

Based on anticipated guidance for FY 1990 activities, the current experiments may be extended to include two additional support plate materials: a copper/nickel alloy (CDA-715) and Incoloy-825. Perforated plates made from these alloys are available from the Metal Samples Co., Munford, AL. Their acquisition, however, will await final guidance.

Electrochemistry of UO_2 Dissolution (Lawrence Berkeley Laboratory)
No activity to report this month.

Spent Fuel Leaching/Dissolution Tests (Pacific Northwest Laboratories)
There may be some advantages in using dilute bicarbonate solutions for flow-through dissolution testing with spent fuel. Dissolution rates measured in flow-through experiments with unirradiated UO_2 and Ca and/or Si-containing waters, such as J-13 water, fall to very low levels. Thus, it would be difficult to analyze congruently dissolved radionuclides nuclides if the tests had used real spent fuel. Formation of thin Ca-Si-U-containing layer at the UO_2 surface appears to act as a barrier to UO_2 dissolution. UO_2 dissolution rates measured in flow-through tests with Ca and Si-containing water compositions have been inconsistent. Also, water compositions that closely duplicate J-13 water precipitate scale in the flow-through columns if the test temperature is raised. Flow-through tests using dilute bicarbonate solutions (no Ca or Si) appear to give more consistent UO_2 dissolution rates, which are sufficiently high that congruently dissolved radionuclides should be readily measurable when the tests are performed with real spent fuel, and should not produce scale precipitation in the

tests at elevated temperatures. Experiments have been started to investigate the effects of flow rate and temperature on unirradiated UO_2 dissolution in dilute $NaHCO_3$ solutions.

The goal is to measure soluble nuclide-to-U dissolution ratios using flow-through methods on fuel temporarily removed from semi-static tests and then use these ratios to determine fuel matrix dissolution rates occurring in the semi-static tests. Soluble-nuclide dissolution rates can be directly measured in semi-static tests. However, fuel matrix dissolution rates, which may eventually control soluble nuclide dissolution rates, can not be directly measured by static or semi-static test methods. Determination of fuel matrix dissolution rates occurring in the semi-static is considered important because these tests simulate some spent fuel dissolution scenarios in the repository. The flow-through tests should provide direct measure of matrix dissolution rates. If water compositions such as dilute $NaHCO_3$ are to be used in the flow-through tests (for reasons discussed above), the effects of water composition on soluble nuclide-to-U dissolution rate ratios need to be determined. Flow-through experiments in the hot cell using preleached spent fuel specimens are being considered to investigate the effects of water composition on soluble nuclide-to-U dissolution rate ratios.

Zircaloy Cladding Corrosion (R. Stout, P.I.)
Stress Analysis of an Oxide Film on a Zircaloy Cladding (Lawrence Livermore National Laboratory)
An analysis to model the elastic plus creep material response of a Zircaloy tube surrounded by a thin oxide film continued. The model provides for a coupling between Zircaloy creep deformation and oxide film fracture response. An analytic solution has been derived for the partial differential equations of the model. Because the Zircaloy fuel rods have a distribution of initial conditions (i.e., oxide film thickness, cladding dimensions, internal fission gas pressure, irradiation damage) and different rods of the same kind may potentially have different repository temperature histories, the solution procedure is being formulated with methods from stochastic differential equations. This will permit, in a probabilistic sense, a conservative model for Zircaloy cladding failure rate that would result from stress corrosion cracking. The conservatism is established by equating the cladding failure time to the time at which the oxide film first fractures. The rationale for this shorter failure time is because the fracture of the oxide film surrounding the Zircaloy is being observed at PNL as the critical step for the initiation of the stress corrosion cracking response in Zircaloy cladding.

Zircaloy Hydride Modeling (Lawrence Livermore National Laboratory)
A write-up of a deformation-thermodynamic model for hydride precipitation kinetics was completed. The model considers the deformation from the formation of zirconium hydride platelets as a discontinuity displacement in the lattice structure. This means that the deformation response due to hydride platelets of various orientations can be coupled into the thermodynamics of hydride precipitation by a stress work term. In the thermodynamic model, the thermodynamic potential is a functional. According to existing experimental evidence, this potential for hydride precipitation kinetics has different values for different orientations of the hydride platelets. Furthermore, the thermodynamic model has a stress dependence that influences the orientation of hydride platelet precipitation. For Zircaloy cladding, the two commonly observed orientations for hydride platelets are circumferential and radial. A stress-dependent model and stress-dependent experimental data to describe the kinetics of transitions from one orientation to the other are necessary to predict cladding failure rates due to hydride platelet precipitation and growth.

Modeling of Cladding Corrosion and Degradation Mechanisms (Bryan Chin, Auburn University)
Work to predict the anticipated damage to the Zircaloy cladding during storage in a Tuff repository is continuing. Work during the month involved a study of how to incorporate anisotropic volume expansion of oxide into computer models. From initial calculations, the overall effect of anisotropic volume expansion on the hoop stress in oxide and in the cladding appear to be negligible. While the oxide stress just after formation of the oxide is lowered by the incorporation of anisotropic volume expansion, the value after relaxation has been taken into account is almost identical to the isotropic volume expansion case. The net result is that hoop stress values are not drastically affected. However, radial stresses are increased.

Experimental work is being pursued to answer the question as to whether the acid etching solution used in the C-ring dissolution experiments is significantly attacking the oxide film. More Zircaloy tubing is being oxidized on the outside surface. This tubing will then be cut into C-rings and Scanning Electron Microscopy analyses of a C-ring, before and after the acid etching, will be performed. This analysis will indicate whether the porosity of the film is significantly altered by exposure to the acid.

Additionally, a literature search for additional information on the diffusion of fluorides and chlorides through zirconium oxide films has been initiated. This is being pursued to confirm the initial conclusion that even a very small thickness of oxide effectively protects the Zircaloy from attack.

Zircaloy Cladding Corrosion Degradation (Pacific Northwest Laboratories)
C-Ring Experiments
Review comments are being incorporated into a draft of a paper, An Interpretation of the High-Stress, Low-Temperature Cracking of Zircaloy-4 Spent Fuel Cladding. It is reported in the paper that the data fall on a straight line on a log(t) vs. % yield stress plot, where t is the time to failure of the C-ring.

Pressurized Tube Stress Corrosion Cracking Test
A specimen of oxidized Zircaloy was pressurized and simultaneously monitored for strain, acoustic emissions, and electrical resistance across the oxide film. The objective was to correlate both acoustic emission and electrical conductivity with strain, and also to correlate acoustic emission and electrical conductivity. Acoustic emissions started at about 0.1% strain and increased in frequency with increasing strain. Electrical resistance through the oxide film and surrounding J-13 water was fairly constant at about 20 megohms, then dropped rapidly starting at about 0.3% strain and continued to drop to a final value of about 15,000 ohms at 0.56% strain. Metallography indicated that the 8μm thick oxide layer contained several circumferential cracks, but very few radial cracks to bare metal (at least in the mid-section specimen examined).

Acoustic emission is sensitive to cracking whatever its orientation, while the resistance technique should detect only the through-oxide cracks which are most relevant to this work. Because of the greater discrimination, higher resolution, and the simplicity of the resistance approach, the plans are to use it to detect through-the-oxide cracks in future work instead of acoustic emission. The resistance technique works because very short current pulses are employed, thereby, minimizing electrochemical effects.

This work is being described in a detailed QA Level I Test Plan, which is currently undergoing internal PNL technical review.

Fluoride/Cladding Interaction Test Development
Work continued on a test plan for the Fluoride/Cladding Interaction Test.

Carbon-14 Release and Concentration Profiling for Spent Fuel Cladding
Work continued on an test plan for the carbon-14 thermal release work. The procedure, "Thermal Release Rate Measurements for Carbon-14 and Tritium from Irradiated Materials", will be incorporated into that plan. H.D. Smith gave a presentation at FOCUS '89 based on an abstract entitled *An Investigation of Carbon-14 from PWR Spent Fuel Cladding* by H.D. Smith and D.L. Baldwin.

