



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

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M E M O R A N D U M

DATE: November 15, 1991
FOR: Joseph Holonich, Director, HLPD
Division of High-Level Waste Management, M/S 4 H 3
FROM: *John W. Gilray* John W. Gilray, Sr. OR - YMP
SUBJECT: YMP Site Report for the months of September and October

I. QUALITY ASSURANCE

A. Audit Activities

◆ NRC Audit of USGS

I participated in the NRC Audit (NRC 91-01) of USGS conducted at the Nevada Test Site from September 16 and 17, 1991, and at the USGS facilities in Denver, Colorado from September 18 through 10, 1991. The purpose of this audit was to conduct a programmatic evaluation of the implementation of the USGS QA program as it relates to the Site Potentiometric-Level Evaluation activity under the Study Plan for Characterization of the site Saturated-Zone Ground-Water Flow System. As a result of this audit the USGS is taking corrective measures to improve the control and use of scientific notebooks during test and experimental field work. The overall results of this audit have been documented in Audit Report No. NRC-91-11 which was released November 12, 1991 from HLPD.

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- ◆ The Office of Civilian Radioactive Waste Management (OCRWM) conducted an internal QA audit (HQ-92-001) of the implementation and effectiveness of OCRWM's QA Program from October 15 through 18, 1991. This audit was conducted at the OCRWM headquarters office, Washington, D.C. and at the YMPO, Las Vegas, Nevada. At the request of the HLWM QA office I participated in the Las Vegas portion of this audit as the NRC observer. The result of observing this audit has been submitted to the HLWM QA office for inclusion in the overall NRC Observation Audit Report. In general I found the conduct of the audit at Las Vegas effective and agree with the preliminary audit findings that the YMPO at Las Vegas has an adequate QA program for those areas that were audited.

- ◆ The implementation of the YMPO QA Program was also audited from October 28 through November 1, 1991, YMP Audit 91-01-01. At the request of the HLWM QA office I assisted in observing the audit of the YMPO procurement activities. The results of this observation has been submitted to the HLWM QA office for use in their final observation report.

- ◆ The YMPO QA organization recently completed auditing the Sandia National Laboratories from August 19 through 23, 1991, Los Alamos National Laboratory from October 1 through 4, 1991, and the U.S. Geological Survey from October 15 through 18, 1991, and the Sandia National Laboratory from November 4 through 8, 1991. As a result of these audits the YMP audit team found the QA program was adequately being implemented in the areas that were audited and no substantive QA findings were identified.

- ◆ The YMPO QA organization plans to audit the REECo QA program November 18 through 22, 1991, (NO. YMP-92-04) Since this audit is limited in scope the HLWM QA office has requested that I represent the NRC staff in observing this audit.

Other audits planned by the YMP QA organization are of the Lawrence Livermore National Laboratory from December 2 through 6, 1991; the Ratheon Services of Nevada from December 16 through 20, 1991; the YMPD from January 6 through 10, 1992 and the SAIC from January 27 through 31, 1992.

B. QA Workshops and QA Program Document Revision

As a result of a recommendation from the QA workshops a YMP Quality Integration Group (YMP-QIG) has been established under the leadership of Larry Hayes, US Geological Survey, Technical Project Officer. The objectives of the YMP-QIG are 1) to facilitate communication, discussion, and resolution of quality-related concerns arising from management, quality assurance, and scientific interactions on the YMP, 2) to contribute to the evolution and implementation of a coherent and stable quality-assurance program that is compatible with the scientific method and with research-and-development activities; and 3) to provide suggestions that assure that the products of site-characterization efforts and basic and applied research will be suitable for use in the licensing process.

The composition of the YMP-QIG is comprised of eight members, one from each of the participant organizations with major scientific responsibilities: Los Alamos, Lawrence Livermore, Sandia, and the US Geological Survey and one each from YMPD management, QA, technical staff, and a chairperson.

Members of the YMP-QIG are actively involved in reviewing and commenting on the October 14, 1991, draft of the OCRWM Quality Assurance Requirements and Description document for the YMP (QARD). This QARD, when approved, will be applicable to all YMP major participants. The goal of the YMP-QIG review of the QARD is to incorporate compatible scientific investigation controls into the QARD. In addition, the Software Advisory Group (SAG), an outgrowth from the Software QA workshops, is also reviewing the draft QARD and has provided substantive QA software

recommendations to the YMP QA organization pertaining to software verification, validation, model validation, configuration management and discrepancy reporting. The YMP QA organization is working closely with QIG and SAG regarding the resolutions to their comments and recommendations. A final draft of the QARD is being prepared incorporating changes resulting from these interactions. The YMP hopes to have the approved QARD submitted to the NRC for review by the end of Decmeber. The YMPO QA organization has developed a matrix which traces and identifies all NRC Standard Review Plan QA Controls to the appropriate requirements in the QARD. The YMPO intends to submit this matrix to NRC to assist the staff in the review of the QARD.

The OR office will continue attending the meetings of the QIG and SAG to keep abreast of their ongoing activities. The NRC QA staff accordingly will be kept informed on the progress of these activities.

C. Appointment of YMP QA Division Director

- ◆ Richard Spence has accepted the position of Quality Assurance Division Director for the Yucca Mountain Quality Assurance Division. Mr. Spence has a Bachelor of Science Degree in Nuclear Engeering from Oregon State University and has 25 years experience in the Nuclear Industry. His experience includes program management, procedure development, reactor operations, QA and ASME program development, training, health physics, radioactive waste shipping and handling, system support, employee concerns, jurisdictional interfacing, inspection, source surveillance, program assessments and auditing. In addition to his Quality Assurance background, Mr. Spence has a scientific background that should support his work in this position. The assignment was effective October 6, 1991.

An updated YMP QA organization chart is enclosed as Enclosure 1.

I have had several meetings with Richard Spence which involved the following issues: the status of the YMP QA Program; his overall QA philosophy towards QA; the responsibilities of this OR office and the need and benefit of having weekly meetings. Richard appears to have a good understanding of the strength and weaknesses that exist within the YMP QA program and organization. I believe he will make a significant contribution in correcting and improving the effectiveness of the YMP-QA program. Already I have seen evidence of his close interactions with the YMP technical staff regarding more timely and improved QA direction and involvement with the technical staff and their activities.

II. LLWM ACTIVITIES

I have devoted a considerable amount of time and effort in developing fourteen QA and administrative procedures for the LLWM Division. This task is essentially complete except for the possibility of being involved in rewrites to these procedures resulting from LLWM reviews. The table of contents for these procedures is enclosed as Enclosure 2 for information.

III. WASTE PACKAGE

The LLNL monthly status reports for August, September, and October are enclosed (Enclosure 3). 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 the impact on the YMP.