SPENT FUEL OXIDATION (Pacific Northwest Laboratories)
TGA Tests
Both TGA systems are undergoing long-term stability tests. Preliminary investigations confirmed by pressure measurements and short-term gas samples indicate that the system leaks have been eliminated. The data acquisition system was upgraded for more complex data analysis. No further reports will be made on the activity until the stop work order is lifted.

Dry Bath Test
Testing continued during September without incident. While temperature remained within acceptable bounds, the temperature fluctuated more than expected in the drybaths flowing dry air. This

instability seems to correlate with the temperature instability in the hot cell canyon. We suspect that the instability is transmitted to the drybaths due to a cooling affect on the gas delivery lines. The temperature instability only affects the baths with dry air since the gas delivery lines supplying the moist air drybaths are heated and maintained at constant temperature.

An abstract titled *Drybath Oxidation Testing* was presented by R. Eizinger at the FOCUS '89 meeting in Las Vegas.

Oxidation Model Development (LLNL)

A write-up of a statistical model development for oxidation kinetics of UO_2 spent fuel was completed. The important physical mechanisms currently being observed during the initial oxidation process appear to strongly depend on grain boundary oxidation and grain volume oxidation phenomena. Thus, the species density of grain boundaries and their associated relationship to the grain volume is being represented in terms of statistical mechanics concepts. This statistical approach is well suited for describing dual rate kinetics where the magnitudes of the rates for the individual kinetics of grain boundaries and grain volumes are different. In addition, a statistical description based on observable physical attributes should be easier to relate to other physical mechanisms and states of UO_2 oxidation for the distribution of spent fuel that will be stored in a repository. Preliminary analysis was completed on the oxidation problem for different sizes of UO_2 fragments from fractured spent fuel pellets in a fuel rod.

MAJOR ACTIVITIES UPCOMING NEXT THREE MONTHS

An Activity Plan (D-20-53) and Test Plans are being written for Flow-Through Dissolution Tests on Spent Fuel and UO_2.

Test plans for pressurized cladding testing, fluoride-Zircaloy testing, carbon-14 release testing, and a revision of a test plan for Series 5 dissolution testing from PNL are being written and should be completed by October (89).

An Activity Plan (D-20-42) for Saturated Semi-Static Dissolution of Spent Fuel and UO_2 is being written.

PROBLEM ISSUES

Redirection of staff to meet new QA requirements has delayed conceptual model development.

MILESTONE PROGRESS

Milestone R205,(9/89), a report on the results of spent fuel leaching at 85°C has been returned from PNL to LLNL and LLNL review has been completed.

Milestone P111 (10/89), initiation of dissolution testing of partially oxidized spent fuel will not be conducted as part of the LLNL program supported at PNL. It is being funded at PNL by RTP (Chicago).

Milestone P250 (10/89), initiation of parametric dissolution tests of spent fuel (Series 5 tests at ANL), is on schedule; however, issues that may arise from planned readiness review could result in a delay.

The new Scientific Investigation Plan (SIP) for YMP WBS Element 1.2.2.3.1.1 (1989) Rev. 1, was approved at LLNL and is at YMPO for approval. The SIP was written to comply with the existing Quality Assurance requirements and QA Level assignments of the activities being planned and conducted in the Spent Fuel Waste Form Modeling and Testing technical area.

Readiness Reviews of Activities D-20-44 and D-20-45 for TGA and Oven Bath oxidation Testing were held in September, 1989.

W.B.S. 1.2.2.3.1.2 WASTE FORM TESTING & MODELING - GLASS
F.J. Ryerson, P.I. (acting)

OBJECTIVE

This task involves the measurement of the radionuclide release from borosilicate glass; these are to be used as input for the performance modeling of long-term radionuclide release from the waste package.

ACTIVITIES AND ACCOMPLISHMENTS

D-20-27 Unsaturated Testing (Argonne National Laboratory)
The N2 tests (SRL-165 glass) continued as scheduled with no sampling periods occurring this month. The N3 tests (ATM-10 glass) continued as scheduled with no sampling periods occurring this month.

No analyses of the test components form the ATM-10 test components have been conducted due to the reduced work order. This will cause a delay in the delivery of the report describing this work. An activity plan for this work is in preparation, when completed the activity will undergo a readiness review and full work plan will again be implemented.

D-20-28 Static leach testing of DWPF and WVDP glass (Argonne National Laboratory)
The Study Plan describing the methodology to perform vapor phase hydration in support of static leaching testing has been completed and is under review.

The Study Plan describing the long-term static leach tests has been completed. The test described are performed to support model validation and consist of three matrices which increase sequentially in degree of complexity. The first matrix is conducted in Teflon vessels using a range of glass compositions in deionized water at 90°C. The plan also allows variations in water chemistry ad SA/V ratios. The second matrix is performed in 304L stainless steel vessels and the glasses will be doped with transuranic elements. The third matrix will attempt to mimic as closely as possible reactions with other repository materials as their identities become known.

D-20-29 Parametric studies of DWPF and WVDP glasses based on the unsaturated test (Argonne National Laboratory)
The parametric tests are ongoing, and a study plan to continue these tests is being prepared. A paper describing the parametric experiments has been submitted for the MRS meeting in November.

D-20-30 Parametric studies of DWPF and WVDP glass (Argonne National Laboratory)
To support the development of a study plan for the vapor phase hydration/leach tests a preliminary set of experiments was continued 7/28/89. SRL-165A and ATM-10 glasses, both of which contain transuranics, had been subjected to vapor phase hydration at 90-200°C, over time periods from a few days to over half a year. These glasses had been in dry storage until recently when they were examined to determine the extent of hydration. The examination was done using a stereomicroscope and the extent of hydration ranged from minimal in the 90°C samples to heavy in the 200°C samples.

Twenty-eight day MCC-1 leach tests were conducted on all glasses except those that were most heavily hydrated (these glasses were reserved for further surface characterization). The twenty-eight day test was completed on 8/25/89. At termination, the following aliquots were extracted for analysis. Samples were taken for pH, anions, cations, U and transuranics. An additional aliquot was taken for the most heavily hydrated samples for filtering through a 1.8 nm filter. After these aliquots were taken, all of the solution had been consumed. The vessels were then subjected to an acid strip which was analyzed for U and transuranics. The glass samples were removed from the vessels, dried, and weighed.

These tests are being developed to study the performance of glass under conditions that will likely occur in an unsaturated environment as the glass is exposed to water vapor upon canister and container failure, and then to liquid water if the borehole environment becomes saturated. As instantaneous infusion of liquid water is not an anticipated event, the test method probably simulates a worst case scenario.

Preliminary results were reported last month and have been included in a paper "Vapor hydration and subsequent leaching of transuranic-containing SRL and WV glasses" to be presented at the International High-Level Radioactive Waste Management Conference in Las Vegas. Additional results have been obtained this month and are given in Table 1.

Table 1. Normalized release of components from vapor-phase hydrated glass

	SRL-165		ATM-10	
Element Group	Fresh	Hydrated	Fresh	Hydrated
B,Li, Na	1.5	30	10	25
Pu, Am	0.1	2	0.001	.0.2
Np, U	0.6	15	2	10

Normalized release (g/m^2)

The extent of glass reaction depends on the degree of hydration. The most striking feature of the results is that the release of Pu and Am from hydrated glass increases by a factor of 100-500X compared to that from fresh glass. The increase is largely due to the release of colloidal material as most of the Pu and Am are filterable with a 1.8 nm filter.

D-20-31 Studies of glass surface layers and precipitation (Argonne National Laboratory)
As was reported last month, the newly installed Kratos quadropole looks promising, but has not operated properly. The spectrometer was not properly configured during installation, and Kratos staff people are continuing to look into the problem.

A new TEM and ultramicrotome have been installed at ANL and are operational.