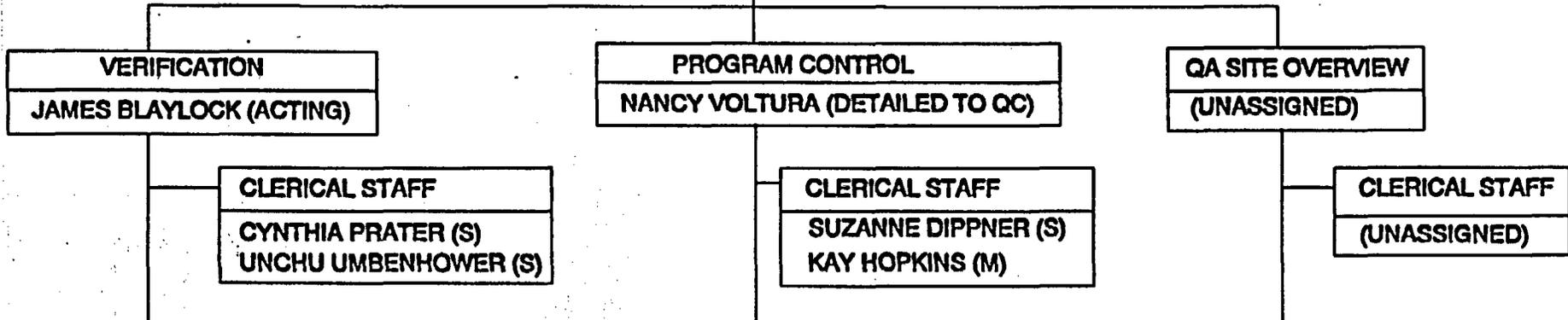
There are no new issues that this office has identified that have not been brought to management's attention.

cc w/enc: K. Hooks, M/S 4H3; R. Ballard, M/S 4H3, J. Latz
wo/enc: J. Roberts, C.P. Gertz, R.E. Loux, C. Pflum, G. Cook,
D.M. Kunihiro, D. Weigel, B. Youngblood, J. Linehan, M/S 4H3;
H. Denton, M/S 17F2, R. Bernero, M/S 6A4; H. Thompson, 17G21;
S. Gagner, M/S 2G5; E. O'Donnell, M/S NLS260

APPROVED BY *R.E. Spence* 7/0/16/91

DIRECTOR
OF
QUALITY ASSURANCE
RICHARD E. SPENCE

SECRETARY
HELGA MASUDA



ROBERT CONSTABLE (DOE)
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DICK KETTEL (S)
JOHN MATRAS (S)
JIM RUSK (M)
JOHN THERIEN (S)
TOM VANDEL (M)
WES WILLIAMS (M)

(H) HARZA
(M) MACTEC
(S) SAIC
(W) WESTINGHOUSE

Enclosure I

NUCLEAR REGULATORY COMMISSION
LOW LEVEL WASTE DIVISION PROCEDURES

Policy for LLWD Compliance with Quality Assurance and
Program Controls

- LLWD-1 Control of Management/QA Procedures
- LLWD-2 Control of Purchased Services
- LLWD-3 Controlling and Correcting Conditions Adverse to
Quality
- LLWD-4 Collecting, Processing, Storing, Retrieving and
Maintaining Control of LLWD Quality Records
- LLWD-5 Audits
- LLWD-6 Procedure for Indoctrination & Training of New
Employees to LLWD
- LLWD-7 Review of Technical Documents
- LLWD-8 Documenting, Positioning and Controlling Allegations
- LLWD-9 LLWD Interactions with other Federal and State
Organizations
- LLWD-10 Inspection Program
- LLWD-11 Development, Review and Control of Software
- LLWD-12 Control of Safety Issues
- LLWD-13 Development of LLWD Rulemaking, Regulatory Guide and
Technical Positions
- LLWD-14 QA Program Controls Applicable to Outside Sources
Seeking LLWD Regulatory Review

Lawrence Livermore National Laboratory



LLYMP9109140
September 19, 1991

WBS 1.2.9
"QA: N/A"

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

SUBJECT: Yucca Mountain Project Status Report - August 1991

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

If further information is required, please contact Elizabeth Campbell of my staff at FTS 532-7854.

Sincerely,


W. L. Clarke
LLNL Technical Project Officer
for YMP

WC/EC/ec

cc
Distribution

DISCLAIMER

The LLNL Yucca Mountain Project cautions that any information is preliminary and subject to change as further analyses are performed or as an enlarged and perhaps more representative data base is accumulated. These data and interpretations should be used accordingly.

LAWRENCE LIVERMORE NATIONAL LABORATORY YUCCA MOUNTAIN PROJECT
AUGUST 1991 TECHNICAL HIGHLIGHTS AND STATUS REPORT

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LAWRENCE LIVERMORE NATIONAL LABORATORY
(LLNL)

YUCCA MOUNTAIN PROJECT (YMP) STATUS REPORT

AUGUST 1991

Effective this month, LLNL-YMP will consolidate its YMPO-required monthly status report with its somewhat longer internal technical status report. The distribution of the combined report will include all those who have received either report in the past.

EXECUTIVE SUMMARY

(Items Proposed for Reporting in YMPO or OGD Reports)

1) The draft of the EQ3NR User Manual was completed and submitted for technical review. This manual is an extensive revision of one published in 1983. New sections deal with Pitzer's equations, the pHCl concept for dealing with pH in brines, and the alkalinity concept. New material was also added dealing with the numerical methods employed, the code architecture, and error processing. Effort has now shifted toward completing the EQ6 User Manual and the EQ3/6 Package Overview and Installation Guide, which are expected to be finished by late September.

2) As a result of the meeting held in July at NTS on water chemistry, specifically the interest expressed in modeling and experimentally accessing water in the unsaturated zone, preliminary calculations were made of the quantity of unsaturated water that could be expected to be removed from intact repository horizon Topopah Spring Tuff via centrifugation. The results of the calculations show that, at most, a few mL of water could be expected to be removed from each sample (6 cm in diameter, 8 cm long) when centrifuged at 18,000 rpm.

3) T. Buscheck is conducting hydrothermal model calculations for the NWTRB meeting on thermal loading which will be held in October. These calculations address several general objectives:

1) what are the accuracies of repository thermal models which only consider heat conduction,

2) how does the repository dry-out volume vary with Areal Power Density (APD) and with the Local Areal Power Density (LAPD) along emplacement drifts,

3) how do heat flux and ground surface temperature vary with APD, and

4) how do gas-phase velocities (which arise due to hydrothermally-driven natural convection) vary with APD.

These hydrothermal calculations are being conducted at several different scales, with the large scale and intermediate scale model requiring the use of the Equivalent Continuum Model (ECM) assumptions, and the small scale model discretely accounting for nonequilibrium fracture-matrix flow behavior.