D-20-32 Geochemical Interactions (Argonne National Laboratory)
Flow-through experiments on a simple analogue glass have been completed and the solution data reduced. This work forms the basis of an MRS paper this Fall. Characterization (by FTIR, XRD, SEM and nuclear reaction depth profiling) of the recovered glass from these experiments is underway. The rate constant for dissolution is a strong function of solution pH reaching a minimum for a given temperature near neutral pH's. Similarly, the release of elements from the glass is also pH dependent. At pH's below 7 elemental release can be incongruent with alkalis being released faster than silicon; as such, a thick gel layer is formed.. At pH higher than 7, leaching is congruent. This suggests that leaching under proposed repository conditions may be modeled as congruent dissolution.

A series of static leaching experiments on the simple analogue glass in Dickson autoclaves has also been completed and the data are being analyzed. Characterization of the reacted glasses is continuing.

MAJOR ACTIVITIES UPCOMING NEXT THREE MONTHS

Approval of the revised SIP is anticipated. Activity plans for D-20-27, D-20-28, D-20-32 will be drafted and submitted for approval. Flow-through tests on SRL-165 will commence. Static leach testing of vapor-phase aged glasses will commence.

PROBLEMS/ISSUES

DWPF glass samples are needed before testing can begin

MILESTONE PROGRESS

2R32 Preliminary leaching database.

Level I batch mode unsaturated tests are completed, and awaiting final QA readiness review before analysis of solids can begin.

2R22 Preliminary glass kinetics models.

A report "Geochemical Modeling of Radioactive Waste Glasses Dissolution Using EQ3/6: Preliminary Results and Data Needs" has been submitted to YMPO for approval. An improved model has been developed and the results will be presented at the Fall MRS meeting. New flow through data will be used in future models.

2R31 Glass leaching database.

Activity plans for saturated testing have been completed.

WBS 1.2.2.3.4.1 WASTE FORM AND MATERIALS TESTING
- INTEGRATED TESTING/ INTEGRATED RADIONUCLIDE RELEASE
M. ten Brink, Acting P.I.

OBJECTIVE

The purpose of this task is to characterize and model the integrated behavior of the waste forms, barrier materials, and surrounding environment in order to yield an understanding of the performance of the waste package system in the repository environment. Emphasis is placed on multi-component tests and on examination of natural analogs.

ACTIVITIES AND ACCOMPLISHMENTS

Core Flow Through Experiment and Tuff Wafer Experiment
The design for a diffusion cell was finalized and fabrication began at LLNL. The teflon cell will consist of two reservoirs and a set of interchangeable sample holders. This will allow use of different sizes of core. In addition, M. ten Brink attended the American Chemical Society Conference, the American Nuclear Society Focus '89 Conference, and visited NTS and YMP facilities this month. Numerous contacts and information helpful to ongoing experimental design, modeling of results, and system characterization were obtained at the conferences; e.g., capability of various photon correlation spectrometers to characterize groundwater colloids; use of fracture and matrix flow models for tuff wafer data; and variability of actinide and rare earth element sorption as a function of mineralogy.

Planning and test development
Improvements continued to be made in the data gathering and processing capabilities of the ion microscope/ion microprobe: Efforts to stabilize the primary beam on the ion microscope were successfully completed this month with installation of a stand alone primary-column electronics package. Corrections and improvements were made to the purchased C. Evans software that is used for acquisition, display, and reduction of Resistive Annode Encoder data. These changes reduce the data processing time and allow the user greater control over data manipulation. In addition, K. McKeegan and D. Phinney attended the 7th International Meeting on Secondary Ionization Mass Spectroscopy, at which technical information was obtained that will be applied to improve our analytical capabilities for SIMMS analysis of YMP tuff, glass, and metal materials.

MAJOR ACTIVITIES UPCOMING NEXT THREE MONTHS

During the next few months, a new SIP will be written for Integrated Testing.

Tuff samples will be prepared for ion implantation in order to calibrate the sensitivity factor on the ion microscope for elements of interest.

Delivery of the diffusion cells is expected in October.

Experiments will be started which will measure diffusion rates for actinide bearing solutions in tuff cores.

WBS 1.2.2.3.2 CONTAINER MATERIALS MODELING & TESTING - METAL BARRIER
D. McCright, P.I.

OBJECTIVE

The goal is selection of a metallic material for fabrication of waste containers and characterization of the material behavior under expected conditions and environments. Test data derived from this work will be used in performance assessment modeling and for licensing. Current emphasis is on two alloy systems: (1) Fe to Ni-base austenitic alloys, and (2) Cu and Cu-base alloys.

ACTIVITIES AND ACCOMPLISHMENTS

Task Management
Technical and management review of the revised Metal Barrier Selection and Testing Task Scientific Investigation Plan (SIP) continued. Following local approval, the revised SIP was forwarded on to YMPO. Also included with the SIP were the Quality Assurance Level Assignment Sheets for the 13 technical activities described in the SIP.

Metal Barrier staff began preparations for a technical planning meeting to be held October 12-13. The purpose of the meeting is to detail experimental work that will be accomplished, mostly in the parametric studies activity, to support the container material selection for advanced studies and long-term performance assessment of the selected material in the repository setting.

Statements of work (SOWs) were received from Principal Investigators (PIs) at Argonne National Laboratory (ANL) for parametric study activities they are performing. The extent of work to be undertaken will depend on the FY-90 budget figure.

Task Quality Assurance
Activity Plans (APs) for activities E-20-18B (Long Term Laboratory Corrosion Tests), E-20-18E (Microstructural Characterization of Candidate Materials) and E-20-16 (Model Development) were completed and circulated for review. Readiness reviews for these activities were conducted on September 27. The E-20-16 AP required an additional Individual Software Quality Assurance Plan (SQAP), which was written and appended.

Metal Barrier staff personnel have been working with Quality Assurance personnel to qualify certain vendors for future procurements. In particular, sources of metallurgical specimens and analytical services are being evaluated for adequacy of their quality assurance provisions (e.g. traceability of specimen identity, documentation of procedures, calibration of equipment) in meeting requirements of the YMP QAPP.

Degradation Mode Surveys
The Metal Barrier staff is working with the Project administrative function in assigning accession numbers to all of the 1200-odd references cited in the 8-volume degradation mode surveys. Only a few referenced articles are lacking the accession numbers. As the articles are physically obtained and catalogued, a master file is being created.

Coordination with Design, Fabrication, and Prototype Testing Tasks
Metal Barrier staff member Greg Gdowski is revising the SIP for the Fabrication and Prototype Testing Task (WBS 1.2.2.4.2) in accordance with the current QAPP. Many of the activities in this task deal with the fabrication, closure, and inspection of the container, and studies in these activities involve the process metallurgical aspects of container material selection and performance modeling.

Selection Criteria
The Metal Barrier staff is still awaiting approval of the restart of this activity. The activity plan was written and approved and the readiness review was conducted in July. Approval of the restart is expected soon. A consulting agreement was initiated with Prof. D. B. Bullen of North Carolina State University, Nuclear Engineering Department to act as administrative and technical liaison for the peer review panel activities to complete this task. Following approval of the restart, the selection criteria document will be revised to reflect recommendations from the peer review panel.

Model Development
The AP for this activity was approved and a readiness review conducted during September. A draft of the paper, "Corrosion Models for Performance Assessment of High-Level Radioactive Waste Containers", presented at the SMiRT conference in August was circulated for technical review. The paper reviews the applicability of existing physical/chemical models on corrosion to the Yucca Mountain repository setting.

Technique Development
The staff is continuing to prepare Technical Implementing Procedures (TIPs) to cover various techniques that will be used in experimental work. Many of these TIPs involve non-standard or advanced procedures.

Parametric Studies
Some new capital equipment has been received during September, and this equipment will be used in parametric study work. Considerable time was spent in installing, setting up and calibrating the equipment. The G.E. Reversing DC Crack Growth Monitoring System was installed and we are currently acquiring preliminary information by running a set of stock samples of each candidate alloy. Only one component of this system will require regular calibration, the HP digital volt meter, and this item will be added to the YMP list of measurement and test equipment (M&TE). General Electric (GE)personnel have been working with the Metal Barrier staff in providing the initial calibration information.