4) The drybath tests continue at PNL. A full interim weighing was conducted, and one sample was lost when a crucible bail failed; however, no additional samples were contaminated. The $\Delta O/M$ data continue to support the predicted behavior. First, it appears that spent fuel variations only affect oxidation in a transitory

manner. Secondly, the first stage of oxidation ends at $\Delta O/M \sim 0.4$ and is essentially a U_4O_9 lattice structure with additional oxygen. The time to reach this $\Delta O/M$ has an Arrhenius behavior. Finally, oxidation of the fuel to a higher O/M ratio will eventually occur. From the preliminary data, it is projected that the first stage of oxidation (to an O/M ratio of about 2.4) should not be complete at repository temperatures before 1000+ years.

1.2.1 SYSTEMS

1.2.1.1 Management and Integration

Activities are reported as part of other WBS elements.

1.2.1.2.4 Systems Engineering Implementation

LLNL received the draft IMOU 330018, "Development of Test Planning Package (TPP) 91-5 and Revision of ESFDR Testing Requirements". A review of this IMOU has been initiated and comments or acceptance will be forwarded to T&MS in early September.

The draft System Studies Plan, prepared by SNL for YMPO, was received by the LLNL staff. The comments and questions raised by LLNL have been discussed with SNL, and a letter summarizing this informal review is in preparation.

A draft report "Incentives for Selection of Spent Fuel for Delivery to the Federal Radioactive Waste Management System (FWMS) - A Preliminary Analysis", edited by PNL, was submitted to LLNL for review. This report integrates the results of LLNL's Spent Fuel Receipt Scenarios Study (UCID-21530) into the overall FWMS. Comments resulting from LLNL's review will be forwarded to PNL.

1.2.1.3.5 Technical Database Input

LLNL completed the GEMBOCHS input to the Technical Database Quarterly Report, to be issued by YMPO, and also prepared a draft section of the Technical Database Handbook.

Responses to the NEA Thermodynamic Database Questionnaire were developed by the LLNL staff and forwarded to YMPO for integration into the Project response.

A revised Schedule for Technical Data Transfer (LLNL-YMP) is in preparation.

1.2.1.2.6 YMP Support to Management Systems Improvement Strategy

No significant activities.

1.2.1.4.2 Waste Package Performance Assessment

A simplified "source term" specification, intended for use in total system performance models, was submitted to the co-authors on August 22 for review.

R. Barnard of SNL visited LLNL to discuss the source term model.

A PANDORA model information summary was transmitted to TESS/INTERA on August 13 responding to their query.

A paper by T. Ueng and W. O'Connell entitled "Diffusive Barrier Simplified Analysis - Design and Sensitivity Applications" will be submitted to YMPO for approval. This paper will be presented at the FOCUS '91, Nuclear Waste Packaging meeting to be held in Las Vegas, September 29 - October 2, 1991.

A paper by D. Chesnut entitled "The Demands Placed on Waste Package Performance Testing and Modeling by Some General Results of Reliability Analysis" will be submitted to YMPO for approval. This paper will be presented at the FOCUS '91, Nuclear Waste Packaging meeting to be held in Las Vegas, September 29 - October 2, 1991.

An internal QA grading package for Activity I-20-22, "Extend PANDORA-1, the Deterministic Single Waste Package Systems Model to PANDORA-1.1" was submitted to LLNL-QA on August 21.

1.2.1.4.5 Geochemical Modeling and Database Development

The draft of the EQ3NR User Manual was completed and submitted for technical review. This manual is an extensive revision of one published in 1983. New sections deal with Pitzer's equations, the pHCl concept for dealing with pH in brines, and the alkalinity concept. New material was also added dealing with the numerical methods employed, the code architecture, and error processing. Effort has now shifted toward completing the EQ6 User Manual and the EQ3/6 Package Overview and Installation Guide, which are expected to be finished by late September.

A review was completed of the NEA draft document "A Comparison of Radionuclide Sorption Databases Used in Recent Performance Assessments" by I. McKinley and A. Scholtis. The review was submitted to R. Levich of YMPO, closing the action item related to this report.

J. Johnson solicited and collated the requested response of several LLNL geochemists to a questionnaire regarding future NEA-TDB efforts. The aggregated response was submitted to J. Oliver, Head, RPWMP, OECD-NEA, Paris.

The document "The LLNL GEMBOCHS Database and Software Library: YMP-TDB Quarterly Report 3rd Qtr., 1991" was submitted to C. Newbury of YMPO, closing the action item related to this report.

The document "The LLNL GEMBOCHS Database and Software Library" was completed and submitted to G. Heitland, SAIC, Schaumburg, IL. The document is to be included as Chapter 4 of the YMP-TDB Handbook.

1.2.1.4.7 Supporting Calculations for Postclosure Performance Analyses

This activity is suspended due to lack of funding.

1.2.2 WASTE PACKAGE

1.2.2.1 Management and Integration

J. Blink attended a meeting of the PARATRAC TDWG on August 22 and provided comments on the draft categorization scheme for 1.2.2 WBS elements.

1.2.2.2 Waste Package Environment

Chemical and Mineralogical Properties of the Waste Package Environment

As a result of the meeting held in July at NTS on water chemistry, specifically the interest expressed in modeling and experimentally accessing water in the unsaturated zone, preliminary calculations were made of the quantity of unsaturated water that could be expected to be removed from intact repository horizon Topopah Spring Tuff via centrifugation. The results of the calculations show that, at most, a few mL of water could be expected to be removed from each sample (6 cm in diameter, 8 cm long) when centrifuged at 18,000 rpm.

Work has begun to compare the two-site ideal Vanselow model for ion-exchange on clinoptilolite with the regular solution model proposed by Pabalan (from SWRL-NRC).

Man-Made Materials

No significant activities.

Hydrologic Properties of the Waste Package Environment

The cleaning up of the pore pressure lines of the high-pressure-high-temperature system continued. It was found that intact (not corroded) stainless steel tubing is suitable as pore-water lines. However, if corrosion occurs, then the corroded part releases iron into water even at room temperature. All of the pore-water lines with new stainless steel tubings will be replaced. Another blind test will then be performed to check the iron concentration in the water before flowing through a rock sample.

Work continued to write a SIP for the laboratory study of the hydrologic properties of the Near-Field environment and to revise the Study Plan for the same activity.

A paper by W. Lin, A. Ramirez and D. Watwood entitled "Temperature Measurements from a Horizontal Heater Test in G-Tunnel" has been submitted to YMPO for approval for the FOCUS '91, Nuclear Waste Packaging meeting to be held in Las Vegas, September 29 - October 2, 1991.

T. Buscheck is conducting hydrothermal model calculations for the NWTRB meeting on thermal loading which will be held in October. These calculations address several general objectives:

- 1) what are the accuracies of repository thermal models which only consider heat conduction,
- 2) how does the repository dry-out volume vary with Areal Power Density (APD) and with the Local Areal Power Density (LAPD) along emplacement drifts,
- 3) how do heat flux and ground surface temperature vary with APD, and
- 4) how do gas-phase velocities (which arise due to hydrothermally-driven natural convection) vary with APD.