The Metal Barrier Task has also acquired an Instron 8562 system for conducting stress corrosion tests at carefully controlled low strain rates. This system has been installed, and some of the software packages have been received. Others needed for calculation of stress intensity factors and J-integrals are awaited. Instron personnel are helping with the initial calibration of the load cell and extensometer, which will be the items added to the YMP M&TE list. Installation and initialization activities for both the GE and Instron systems will continue into October. Several members of the Metal Barrier staff are planning to follow an operations training course offered by Instron in November. They are also planning a technical visit to ANL where a GE unit is used for subcontract work to learn more about the details of the measurements.

In planning the parametric study work, the activity has been divided into a number of sub-activities, and the corresponding plans have been/are being written. The organization of this activity is thus far:

A. Determination of critical potentials for localized corrosion initiation. These are relatively rapid tests to determine the electrochemical characteristics of the candidate materials in a matrix of accelerated environments for indicating the comparative susceptibility of the candidate materials to pitting attack.

B. Determination of crevice corrosion and stress corrosion behavior of the candidate materials in repository-simulated environmental condition. These tests will be conducted in the laboratory under conditions that will require relatively minor monitoring. Self-loaded specimens will be used, with periodic withdrawal of specimens to indicate attack initiation and propagation. These tests are planned to run for long times (months to years).

C. Determination of the plane strain stress intensity factor for fracture of the candidate materials. This sub-activity is closely related to the following one.

D. Determination of the critical stress intensity for stress corrosion initiation of the candidate materials. These tests will use the rising load method on modified wedge-opened loading (WOL) specimens. The critical stress intensity is associated with crack arrest.

E. Determination of the microstructural characteristics of the candidate materials, both in the base metal and welded conditions. Plate stocks of each candidate material had been welded (copper and aluminum bronze by electron beam, the other candidate materials by metal inert gas processes) and with different filler materials used for alloy 825.

The ANL sub-contract work will be brought in under sub-activities F (radiation effects) and G (stress corrosion cracking susceptibility). Other sub-activities will be added as needed. The assignment of sub-activities, details of experimental plans, and personnel is expected to be a major focus of the technical planning meeting to be held October 12-13.

Container Material Selection
There is no progress to report this month since the start of this activity is linked to completion of the selection criteria document.

MAJOR ACTIVITIES UPCOMING IN NEXT THREE MONTHS

Metal Barrier task will continue to write activity plans for QALA Level I and II activities and conduct readiness reviews of these activities as appropriate.

PROBLEMS/ISSUES

Multiple activities are awaiting readiness reviews and approvals before start up.

MILESTONE PROGRESS

Milestones are on schedule.

WBS 1.2.2.4.2. CONTAINER MATERIALS, FABRICATION and CLOSURE
E. Russell, P.I.

OBJECTIVE

To develop, analyze, fabricate and test waste package designs that incorporate qualified materials and that are fully compatible with the repository design in order to support license application by demonstrating conformance with requirements for safe handling emplacement, possible retrieval, and credible accident conditions per 10CFR60 and 40CFR191, in a cost efficient manner.

ACTIVITIES AND ACCOMPLISHMENTS

Container Fabrication and Closure Process Development
1) Container Cost Estimate Study: Container cost estimate data was obtained from three independent, domestic sources, all experienced in manufacture of similar components. The manufacturing organizations utilized for this study were: The Youngstown Welding and

Engineering Co. (Youngstown,OH), The Joseph Oat Corp. (Camden,NJ), and Babcock and Wilcox Commercial Nuclear Fuel Plant (Lynchburg,VA). The estimates received were based on two candidate container metals, Alloy 825 and CDA 715, applied to three types of container designs that represent containers for spent fuel and vitrified high-level waste. The container estimates ranged from $44,813 to $82,704. An LLNL engineering report documenting all of the estimates is in preparation, and will be internally reviewed by 11/6/89.

2) Accelerated Inertia Welding and Thermal/Mechanical Processing Feasibility Studies: a) Inertia welded, 18-inch diameter, slotted cylinders (CDA 715 and Alloy 825), and 4-inch diameter, CDA 952 cylinders were completed on 9/22.; b) The thermal/mechanical (T/M) processing feasibility study deliverables consists of 0.16-inch, finished thickness plates (CDA 715, CDA 952, Alloy 825). Initially the 0.625-inch plates (starting thickness) were butt-welded longitudinally by the GTAW process, and then processed through three cold- rolling/annealing cycles, for a total wall-thickness reduction of 75% .The goal of this study is to ascertain if the metallurgical quality of the weld and Heat- Affected-Zone regions can be improved by the T/M processing cycles.

3) B&W FY90 Workscope: A decision was made to restrict efforts for the remainder of the subcontract term (1/31/90) to (a) preparation of a records- turnover package for all activities conducted over the subcontract term, and (b) support production of the project deliverable, "Container Cost Estimate Report".

4) The paper, "Fabrication and Closure Development of Corrosion Resistant Containers for the Yucca Mountain, Nevada High-Level Nuclear Waste Repository", is in preparation for the Corrosion/90 (April 1990, Las Vegas).

Container Closure Nondestructive Evaluation Activity
An Activity Plan is in preparation per QP 3.0 requirements.

Parametric Studies
A meeting was held on 9/27 at LLNL to discuss the scope and budget required for FY90 studies in criticality, thermal and structural analyses.

MAJOR ACTIVITIES UPCOMING IN NEXT THREE MONTHS

Support of the April 1990 milestone, "Selection of Container Metal" Plans are being formulated to characterize the inertia-welded subscale cylinders completed this month by B&W. Due to lack of funding for the B&W subcontract, this work will be conducted at LLNL. Also, once the inertia welded cylinders are received from B&W, specimens will be removed for corrosion and further characterization studies.

PROBLEMS/ISSUES

There are no problems or issues identified at this time.

MILESTONE PROGRESS

See discussion above for support of the Metal Barrier Selection Milestone(4/90), under Container Fabrication/Closure Development.

WBS 1.2.1.4.5. GEOCHEMICAL MODELING - MODEL DEVELOPMENT
K. J. Jackson/J. W. Johnson P.I.s

OBJECTIVE

This task is the development of advance calculational capabilities for modeling geochemical processes in the repository environment. The work is being carried out by extending the capabilities of the existing EQ3/6 software. The applications objective is to support site, waste package, and performance assessment through calculations of solubilities, rock/water interactions, etc., leading to long-term predictions of geochemical behavior necessary for the DEIS and license application.

ACTIVITIES AND ACCOMPLISHMENTS

Code and Development
Work delayed pending approval of the Software Quality Assurance Plan (SQAP). A modified version of the SQAP was sent to YMPO on September 12, 1989. This version included modifications resulting from the meeting in August between YMPO personnel and LLNL personnel. Editorial changes were also included. Also completed were three of four matrix documents listing where the QA requirements are included in the SQAP. Internally, copies of modified SQAP were distributed for technical review.

Data Base Development
The SUPCRT software package was completed in collaboration with Dr. H. C. Helgeson at U. C. Berkeley. After completion, the software package was transferred to Helgeson's group for critical evaluation and extensive testing, as will also be accomplished concomitantly at LLNL. Following completion of this evaluation/testing and subsequent code refinement, selected SUPCRT routines, together with the recently-augmented SUPCRT data base, will be incorporated into the existing local data base software, providing an up-to-date prediction of the thermodynamic behavior of all SUPCRT species, an essential subset of the EQ3/6 data base.

The dØout code was transferred from the Vax to the Sun computer. After modifying the code to operate on the Sun, some preliminary testing was accomplished. The data all transferred correctly, but three small subsets of the code got different results. These should be corrected in October.