These hydrothermal calculations are being conducted at several different scales, with the large scale and intermediate scale model requiring the use of the Equivalent Continuum Model (ECM) assumptions, and the small scale model discretely accounting for nonequilibrium fracture-matrix flow behavior.

The large scale calculations represent the repository as a disk shaped heat source with a diameter of 3 km. The repository thermal load is assumed to be uniformly distributed throughout the 3 km diameter disk. All major hydrostratigraphic units in the unsaturated zone at Yucca Mountain are included in this model. Various initial steady-state conditions are considered, including the "nominal" recharge flux case as well as cases of increased recharge flux. Various spent fuel ages from 10 year old spent fuel to 80 year old spent fuel are being considered. For the reference case, the 30 year old fuel is being emphasized.

The intermediate scale calculations explicitly incorporate the emplacement drift geometry and spacing. The intermediate scale models also include all major hydrostratigraphic units in the unsaturated zone at Yucca Mountain. For the intermediate scale models, it is assumed that the thermal load for an emplacement is averaged along the axis of the drift. This assumption closely corresponds to drift emplacement configurations where the waste packages are oriented along the axis of the drift. This assumption is also applicable to borehole emplacement; particularly after the saturation and temperature fields between neighboring waste packages have coalesced (which occurs within five years of waste emplacement). Because peak waste package temperatures generally occur 35 or more years following waste emplacement, axially-averaging of the temperature field should not significantly affect the predictions of maximum waste package temperatures.

It was found that the intermediate scale model which discretely accounts for the thermal distribution along emplacement drifts predicts greater dry-out volumes than the model which averages the repository thermal load over the entire repository. Therefore, the large-scale model calculations provide conservative lower bounds on repository dry-out volumes. The large scale modeling does not show the "hydrothermal umbrella" effect because it does not represent "cold spots" within the repository. Because the intermediate model discretely accounts for the thermal loading of each drift, it does show some of the "hydrothermal umbrella" effect by calculating the temperature distribution between emplacement drifts. However, because it does not account for nonequilibrium fracture-matrix interaction, the intermediate scale model significantly under-predicts the extent of condensate shedding due to the "hydrothermal umbrella" effect.

It is planned to conduct nonequilibrium fracture-matrix calculations wherein the impact of APD and LAPD on discrete nonequilibrium fracture flow will be investigated. The emphasis will be placed on relatively large aperture fractures. The objective of the small scale model is to demonstrate the potential benefits of higher APDs on mitigating fracture-dominated flow from reaching the repository horizon.

J. Nitao continued the development of the NUFT (Nonisothermal Unsaturated Flow and Transport) Code. NUFT has already proven to be extremely useful in conducting isothermal nonequilibrium fracture-matrix calculations. Because of its efficiency, isothermal calculations using the NUFT code can be easily accommodated by a SPARC 1 Sun Workstation. J. Nitao continues to work on linear equation solvers using the Pre-conditioned Conjugate Gradient (PCG) method for both the V-TOUGH and NUFT codes. First-degree pre-conditioning using natural ordering of the variables as well as the combinative pre-conditioning scheme has been implemented.

J. Nitao has modified V-TOUGH to include an additional option for the relative permeability and capillary pressure functions for equivalent continuum models. He has also begun research into volume averaging schemes which will enable equivalent continuum models to account for nonequilibrium fracture-matrix behavior. He is also continuing to research the use of percolation networks to model nonequilibrium fracture-matrix flow in Yucca Mountain.

T. Quinn developed a pre-processor that takes the output from a one-dimensional steady-state V-TOUGH model and creates the initial primary variable conditions for a two-dimensional V-TOUGH model which uses the same vertical grid and hydrostratigraphic information as the one-dimensional model. T. Quinn also added the capability of extracting heat flux, vapor flux, and liquid flux to the EXTBIN post-processor.

S. Larsen began half-time support for the Hydrology Group on August 1 and has been introduced to V-TOUGH and NUFT and their pre-and post-processors. He is evaluating alternative matrix pre-conditioning schemes for the conjugate gradient linear equation solver. His first task is to implement one of the methods in the NUFT code.

T. Quinn incorporated V-TOUGH modifications into version 4.1 and has submitted the changes to the on-line SCCS software configuration management system. The recent modifications allow V-TOUGH to run on the NERSC center CRAYS which will soon be using the UNICOS operating system. Other modifications include additional error checking and a feature which allows the user to turn off gas flow for specified gridblocks.

R. Gulliford completed the installation of a V-TOUGH orthogonal mesh generator on the Sun Workstations. S. Daveler is taking responsibility for assisting users in the use of this pre-processor.

S. Daveler modified the window display features of the EXTOOL post-processor to enhance its usability, and she optimized its code performance, obtaining a

substantial improvement in speed. Routines were devised which make V-TOUGH time-history files more robust, options were added for contour plotting, and user documentation was updated. The ability to plot vector fields of V-TOUGH and NUFT calculations was added.

Mechanical Attributes of the Waste Package Environment

Work continued on the resolution of comments on Study Plan 8.3.4.2.4.3, Characterization of Mechanical Attributes of the Waste Package Environment.

Staff participated in an internal audit of Sample Shipping, Handling and Storage.

EBS Field Tests/ESF Test Design

W. Lin, D. Wilder and J. Blink met with N. Elkins of LANL to review and update ESF planning documents.

A paper by N. Mao entitled "Thermocouple Psychrometer Measurements of In Situ Water Potential Changes in Heated Welded Tuff" has been submitted to YMPO for approval for the FOCUS '91, Nuclear Waste Packaging meeting to be held in Las Vegas, September 29 - October 2, 1991.

A paper by K. Lee and T. Ueng entitled "Field Air Injection Test to Determine the Effect of a Heat Cycle on the Permeability of Welded Tuff" has been submitted to YMPO for approval for the FOCUS '91, Nuclear Waste Packaging meeting to be held in Las Vegas, September 29 - October 2, 1991.

1.2.2.3 Waste Form and Materials Testing

Waste Form Testing - Spent Fuel

The drybath tests continue at PNL. A full interim weighing was conducted, and one sample was lost when a crucible bail failed; however, no additional samples were contaminated. The $\Delta O/M$ data continue to support the predicted behavior. First, it appears that spent fuel variations only affect oxidation in a transitory manner. Secondly, the first stage of oxidation ends at $\Delta O/M \sim 0.4$ and is essentially a U_4O_9 lattice structure with additional oxygen. The time to reach this $\Delta O/M$ has an Arrhenius behavior. Finally, oxidation of the fuel to a higher O/M ratio will eventually occur. From the preliminary data, it is projected that the first stage of oxidation (to an O/M ratio of about 2.4) should not be complete at repository temperatures before 1000+ years.

The new ceramography lab at PNL is completely operational and ~ 10 samples have been polished and examined. The x-ray diffraction (XRD) results have been confirmed by spot checks using electron diffraction. No phases other than UO_2 and U_4O_9 were observed.

The variable flow-rate tests at PNL are nearing completion with generally satisfactory results. The results indicate that the concentrations of uranium in the

flow-through columns are well below saturation and that the measured dissolution rates represent the true kinetic rate constants. Some variable flow-rate tests will continue for a brief additional period, but the testing emphasis will be changing toward completion of the test matrix provided in the test plan.

Because of some unexpected results obtained both at PNL and at LLNL using unirradiated UO_2 specimens, another source has been identified of well-characterized unirradiated UO_2 at PNL, and new test specimens have been prepared. A portion of this UO_2 material, prepared in both pellet and particle forms, was shipped to LLNL on August 20; both programs will be conducting tests on the same well-characterized material.

A developmental flow-through test was set up at PNL to measure the surface potential of unirradiated UO_2 using the streaming potential method while simultaneously measuring dissolution rate. A run was started which duplicated a previous flow-through test measuring the effects of Ca and Si additions to dilute bicarbonate solution. Dissolution rate responses matching those observed in the previous test were measured while successfully measuring stable streaming potentials. These encouraging results confirm the feasibility of simultaneously measuring surface potential and dissolution rate in a single test. Such tests were recently proposed in an addendum to the current flow-through test plan.

Glove box modifications and acquisition of gas mixtures for the next series of dissolution tests at LLNL have been completed.

L. Thomas of PNL visited LLNL on August 5 to discuss future work scope.

PNL is planning a meeting to be held September 4 in Richland, WA which will coincide with an EM meeting ongoing at the laboratory. The meeting will be used to present the results of the spent fuel oxidation tests and possible future directions for spent fuel testing to members of the M&O, LLNL, YMPO, and DOE/RL.

Some final additions have been made to the draft Waste Form Characterization Report.

Minor comments have been received from the referees for the paper submitted to Materials Characterization by L. Thomas of PNL, entitled "Grain Boundary Oxidation of PWR Spent Fuel in Air".

All LLNL and other technical reviewer comments have been resolved on the paper by R. Einziger of PNL entitled "Effects of an Oxidizing Atmosphere in a Spent Fuel Packaging Facility". The paper has been submitted to YMPO for approval for the FOCUS '91, Nuclear Waste Packaging meeting to be held September 29 - October 2, 1991 in Las Vegas.

The LLNL review comments were incorporated into the draft report by M. Cunningham of PNL entitled "The Impact of Burnup and Fission Gas Release Distributions of the U.S. LWR Spent Fuel Inventory on the Selection of Spent Fuel Test Materials for the U.S. Geologic Repository". The text and graphics are

being revised and copies of references not presently in the YMPO Information System were compiled for future transmittal.

Comments from LLNL were reviewed and incorporated into the drafts of the papers by R. Guenther of PNL entitled "Characterization of Spent Fuel Approved Testing Material - ATM-104" and "Characterization of Spent Fuel Approved Testing Material - ATM-105". The document review sheets were completed.

An internal audit was held at PNL the week of August 26.

H. Leider will be the Technical Specialist for the audit that is planned to take place at PNL in late September. The audit will be followed by discussions on progress in dissolution testing.

Waste Form Testing - Glass

The N2 tests (SRL actinide-doped glass) continued as scheduled with no sampling period occurring this month. These tests have now been in progress for 288 weeks. The N3 tests (ATM-10, a West Valley actinide-doped glass) continued as scheduled. The tests have been in progress for 206 weeks.

The abstract "Low-Temperature Vapor Alteration of Glass under Potential Storage Conditions" was submitted for inclusion in a special issue of the Journal of Radioactive Waste Management and the Nuclear Fuel Cycle. This work describes the structure of glass reacted at 75°C and 95% relative humidity for time periods up to five years. These conditions are similar to those expected during long-term storage and Analytic Electron Microscopy (AEM) work to analyze the reacted glass structure is ongoing.

In a response to a request from LLNL to help update the data base in support of EQ3/6, a list of mineral phases identified during glass testing was compiled by ANL. The list included phases formed during vapor phase alteration, static and unsaturated testing, and as colloidal material in test solutions. Information was compiled from tests using SRL 131, 202, and 165 glasses; WV 44, 50, and ATM-10 glasses; and from natural glasses.

The Scanning Ion Mass Spectroscopy (SIMS) system has been developed at LLNL to profile transuranic elements in reacted glass samples. This has been an ongoing effort which was last discussed in the 1989 monthly reports. The SIMS system can detect and resolve ^{237}Np , ^{238}U , ^{239}Pu , and ^{241}Am at weight percents of 0.02, 1.0, 0.02, and 0.0002, respectively. The system is now ready to profile actinide concentrations in reacted glasses and will be applied to archival samples.

Work is continuing to analyze the SVT samples to provide input to the Materials Research Society (MRS) paper "The Effect of SA/V Ratio on the Formation of Secondary Phases during Glass/Water Reactions." While the emphasis of the paper is on the samples reacted in deionized water, samples reacted in 60 and 120 ppm silicate water are also being analyzed to judge the effect of this component on glass reaction.

The flow-through tests having buffer solutions doped with calcium and magnesium were terminated after 6 weeks. Analytical results obtained at this time indicate the tests reached steady-state concentrations after about 30 days. Calcium and magnesium in the buffer solutions slowed down the dissolution rates relative to undoped buffers. Further analyses of these data will be performed after the remaining solutions have been analyzed.

A simple glass dissolution model based on three parameters (temperature, pH and silica concentration in solution) was put into the draft Preliminary Waste Form Characterization Report.

The ANL Office of Quality Assurance (OQA) has scheduled an audit of the YMP QA records on September 24-25, 1991. Preparation for this audit has begun.

Container Materials Modeling and Testing

A paper by G. Henshall entitled "Stochastic Models for Predicting Pitting Corrosion Damage of HLRW Containers" has been submitted to YMPO for approval for the FOCUS '91, Nuclear Waste Packaging meeting to be held September 29 - October 2, 1991 in Las Vegas.

A paper by D. Reed and R. Van Konynenburg entitled "Progress in Evaluating the Corrosion of Candidate HLW Container Metals in Irradiated Air-Steam Mixtures" is in the review process for submittal to the FOCUS '91, Nuclear Waste Packaging meeting to be held in Las Vegas, September 29 - October 2, 1991.

Integrated Radionuclide Release

Work continued on flow testing the flow-through system which is designed to study the adsorption and hydrology of water with radionuclide tracers. Diaphragms to separate the pore-fluid from the measuring devices, such as pressure gauges and transducers, are being tested. The purpose of using the diaphragms is to make sure that the pore fluid will not contact metal. Further tests are needed. Construction of sample lines continued.

Analysis and data reduction of uranium and thorium sensitivity standards continues. The granite and feldspar sample analyses were completed.

An internal audit of Sampling, Tracking and Storage was completed for this Task with no findings.

Thermodynamic Data Determination.