John Tangier of the National Institute of Standards and Technology (NIST) met with LLNL representatives concerning the CATCH code. LLNL intends to use this CATCH code to improve the quality of the EQ3/6 data base. The finished part of the code worked well, but several new requirements will have to be worked on and incorporated. This work was begun but not completed.

The data base utility gmake was modified so that all seven libraries needed by INGRES are included in the file gmakefile.

Code Maintenance, Documentation, and Release
Work continued in scoping the addition of a surface complexation model to the EQ3/6 codes. A draft requirements document was revised and planning continued for the code modifications. EQPT and EQLIB were modified by adding another option to include surface complexation upon request. A new routine, pesrf.f, was added to EQPT. This reads surface complexation data from a new input file called srfdat. Any comments are stripped out and the processed data is appended to the data1 file.

Work also continued on determining the requirements for the chemical reaction path code for the license application design (LAD). Work concentrated on setting priorities for these requirements needs and on gathering outside information on numerical algorithms used by other workers to solve similar problems.

The prototype ion exchange capability for EQ3/6 was tested by running EQ3NR jobs that exercised various ion exchange options. This involved a sequence of five major steps.

About one-third of the coding for Geodata has been completed. This is a post processor for the EQ6 code. This involved reading in the input file with the retrieval requests and the tables with information on the retrievals. The data flow diagrams/structure charts for Geodata were also completed.

Preliminary comparisons were made of the solid-solution model predictions vs experimentally measured smectite compositions from Yucca Mountain. The results indicate that the model predictions (using EQ3NR) are very sensitive to reported aqueous solution compositions. The differences noted between model prediction (using EQ3NR) and observation may be due to any or all of the following: 1. inappropriate model; 2. poor model parameters; 3. poor fluid analyses; 4. poor solid phase analysis. When alterations are complete to EQ6, more model testing will be undertaken. Ultimately, more comparisons between observed and model predictions will need to be made to effectively judge the appropriateness of the prototype model.

MAJOR ACTIVITIES UPCOMING NEXT THREE MONTHS

Continuing work on validation and verification of the data base.

Preparation and approval of the necessary Scientific Investigation Plan (SIP), Activity Plans, and TIPs.

Successful completion of the Readiness Reviews.

Continuing work on code documentation and verification and validation projects.

Release of version 3245.0889 of the EQ3/6 code. (INGRES-based data base release.)

PROBLEMS/ISSUES

Code development work on the Quality Level I EQ3/6 code is delayed pending approval of the SQAP, Activity Plans, and TIPs, the preparation of a revised SIP, and conducting successful Readiness Reviews.

MILESTONE PROGRESS

Internal technical reviews of the draft EQ6 User's Manual have begun. Subsequent to the review cycle, an updated version of the user's guide will be submitted to YMP to comprise completion of Milestone P314. **Code development milestones (e.g., L078, L084, L091, L092, and C395) will slip on a day for day basis during the stop work action.**

WBS 1.2.2.3.4.2 GEOCHEMICAL MODELING - THERMODYNAMIC DATA DEVELOPMENT
R. Silva, P.I.

OBJECTIVE

The purpose of this task is to experimentally evaluate the thermodynamic properties of solids and solution species needed for geochemical modeling of waste form performance.

ACTIVITIES AND ACCOMPLISHMENTS

Hydrolysis and Carbonate Complexation of Pu(V)
The photo-acoustic spectra of Pu(V) was measured as a function of carbonate concentration of the aqueous solution. The spectra are being analyzed to determine the carbonate complexation constant.

High-temperature Calorimetry and Spectroscopy (LLNL)
Calorimetric runs were made to determine heats of dilution and the heat of protonation of tris (hydroxymethyl) aminomethane (TRIS). The value for the TRIS derived from a statistical analysis of the data taken at 50°C agreed to within 1% of the published value of Grenthe et al. with a precision of ±5%. A new wheatstone bridge was designed with an R-F shield to reduce the noise on the signal.

Some 50-60 spectra of Pr(III) were taken using the variable temperature guided wave spectrometer at temperatures of 25, 60 and 95°C. Analysis of the spectral data indicated precision of 1-2% at high concentrations (0.06M) of Pr but of the order of 20% for the lowest concentration studied (0.002M)

High-temperature Calorimetry (Florida State University)
The new calorimeter has been successfully calibrated at 45°C with TRIS and is being further calibrated with bis-TRIS. Calibration at 70°C will be started in about one week.

Resolubility Studies
The new inert atmosphere boxes have arrived and are being fitted to initiate solubility measurements on uranium silicates at elevated temperatures.

MAJOR ACTIVITIES UPCOMING NEXT THREE MONTHS

Complete readiness review complete and surveillance in order to initiate QA Level I measurements.

PROBLEMS/ISSUES

Awaiting completion of the readiness review and the surveillance.

MILESTONE PROGRESS

None due this period.

WBS 1.2.2.5.1 PERFORMANCE ASSESSMENT
W. O'Connell, P.I.

OBJECTIVE

The objective for performance assessment is to provide predictions of post-closure waste package performance in order to assess compliance with EPA and NRC regulations (40CFR191 and 10CFR60, respectively). These assessments will consist of deterministic and probabilistic analyses. A source term necessary for total system performance assessment will also be provided.

ACTIVITIES AND ACCOMPLISHMENTS

Review comments for the PANDORA-1 report have been received, and comment resolutions are in progress.

Most effort in the Performance Assessment area centered around SIP revision, activity plan drafts, Long Range Planning/Planning and Control System network conversions, and QP training.

W. O'Connell attended a YMPO meeting on the YMP Performance Assessment Implementation Plan on September 13 in Las Vegas, NV.

W. O'Connell attended the UCLA Engineering and Management course on September 18-23 in Los Angeles, CA

W. Johnson attended the Performance Assessment Technical Integration Group meeting at the Project Office on September 21-22 in Las Vegas, NV.

MAJOR ACTIVITIES UPCOMING NEXT THREE MONTHS

Further activities in establishing readiness to start QA Level I work will include SIP review and approval, Activity Plan drafts, establishment of procedures and training needs, and finalization of the LLNL Software QA Plan.

Conversion of the long range planning network to the PACs network and iterations to logic, interconnects, and resource loading will be ongoing.

Issuance of draft report M260 on performance assessment of WP conceptual design.

Finalization of enhancements to uncertainty methods model and revision of draft report.

PROBLEMS/ISSUES

The reduced budget this FY combined with a redirection of effort to meet QA program and long-range planning requirements, have left little resources for the originally planned technical work and technical milestones. Schedules are being revised in light of available resources for technical work.

MILESTONE PROGRESS

Performance assessment participation in QA program implementation and in long-range planning are level-of-effort; the contents of successful end points and milestones have not been specifically defined. The degree of reprogramming of effort away from technical milestones has not been specifically defined.

WBS 1.2.2.4.1 SPECIAL STUDIES - DESIGN AND ANALYSIS
L. Ballou, P.I.

OBJECTIVE

The objective for package design is to develop and analyze waste package designs that incorporate Yucca Mountain Project qualified materials and that are compatible with the repository design. The designs and analyses are needed to support license application by documenting conformance with NRC requirements for safe handling, emplacement, retrieval, containment, and release rate.

ACTIVITIES AND ACCOMPLISHMENTS:

None to report this period.

MAJOR ACTIVITIES UPCOMING NEXT THREE MONTHS

None to report this period.

PROBLEMS/ISSUES

None to report this period.

MILESTONE PROGRESS

None to report this period.

1.2.5 REGULATORY INTERACTIONS

WBS 1.2.5.2.1 NRC INTERACTION SUPPORT
D. Emerson, P.I.

OBJECTIVE

Support DOE interactions on the site program with NRC by providing information, coordination and support within the Project.

ACTIVITIES

None to report in this period.