In preparation for the next series of Americium variable temperature spectroscopy experiments, ion-exchange radiochemistry was performed to isolate ^{243}Am from solutions of hydroxylamine buffer and NaClO_4 salts. Preliminary speciation calculations on the carbonate system were performed and experimental apparatus in the Building 281 glove box was modified to accommodate experiments requiring a reactive gas phase. Specialty lecture bottles of CO_2/Ar gas mixtures were obtained

from the LLNL gas plant and adapted to the variable temperature spectroscopy instrumentation.

There has been considerable construction work in Building 281 during the last several months. Use of glove boxes and fume hoods has been restricted a significant portion of the time.

A power meter and head were sent to the EE Shop for routine calibration.

1.2.2.4 Design, Fabrication, and Prototype Testing

Waste Package Design

No significant activities.

Container Fabrication and Closure Development

No significant activities.

Container/Waste Package Interface Analysis

Preliminary design selection criteria are being constructed based on systems engineering requirements. Selection criteria are based both on the requirements and on the ability of particular design architectures to be predictable over the long time spans required. Emphasis is being placed on predictability as the most important parameter. Decision analysis (Baysian Utility Theory) will be used (Keeney & Raiffa) as modified for use in NQA-1 environments. A literature search has provided nuclear Probabilistic Risk Assessments that serve as a good model for evaluation of selection criteria. Writing has begun on a proposed methodology and on the Selection Criteria themselves.

A first cut thermal analysis has been done on a consolidated waste package design with drift emplacement to evaluate near field temperatures.

1.2.5 REGULATORY AND INSTITUTIONAL

NRC Interaction Support

L. Jardine, J. Blink, D. Wilder, T. Buscheck, D. Ruffner, G. Gdowski and W. Lin attended the dry run held in Las Vegas, August 13-14 of the NWTRB Thermal Loading Workshop.

Site Characterization Program

Comment Resolution Forms and complete reference listings/hardcopies were forwarded to SAIC for the Postclosure Rock Characteristics section of the ESSE Report.

L. Ballou attended the kick-off Peer Review meeting of the ESSE on August 13 in Las Vegas and briefed the reviewers on the Rock Characteristics guideline.

Technical Support Documentation

No significant activities.

Study Plan Coordination

No significant activities.

Semi-Annual Progress Reports

No significant activities.

1.2.9 PROJECT MANAGEMENT

1.2.9.1 Management

A technical presentations was given at a LLNL-YMP staff meeting on August 12:

- 1) L. Ballou gave a talk on the Early Site Suitability Evaluation (ESSE).

L. Jardine attended the TPO meeting in Las Vegas on August 13.

J. Blink participated in the one-day public outreach training on August 2. He acted as a guide at the Information Office on August 10 and as an Open House tour guide on August 24.

J. Blink attended a meeting of the Quality Integration Group on August 7-9. The QIG reviewed the draft QARD and provided written comments to D. Horton of YMPO.

T. Quinn reviewed the proposed Supplement 1 to the new YMP Software Quality Assurance Requirements.

Records

Document Control issued 8 Change Notices and 18 new issues under controlled distributions. Routine follow-up for receipt acknowledgements continues.

A total of 181 items were logged into the LLNL-YMP tracking system. This includes 29 records/records packages that were processed through to the CRF. Eight action items were closed.

B. Bryan attended a Records Management meeting in Las Vegas on August 14-15.

1.2.9.2 Project Control

The August FTE report and the August Cost Plan were submitted to YMPO.

Variance analysis reports for July 1991 PACS activities were submitted. Variances occurred in 27 P&S accounts.

The actual costs and the latest revised estimated and actual schedule data were submitted to the YMPO PACS system. FY91 budget analysis was completed with a projected under run of \$900K. An analysis was conducted at the PWBS level, and a written report was developed and sent to YMPO.

Detailed FY92 budget packages based on allocations provided by YMPO were prepared, incorporating planning rates provided by LLNL management. PACS planning was initiated for FY92 based on current funding/workscope guidance from YMPO and LLNL management. L. Jardine attended a series of meetings on FY92 budget planning during the first two weeks of August.

Several meetings were held at LLNL with GAO auditors, and they were provided materials describing the LLNL/YMP PACS system.

J. Pobodnik attended a YMPO project control steering subcommittee meeting in San Diego on August 6 on management training. Issues and topics were discussed that are to be included as agenda items for the next meeting scheduled for September 10. L. Jardine attended a Planning and Control Meeting in San Diego on August 13. The meeting was chaired by V. Iorri of YMPO. J. Blink attended subcommittee meetings on hardware/software and training on August 15.

1.2.9.3 Quality Assurance

The process has been initiated to replace the LLNL YMP QA manager. R. Dann has accepted another position and will be leaving the program in September. R. Monks will be the interim QA Manager.

Audit 91-02, "QA Program Management" (NCRs, CARs, Audits/Surveillance, Procedure & Program Management), was conducted.

Audit 91-06, "Engineering and Systems Analyses", was conducted.

Audit 91-010, "Handling, Storage and Shipping and Identification and Control of Items and Samples", was conducted.

Audit Report 91-04, "LLNL-YMP Indoctrination, Training, and Qualification of Personnel, Review of Technical Publications", was transmitted to YMPO.

Responses to CARs YM-91-055 through YM-91-062 resulting from Audit 90-01 were transmitted to YMPO. These replaced the responses which were submitted July 22. The replacement responses were discussed with YMPO QA personnel at a Las Vegas meeting on August 14.

Change Notice D-20-53b-0-1 to Activity Plan D-20-53b, "Flow Through Dissolution Tests on Spent Fuel", was issued.

LLNL hosted the monthly Yucca Mountain Quality Assurance Managers meeting on August 1 with twelve QA managers attending the meeting. The QARD was discussed.

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Lawrence Livermore National Laboratory

LLYMP9110034
October 4, 1991

WBS 1.2.9
"QA: N/A"

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

SUBJECT: Yucca Mountain Project Status Report - September 1991

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

If further information is required, please contact Elizabeth Campbell of my staff at FTS 532-7854.

Sincerely,

A handwritten signature in cursive script that reads "John Clodolph" followed by "for W. Clarke". The signature is written in dark ink and is positioned above a horizontal line.

W. L. Clarke
LLNL Technical Project Officer
for YMP

WC/EC/ec

cc:
Distribution

DISCLAIMER

The LLNL Yucca Mountain Project cautions that any information is preliminary and subject to change as further analyses are performed or as an enlarged and perhaps more representative data base is accumulated. These data and interpretations should be used accordingly.