WBS 1.2.5.2.2 SITE CHARACTERIZATION PROGRAM
D. Emerson, PI

OBJECTIVE

Support the DOE in the completion of the Site Characterization Plan. Provide ongoing technical planning and support of site characterization activities. Integrate results into site characterization activities and programs as appropriate, monitor each site program, serve as the interface between the principle investigator and the DOE/HQ

ACTIVITIES

The comments and questions assigned to LLNL by SAIC from NRC's SCA have been received and distributed to the technical area leaders for a response.

WBS 1.2.5.2.3 REGULATORY REVIEW
D. Emerson, P.I.

OBJECTIVE

Support DOE/HQ in the review of site aspects of proposed NRC regulatory changes. Review Project technical products to determine relationship and compliance with site-related requirements. Review DOE licensing positions and related technical reports.

ACTIVITIES

The Final Draft of the Carbon-14 Release Technical Position Paper was transmitted to YMPO on September 26.

WBS 1.2.5.2.5 STUDY PLAN REVIEW AND APPROVAL
D. Emerson, P.I.

OBJECTIVE

Coordinate the Project and Headquarters reviews of Study Plans.

ACTIVITIES

LLNL Study Plans

None to report in this period

Other participant's Study Plans

The technical reviews of LANL-SP-8.3.1.3.6.1, R0 "Dynamic Transport Column Experiments" and LANL-SP-8.3.1.3.6.2, R0 "Diffusion" were sent to YMPO.

WBS 1.2.5.2.6 SEMI-ANNUAL PROGRESS REPORTS
D. Emerson, P.I

OBJECTIVE

Provide support to DOE/HQ for the development and preparation of the Site Characterization Semi-Annual Progress Reports.

ACTIVITIES

Information about the input for the 2nd Semi-annual Progress Report was received and distributed to the Technical Area Leaders.

1.2.9 PROJECT MANAGEMENT

WBS 1.2.9.1.1 PROJECT MANAGEMENT
L. Jardine, TPO

OBJECTIVE

This task manages and coordinates all LLNL Yucca Mountain Project activities to be consistent with the goals and objectives of the overall DOE Yucca Mountain Project, including planning, technical direction, cost, and schedule control.

ACTIVITIES AND ACCOMPLISHMENTS

A review of the LLNL programs was conducted on September 26 and 27, 1989 by the LLNL technical staff for L. Little and M. Cloninger of YMPO. This was a very effective interchange.

MAJOR ACTIVITIES UPCOMING NEXT THREE MONTHS

None to report this period.

PROBLEMS/ISSUES

None to report this period.

WBS 1.2.9.1.4 RECORDS MANAGEMENT
B. Bryan, P.I.

OBJECTIVE

Establish and operate and LLNL Local Records Center that meets the requirements of the Quality Assurance Program Plan and other Project-level requirements, including receipt, retention, and protection of all records, issue of controlled documents, and operations of correspondence, logging, tracking, and distribution systems.

ACTIVITIES AND ACCOMPLISHMENTS

In the month of September, the Records staff completed processing all backlogged LLNL records through to the Central Records Facility. The Records staff reorganized files based on a numerical system for quicker filing and retrieval. The task of acquiring fire cabinets for areas other than Records and Document Control continues.

An inventory of backlogged records within the LLNL-YMP was conducted this month. Results were sent to Jan Statler, SAIC, on 9/19/89.

Revisions to the Quality Procedures for Records and Document Control are undergoing final review and approval.

Document Control issued 2 activity plans, and 1 revision and 12 change notices to the quality procedures under controlled distributions. Routine follow-up for receipt acknowledgements continued.

The controlled document distribution list was refined to more easily track acknowledgement receipts.

During September, 21 action items were closed on the action item report.

MAJOR ACTIVITIES UPCOMING NEXT THREE MONTHS

Efforts will continue to refine the daily operating procedures in handling records. Acquisition of fire cabinets should be completed by the end of October. Efforts will be directed to upgrading the Document Control database, creating menu driven items. No other major activities are scheduled.

WBS 1.2.9.2 PROJECT CONTROL
J. Podobnik, P.I.

OBJECTIVE

This task manages and coordinates all LLNL Yucca Mountain Project activities to be consistent with the goals and objectives of the overall DOE Yucca Mountain Project, including planning, technical direction, cost, and schedule control.

ACTIVITIES AND ACCOMPLISHMENTS

Completed FY89 accounting close.

Submitted first PACs input covering 15 month period from October 1 to December 30, 1990. Input consisted of 45 accounts with unique PACs identifiers, resource information and preliminary schedule information.

Converted all scheduling information to Prima Vera-based system. LLNL schedules are now developed in PDM modes.

Continuing development of data requirements and assumptions for support of a fully integrated cost and schedule system. Objective is to acquire information that will provide the basis to develop the WAS, FY budgets and satisfy PACs, using a single data input form.

Issued FY90 budget call to technical areas. Most inputs are complete.

MAJOR ACTIVITIES UPCOMING NEXT THREE MONTHS

Refine PACs data and submit next quarterly increment.

Resource load all LRP activities and modify program based on FY90 budget levels.

Complete FY90 working budgets.

Complete Prima Vera conversion and institutionalize internal cost/schedule systems.

WBS 1.2.9.3.L QUALITY ASSURANCE
D. Short, P.I.

OBJECTIVE

The objective of Quality Assurance is to develop, implement, and maintain a Quality Assurance Program Plan in accordance with requirements set forth in the YMP QA Plan, NVO-196-17, and the Project Administrative Procedures.

ACTIVITIES AND ACCOMPLISHMENTS

Supplemental information was transmitted to DOE-LV on September 11, 1989 relative to the transition from the old Scientific Investigation Plan, Quality Assurance Level Assignments system, to the new SIP/Study Plan, QALA, grading system.

A modification of LLNL Yucca Mountain Project Software Quality Assurance Plan, Rev 0, was transmitted to DOE-LV on September 12, 1989 for review. We expect to formally submit the LLNL SQAP for approval two working days after receiving Project Office comments on this preliminary draft.

Six Readiness Review Notices were forwarded to DOE-NV on September 13, 1989.

The LLNL-YMP approved the Quality Assurance Plan for Calibration Services, Engineering Measurements and Analysis Section, Rev 1, on September 1, 1989. A surveillance of the EM&A facility will be conducted to verify implementation of the QA Program.

The LLNL-YMP FY 1990 Quality Assurance Audit Schedules, both internal and external, were transmitted to YMP-NV on September 15, 1989. Additional external audits will be conducted as additional subcontractors who will be performing QA Level I and II activities are identified.

QA Surveillance, S89-18, Pacific Northwest Laboratory, was completed on September 21, 1989. No nonconforming conditions were identified during this surveillance and PNL is ready to implement a QA Program consistent with LLNL-YMP QARS-001C.

The LLNL-YMP FY 1990 Quality Assurance Surveillance Schedules, both for internal and external surveillances, were transmitted to YMP-NV on September 25, 1989. Additional external surveillances will be conducted as LLNL begins performing QA Level I and II activities.

The FY 1989 QA Surveillance Log was finalized on September 25, 1989 and entered into the Records Management System. Eighteen surveillances were completed during FY89.

Revision 1 of QP 2.9, Indoctrination and Training, was distributed internally for review. This revision incorporates Change Notices 2.9-0-1 to 2.9-0-3.

As requested, LLNL-YMP transmitted comments and suggestions concerning NNWSI/88-9, Rev 2 to DOE-NV on September 28, 1989.

D. Short attended the Project Quality Assurance Managers' Meeting in Las Vegas on September 21, 1989.

D. Short attended the Sixteenth Annual National Energy Division Conference in Fort Lauderdale, FL on September 17-20, 1989.

A Readiness Review Board Meeting was conducted on September 27-28, 1989; "Development of Models for Degradation Modes", "Mechanical Properties and Microstructure; Long Term Corrosion Studies"; "Characterization of Candidate Materials;" "Temperature Oven Method for Spent Fuel Oxidation Testing", and "Thermogravimetric Analysis for Spent Fuel Oxidation Testing" were reviewed. R. Edwards, YMPO, and S. Nolan, SAIC, attended the meeting.