LAWRENCE LIVERMORE NATIONAL LABORATORY YUCCA MOUNTAIN PROJECT
SEPTEMBER 1991 TECHNICAL HIGHLIGHTS AND STATUS REPORT

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LAWRENCE LIVERMORE NATIONAL LABORATORY
(LLNL)

YUCCA MOUNTAIN PROJECT (YMP) STATUS REPORT

SEPTEMBER 1991

EXECUTIVE SUMMARY

(Items Proposed for Reporting in YMPO or OGD Reports)

1) The paper by W. L. Clarke, W. G. Halsey, and R. D. McCright entitled "Candidate Container Materials for Yucca Mountain Waste Package Designs", was presented at the FOCUS '91 Nuclear Waste Packaging Conference held in Las Vegas, September 29 - October 2, 1991. This paper included LLNL's recommended waste package materials for the SCP conceptual design, a thin walled container. The materials recommended are nickel-base Alloy 825, nickel-base Alloy C-4, and titanium grade 12. Alloy 825 is from the list of six candidate materials, and C-4 and Ti-12 have been added based on quantitative ranking of a large number of materials. Other materials and design configurations will also be studied during ACD. A more detailed report on the recommendations of materials for advanced study during the ACD design phase is planned.

2) Drift emplacements were studied to support a repository using 114 kW/acre loadings of 60 year old spent fuel. Such a repository would require only 15% of the footprint of the SCP-CD layout and would remain above the boiling point of water for eleven thousand of years and remain dry for thirty thousand years, based on conservative hydrology calculations.

3) Fourteen papers were presented by LLNL and its subcontractors at the FOCUS '91 Nuclear Waste Packaging Conference held in Las Vegas, September 29 - October 2, 1991.

4) The flow-through test series that began July 16 is complete. The glasses reached steady-state behavior after 2-3 weeks. The tests were continued at higher flow rates to insure there was no fluid transport control of dissolution rate. Test results show that the SRL-165 glass dissolves at the same rate and with the same pH dependence as our simple (5 component) analog glass of SRL-165. These results show that the dependency of dissolution rate on glass composition can be simplified by considering the role of each type of element in the glass structure, rather than each individual element contained in the glass.

1.2.1 SYSTEMS

1.2.1.1 Management and Integration

Activities are reported as part of other WBS elements.

1.2.1.2.4 Systems Engineering Implementation

The turnover of the EBS concept development lead to the M&O has begun. This effort is to continue throughout FY92. The M&O will use the LLNL Systems Engineering approach to concept development, working as a team with LLNL.

LLNL staff completed a review of the draft report "Incentives for Selection of Spent Fuel for Delivery into the Federal Radioactive Waste Management System - A Preliminary Analysis". This document, edited by PNL, integrates the results of LLNL's Spent Fuel Receipt Scenarios Study (UCID-21530) into the OCRWM Task 8 Report. LLNL comments, were forwarded to PNL for resolution/revision.

LLNL comments on the draft Systems Studies Plan, prepared by SNL for YMPO, were delivered to both organizations. The results of this informal review had previously been discussed with SNL staff.

1.2.1.3.5 Technical Database Input

LLNL submitted a TDIF for the "Dissolution and Precipitation Kinetics of Gibbsite at 80°C and pH 3: The Dependence on Solution Saturation State" to the SEPDB Administrator at SNL.

Entries of LLNL TDIF's into the ATDT were reviewed and verified by Livermore staff. Work continued to implement the electronic ATDT system at the LLNL Local Records Center.

LLNL staff completed a QMP-06-04 review of YMP Administrative Procedures AP-5.1Q and AP-5.2Q. Comments were forwarded to SAIC, and the resolution process was completed on September 24.

1.2.1.2.6 YMP Support to Management Systems Improvement Strategy

No significant activities.

1.2.1.4.2 Waste Package Performance Assessment

A specification for a simplified source term model was provided to SNL for use in their Total System Analyzer model. The simplified model parametrizes the results of the most important processes affecting the source term, and does not attempt to track finer details. SNL staff commented that the "simplified" model was at about the right level of summary information to be useful in their larger-scope model.

The upgrade of PANDORA began with a planning meeting. Source code files for the latest in-process version were checked.

The following papers were presented at the FOCUS '91, Nuclear Waste Packaging Conference held in Las Vegas, September 29-October 2, 1991:

"Diffusive Barrier Simplified Analysis -- Design and Sensitivity Applications", T-S. Ueng, and W. J. O'Connell.

"The Demands Placed on Waste Package Performance Testing and Modeling by Some General Results of Reliability Analysis", D. A. Chesnut.

Internal QA grading was completed for Activity I-20-27, Prototype Study of Impact of Unanticipated Events.

1.2.1.4.5 Geochemical Modeling and Database Development

Effort this month was focused on the EQ6 User Guide and the EQ3/6 Package Overview and Installation Guide. The Package Overview and Installation Guide is now ready for internal technical review.

"The LLNL GEMBOCHS Database and Software Library: YMP-TDB Quarterly Report" 3rd Qtr., 1991 was submitted to YMPO.

A review was completed of the NEA draft document by I. McKinley and A. Scholtis entitled "A Comparison of Radionuclide Sorption Databases Used in Recent Performance Assessments".

1.2.1.4.7 Supporting Calculations for Postclosure Performance Analyses

This activity is suspended due to lack of funding.

1.2.2 WASTE PACKAGE

1.2.2.1 Management and Integration

J. Blink and D. Chesnut attended the Hydrogeology Decision Analysis Course taught by A. Freeze on September 9-13.

1.2.2.2 Waste Package Environment

1.2.2.2.1 Chemical and Mineralogical Properties of the Waste Package Environment

Water/rock reactions occurring in the vadose zone were modeled using EQ3/6. Using the results of hydrologic models, the variation in the activity of water in the vadose zone in the near field was estimated. The activity of water was independently controlled in EQ3/6 by setting the fugacity of inert gas in the system model. The preliminary results, for cases where the activity of water is greater than 0.8, were similar to results obtained for simulations of fully saturated systems. However, the preliminary simulations do not account for possible changes in the relationship between the concentration of a dissolved constituent and its activity that might occur as a result of the interactions between water and mineral surfaces. These results were presented at the YMPO technical exchange meeting on water chemistry held at NTS in July. As a result of this meeting, specifically the interest expressed in modeling and experimentally accessing water in the unsaturated zone, preliminary calculations were made of the quantity of unsaturated water that could be expected to be removed from intact repository horizon Topopah Spring Tuff via centrifugation. The results of the calculations show that, at most, a few mL of water

could be expected to be removed from each sample (6 cm in diameter, 8 cm long) when centrifuged at 18,000 rpm.

1.2.2.2 Hydrologic Properties of the Waste Package Environment

Cleaning of the pore pressure lines of the high-pressure-high-temperature system was completed. Testing of the system with deionized water at room temperature has begun. The system is now filled with water. Water samples are being collected periodically for chemical analysis.

Work continues on writing a SIP for the laboratory study of the hydrologic properties of the near field environment and to revise the Study Plan for the same activity.

The following paper was presented at the FOCUS '91, Nuclear Waste Packaging Conference held in Las Vegas, September 29-October 2, 1991:

"The Impact of Episodic Nonequilibrium Fracture-Matrix Flow on Geological Repository Performance", T. A. Buscheck, J. J. Nitao, and D. A. Chesnut.