Enclosure #3

Lawrence Livermore National Laboratory

LLYMP8911068
November 9, 1989

WBS 1.2.9.
QA: N/A

Carl Gertz, Project Manager
Department of Energy
Nevada Operations Office
Yucca Mountain Project Office
P.O. Box 98518
Las Vegas, Nevada 89193-8518

Attention: W. R. Dixon, Director
Project and Operations Control Division

SUBJECT: LLNL Yucca Mountain Project Status Report - October 1989

Attached is the LLNL October Project Status Report for summarizing the major highlights completed for the Yucca Mountain Project.

If further information is required, please contact Deborah A. Kiraly at FTS 543-4571.

Sincerely,

Leslie Jardine
LLNL Technical Project
Officer for YMP

LJJ/DK/dk
Enclosure

YMPO, M. Blanchard
YMPO, M. Cloninger
YMPO, J. R. Dyer
YMPO, V. Iorii
YMPO, L. Little
SAIC, B. McKinnon
SAIC, D. Morissette

DISCLAIMER

QA checks on data contained here have only been performe
that the data has been obtained and documented properly. The
Management Project cautions that any information is preliminary
subject to change as further analyses are performed or as an enlarged and perhaps more representative data base is accumulated. These data and interpretations should be used accordingly.

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

OCTOBER 1989

1.2.1 SYSTEMS

1.2.1.2 SYSTEMS ENGINEERING IMPLEMENTATION

LLNL reviewed the proposed resolutions to earlier comments on the July 1989 draft of AP-5.1Q ("Management and Development of Technical Data on the Yucca Mountain Project"). The Document Review Sheet forms, indicating the acceptance or rejection of each response, and several points of clarification were returned to YMPO on October 11, 1989.

LLNL staff attended the Technical Data Advisory Group (TDAG) meeting at LANL on October 26, 1989. Agenda items included technical data management priorities for FY90, discussion of the revised Technical Data Management Plan annotated outline, identification of existing data compilation and qualification of data.

LLNL reviewed drafts of the Waste Package - Repository Interface Control Drawings and met with SNL staff in Albuquerque on October 27, 1989 to discuss the status of the proposed drawings. Formal comments were transmitted to SNL and YMPO on November 1, 1989.

1.2.1.4 PERFORMANCE ASSESSMENT

Resolution of internal review comments for the PANDORA-1 report (Milestone M260) are in progress.

Efforts are continuing in developing SIP revisions, activity plan drafts, Long Range Planning networks and inputs to the Project Control System network conversions. Further activities are required prior to initiating readiness reviews to start QA Level I work.

Input was transmitted to YMPO for the OCRWM Performance Assessment Implementation Plan (PAIP), (ACTION ITEM NN1-1989-3438).

1.2.1.4 GEOCHEMICAL MODELING AND DATA BASE DEVELOPMENT

A meeting was held at YMPO with the DOE Performance Assessment - TIG group. Presentations by staff and follow on discussions were used to demonstrate how the Geochemical Modeling Code EQ3/6 is used by LLNL to directly support both the waste package and engineered barrier system performance assessments and to guide the LLNL experimental programs.

Responses to comments received from YMPO on the LLNL Software QA Plan were prepared for submittal to the Project Office.

1.2.2 WASTE PACKAGE

1.2.2.2 NEAR FIELD ENVIRONMENT MODELING AND TESTING

Activity continued in revising and developing SIPs, Study Plans, and Implementing Procedures. Work continued on documenting the completed horizontal emplacement tests in G-tunnel.

1.2.2.3 WASTE FORM MODELING AND TESTING

SPENT FUEL, ZIRCALOY CLADDING DEGRADATION, GLASS WASTE FORM

Flow-through dissolution testing on spent fuel continued to determine data regarding the rates radionuclides are dissolved. These data are required for spent fuel release rate model development. Effects of flow rate on UO2 dissolution rates are being tested in two other columns using deionized water (DIW) and dilute bicarbonate solution. The effects of water composition on UO2 dissolution rates are being tested in another column.

Draft Test Plans for pressurized tube testing of Zircaloy cladding and for the thermal release of carbon-14 from PWR and BWR cladding were completed. These test plans are a primary step in the requirements to describe experimental plans for obtaining QA Level I data for the development of a cladding failure model and a carbon-14 release model.

Reviews of the glass waste form model development and glass waste form testing activities were presented to representatives and subcontractors of NE, DP and OCRWM at a glass review meeting held in Las Vegas on October 18, 1989. The presentations emphasized the need for experimental data to guide glass dissolution model development and to describe glass performance when placed in the environmental conditions of a proposed repository.

1.2.2.3 METAL BARRIER SELECTION & TESTING

A DOE-NRC Technical Exchange on nuclear waste container materials was held on October 26 at NRC offices in Rockville, MD

LLNL staff presented material on (A) Background, including the historical development of container design configurations and candidate materials, and an overview of the LLNL Container Materials effort, (B) Material Selection, including the status of the selection criteria document, the peer review activity, and plans toward the selection for advanced studies, (C) Inputs into the Selection, including an outline of the parametric studies needed to obtain quantitative and comparative information on the candidates, (D) Modeling, including the status of existing models for the candidate materials and plans for model development and performance assessment of the selected material(s), and (E) Test Plans, including standardized tests and needs for non-standard tests to demonstrate the long-term performance.

LLNL staff held an internal technical planning meeting on October 12-13 to lay plans for experimental activities planned for the near and more distant future. The focus was to establish test details (specimen materials, specimen configuration, specimen treatment, environment chemistries, temperatures, and so on) for the parametric studies that will provide information for the container material selection activity planned for next April.

1.2.2.3 THERMODYNAMIC DATA DEVELOPMENT

Hydrolysis and Carbonate Complexation of Pu(V) The photo-acoustic spectra of Pu(V) obtained as a function of carbonate solution concentration have been analyzed and formation constants for the first and second carbonate complexes obtained from the analyses. Values for the logarithms of beta(1) and beta(2) were found to be 4.65 ±0.12 and 7.02 ±0.20, respectively.

High-temperature Calorimetry and Spectroscopy The activity plan and technical procedures were completed for this task and a readiness review conducted. The precision of the new variable temperature calorimeter was improved from ±5% to ±3.8% and the aguement in the measured value for the heat of protonation of TRIS with that of the published value of Grenthe at 50°C was improved to 0.5%. The calorimeter is now ready to initiate measurements on the enthalpies of waste radionuclides reactions as a function of temperature.

Spectroscopic data taken at 25, 60 and 95° showed discrepancies in their Beer's law plots, i.e., the Beer's law plots were not collinear as expected. The absorptivity appears to decrease linearly with temperature. This effect could not be explained by thermal expansion of the aqueous solution and may reflect the change in the absorption process.

High-temperature Calorimetry (Florida State University) The activity plan and technical procedures for this task were nearly completed this month and the readiness review completed. The variable temperature was successfully operated at 70°C.

Resolubility Studies. The inert atmosphere boxes are being prepared to initiate solubility studies of schoepite, soddyite, sodium boltwoodite and sodium weeksite at 50 and 75°C.

1.2.2.4 CONTAINER MATERIALS, FABRICATION AND CLOSURE

A letter report entitled, "Cost Estimate of High-Level Radioactive Waste Containers for the Yucca Mountain Project" is in review with expected delivery to YMPO in November, 1989.

Additions and changes were made to the 9/89 draft of the DOE/AECL Cooperative Scope, "Waste Container Fabrication, Closure, and Inspection Activities", in preparation for a negotiation meeting of DOE staff planned for November 1989.

1.2.5 REGULATORY AND INSTITUTIONAL

1.2.5.2

LLNL completed and submitted the draft inputs to the Biannual Status Report.

1.2.9 PROJECT MANAGEMENT

1.2.9.1 MANAGEMENT

A summary of the FY89 LLNL activities was presented to the EEI group at Las Vegas on October 17, 1989.

1.2.9.2 PROJECT CONTROL

LLNL staff received and analyzed inputs for FY90 budget submission requirements. Development of internal project control and planning systems necessary for PACs implementation were completed.

The Workscope to comply with FY90 funding guidance was revised and development of PACs inputs and other planning activities were continued.

1.2.9.3 QUALITY ASSURANCE

LLNL-YMP conducted five Readiness Reviews during the month of October (Activities D-20-44, D-20-45, E-20-15, J-20-8.1, and E-20-18). Readiness Reviews have verified that the prerequisites have been met for a total of twelves activities.

Two procedures were transmitted for internal review during October: QP 2.9 Rev 1 "Indoctrination and Training" and QP 3.5 "Control of Internal Technical Interfaces".

On October 24-26 DOE-Yucca Mountain Project representatives performed surveillance of LLNL activities related to QP 2.1, QP 4.0, QP 4.1, QP 7.0, QP 5.0, QP 6.0, QP 14.0, and QP 17.0.

Enclosure #4.

Lawrence Livermore National Laboratory

LLYMP8911227
November 30, 1989

WBS 1.2.9
QA: N/A

YMP

Carl Gertz, Project Manager
Department of Energy
Nevada Operations Office
Yucca Mountain Project Office
P.O. Box 98518
Las Vegas, Nevada 89193-8518

Attention: W. R. Dixon, Director
Project and Operations Control Division

SUBJECT: Yucca Mountain Project Status Report - NOVEMBER 1989

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

If further information is required, please contact Deborah A. Kiraly of my staff at FTS 543-4571.

Sincerely,

Leslie Jardine
LLNL Technical Project
Officer for YMP

LJJ/DK/dk
Enclosure

YMPO, V. Iorri
YMPO, M. Cloninger
YMPO, L. Little
YMPO, E. Wilmot
YMPO, M. Blanchard
SAIC, B. McKinnon
SAIC, D. Morissette

DISCLAIMER

QA checks on data contained here have only been performed to determine that the data has been obtained and documented properly. The LLNL Waste Management Project cautions that any information is preliminary and subject to change as further analyses are performed or as an enlarged and perhaps more representative data base is accumulated. These data and interpretations should be used accordingly.

12/11/89

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

November 1989

1.2.1 SYSTEMS

1.2.1.2 SYSTEMS ENGINEERING IMPLEMENTATION

No significant activities or milestones were completed in November.

1.2.1.4 PERFORMANCE ASSESSMENT

LLNL provided written comments to the YMPO on the NRC's Site Characterization Analysis interpretation of "anticipated processes and events".

LLNL approved the Scientific Investigation Plan for the Performance Assessment of the Conceptual Design reference case. This pre-ACD Performance Assessment will provide design input guidance and design requirements for the Advanced Conceptual Design.

LLNL completed and transmitted to the YMPO, the Planning and Control Systems (PACS) input logic for near-term Performance Assessment activities at LLNL.

LLNL continued the disposition of internal review comments on the PANDORA report.

The QA Level Assessment on the PA Scenario Identification subactivity was completed, and a Readiness Review for the start of this activity is scheduled for December 1, 1989.

LLNL technical personnel participated in the Annual Conference of the Society for Risk Analysis, San Francisco, 10/31 to 11/1/89.

No significant activities or milestones were completed in November.

1.2.1.4 GEOCHEMICAL MODELING AND DATA BASE DEVELOPMENT

LLNL personnel participated in the Radionuclide Migration Conference, Monterey, CA, and met with representatives of the Hahn Meitner Institute, Berlin, and the SKB, Sweden, on the current status and development of the EQ3/6 Program.

No significant activities or milestones were completed in November.

1.2.2 WASTE PACKAGE

1.2.2.2 NEAR FIELD ENVIRONMENT MODELING AND TESTING

Analysis continued on the re-wetting behavior of tuff and on the modeling of fracture imbibition.

The LLNL source code Version 1.1.2 of V-TOUGH was transmitted to Sandia National Laboratory for use in their performance assessment activities.

LLNL prepared planning documents and dispositioned comments received on the Mechanical Attributes Study Plan.

LLNL staff continued preparation of final reports on horizontal prototype tests in G-Tunnel.

LLNL approved the Scientific Investigation Plan on vertical prototype testing.

No significant activities or milestones were completed in November.

1.2.2.3 WASTE FORM MODELING AND TESTING

LLNL continued preparation of Activity Plans for D-20-42, Saturated Semi-Static Dissolution Tests of Spent Fuel and UO_2; D-20-53, Flow-through Dissolution Tests of Spent Fuel and UO_2.

LLNL processed the procurement of a glove box for spent fuel and glass dissolution work at LLNL.

LLNL reviewed the Argonne National Laboratory (ANL) Test Plan for Series 5 Spent Fuel Leaching, obtained Pacific Northwest Laboratory (PNL) comments on the Plan, and processed an annotated copy of the Test Plan back to ANL for revision.

LLNL continued preparation of Scientific Investigation Plans for Integrated Radionuclide Release activities.

LLNL participated in the International Conference on the Chemistry and Migration Behavior of Actinides and Fission Products in the Geosphere (Monterey, CA).

LLNL measured and analyzed diffusion profiles for ^{18}O in diopside and spinel samples.

No significant activities or milestones were completed in November.

1.2.2.3 METAL BARRIER SELECTION AND TESTING

LLNL approved the Activity Plan for "Actinide and Technetium Thermodynamic Measurements," Activity J-20-8.1 for theThermodynamic Data Development activities.

No significant activities or milestones were completed in November.

1.2.2.4 SPECIAL STUDIES

The Container Fabrication and Closure Development task was deferred for budgetary reasons. Babcock and Wilcox is assembling all data, QA information, etc., into a turn-over/close-out package for transmittal to LLNL.

No significant activities or milestones were completed in November.

1.2.5.2 REGULATORY AND INSTITUTIONAL

LLNL provided assessment responses to the NRC's Site Characterization Analysis (SCA) to SAIC on November 3.

No significant activities or milestones were completed in November.

1.2.9 PROJECT MANAGEMENT

1.2.9.1 MANAGEMENT

Extensive staff meetings were initiated to develop FY 1990 work scopes for reduced budget scenarios. Staffing, technical activity alternatives and deliverables for various FY 1990 budget scenarios were developed.

LLNL prepared material and technical inputs for the Nuclear Waste Technical Review Board (NWTRB) meeting to be held at LLNL on January 18-19, 1990 .

A meeting was held on November 14, 1989, at LLNL between L. Little of the YMPO, J. Hale of DOE/HQ, LLNL and SAIC to discuss the approach for developing a Waste Package Program Plan. LLNL was given the lead responsibility and assignment to develop the Plan. An LLNL approved Program Plan will be submitted to the YMPO by January 1, 1990. A progress review meeting is scheduled for December 8, 1989 at LLNL.

A meeting was held on November 28, 1989, between C. Gertz of the YMPO and L. Jardine of LLNL to discuss various aspects of the FY 1990 programs at both LLNL and the YMPO.

1.2.9.2 PROJECT CONTROL

LLNL staff completed and submitted the second PACS input for WBS 1.2.1.4.2 (Performance Assessment Systems).

LLNL staff constructed budget spreadsheets illustrating FY 1989 actuals and the initial FY 1990 budget estimates.

Peat, Marwick and Main completed the DOE financial audit of LLNL Waste Management. No significant discrepancies were identified. Feedback received on LLNL control systems and applications was very favorable.

1.2.9.3 QUALITY ASSURANCE

The YMPO notified LLNL that the LLNL-QAP, Revision 0, was accepted by the NRC.

LLNL received comments and submitted responses to the Project Office on the LLNL-YMP Software Quality Assurance Plan.

LLNL QA conducted an internal QA Surveillance of the Personnel Qualification Records; no discrepancies were found.

The YMPO completed a QA Surveillance of LLNL Computer Software Control; no discrepancies were identified.