1.2.2.3 Mechanical Attributes of the Waste Package Environment

A revised draft of Study Plan 8.3.4.2.4.3, Characterization of Mechanical Attributes of the Waste Package Environment, was submitted to YMPO following incorporation of comments made at the comment resolution meeting. The Study Plan is being sent by YMPO to the reviewers for resolution verification prior to submitting it to the RSED Director and YMPO QA for approval.

1.2.2.4 EBS Field Tests/ESF Test Design

The ESF Test Planning Package and ESFDR input were completed and submitted to LANL.

The SIP for the Initial (Prototype) Engineered Barrier System Field Tests has been revised and reviewed by D. Wilder. It is now in the approval process.

The following papers were presented at the FOCUS '91, Nuclear Waste Packaging Conference held in Las Vegas, September 29-October 2, 1991:

"Field Air Injection Test to Determine the Effect of a Heat Cycle on the Permeability of Welded Tuff", K. H. Lee and T.-S. Ueng.

"Thermocouple Psychrometer Measurements of In Situ Water Potential Changes in Heated Welded Tuff", N. H. Mao and H. F. Wang.

"Temperature Measurements from a Horizontal Heater Test in G-Tunnel", W. Lin, A. L. Ramirez, and D. Watwood.

1.2.2.5 Man-Made Materials

Completing the literature search under FY91 funding.

1.2.2.3 Waste Form and Materials Testing

1.2.2.3.1.1 Waste Form Testing - Spent Fuel

R. Stout, H. Leider and R. Monks participated in the audit at PNL September 17-19.

Work continued on the final comments to the draft Waste Form Characteristics Report.

Spent Fuel Oxidation

Pacific Northwest Laboratory

Dry Bath Test

The dry bath tests at PNL continue as scheduled, the next major interim examination will be conducted in the last quarter of the calendar year. Over 20 spent fuel samples have been mounted and subjected to ceramographic examination. Image analyses of the photographs is ongoing.

Examination of the data from current and past oxidation tests has indicated that a simplified description of the oxidation process may exist, and may be independent of fuel type. If confirmed, the description would have implications for all phases of the storage and disposal process. The description was presented at a meeting of DOE, LLNL, and PNL representatives on September 4, 1991.

The following paper was presented at the FOCUS '91, Nuclear Waste Packaging Conference held in Las Vegas, September 29-October 2, 1991:

"Effects of an Oxidizing Atmosphere in a Spent Fuel Packaging Facility",
R. Einziger.

All comments have been received and final corrections are being incorporated on the paper by L. Thomas and R. Einziger entitled "Grain Boundary Oxidation of PWR Spent Fuel in Air" that was submitted to Materials Characterization. A summary was submitted for the High Level Waste Management Conference in Las Vegas, April 1992 and the full paper, which summarized work performed in FY91, is in preparation.

Spent Fuel Dissolution

H. Leider attended a meeting at PNL on September 20 discussing the progress of dissolution tests at PNL and LLNL.

Lawrence Livermore National Laboratory

Flow-Through Dissolution Tests on Unirradiated UO₂

Series 2 dissolution tests on UO₂ pellets, UO₂ powder and synthetic dehydrated schoepite at 25°C were initiated.

LLNL Operational Safety Procedure 251.6 - Dissolution of UO₂, was revised and re-issued.

Pacific Northwest Laboratory

A flow-through test measuring both dissolution rate and streaming potential of a UO_2 particle specimen at PNL was terminated at 37 days after Si gel precipitation at the column inlet was observed. A second column, which used a solution containing dissolved silicic acid and $NaHCO_3$ prepared using a modified procedure, continues to operate with no apparent precipitation of Si. Zeta potential of the UO_2 particles appeared to become more negative with time in both test columns as the uranium dissolution rate decreased in response to the presence of Si. Since Si is dissolved as a negative species in these solutions, the results suggest that the observed reductions in uranium dissolution rates may be caused by a mechanism in which the negative Si species are adsorbed on or react with the UO_2 surface. The variable flow-rate tests are nearing completion with generally satisfactory results. The results indicate that the concentrations of uranium in the flow-through columns are well below saturation and that the measured dissolution rates represent the true kinetic rate constants. Some variable flow-rate tests will continue for a brief additional period, but testing emphasis will be changing toward completion of the test matrix provided in the test plan.

Spent Fuel Characterization

MCC - Pacific Northwest Laboratory

The LLNL review comments of the paper by M. Cunningham entitled "The Impact of Burnup and Fission Gas Release Distributions of the U.S. LWR Spent Fuel Inventory on the Selection of Spent Fuel Test Materials for the U.S. Geologic Repository" were sent to the author for incorporation into the paper.

The following two papers have been returned to YMPO with review comments addressed:

"Characterization of Spent Fuel Approved Testing Material - ATM-104" by R. Guenther, et al.

"Characterization of Spent Fuel Approved Testing Material - ATM-105" by R. Guenther, et al.

The following paper was submitted to the Material Research Society Conference to be held in Strasbourg, France, November 4-7, 1991:

"Gap and Grain-Boundary Inventories of Cs, Tc, and Sr in Spent LWR Fuel" by W. Gray et al.

1.2.2.3.1.2 Waste Form Testing - Glass

The Glass Task at ANL was audited by the ANL Office of Quality Assurance on September 24 and by LLNL on September 25-26. R. Stout and R. Monks participated in the LLNL audit of ANL.

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

The N2 tests (SRL actinide-doped glass) continue with no sampling period occurring this month. These tests have been in progress for 292 weeks. The N3 tests (ATM-10,

a West Valley actinide-doped glass) continue and have been in progress for 210 weeks.

D-20-31: Studies of Glass Surface Layers and Precipitation

The manuscript "The Effect of SA/V Ratio on the Formation of Secondary Phases During Glass/Water Reactions" was completed and forwarded to LLNL for review. The data presented in this paper will be augmented with additional Analytical Electron Microscopy (AEM) results on the Surface-Volume-Time (SVT) samples to form the basis of a full journal publication.

D-20-32: Geochemical Interactions

The flow-through test series that began July 16 is complete. The glasses reached steady-state behavior after 2-3 weeks. The tests were continued at higher flow rates to insure there was no fluid transport control of dissolution rate. Test results show that the SRL-165 glass dissolves at the same rate and with the same pH dependence as our simple (5 component) analog glass of SRL-165. These results show that the dependency of dissolution rate on glass composition can be simplified by considering the role of each type of individual element in the glass structure, rather than each element contained in the glass.

Glasses for the next test series are currently being loaded into the sample cells. In this series, three SRL glasses (165, 131, and 202) will be tested along with the simple analog glass of SRL-165 (CSG). The four glasses will be leached in four buffer solutions of sodium acetate, tris, bistris, and sodium carbonate. The results will provide the rate constant and the pH dependence of the rate constant for SRL-202 and SRL-131 glasses.

D-20-34: Development of licensing database for glass waste form materials interactions

The draft of the glass sections of the preliminary "Waste Form Characterization Report" is complete.

D-20-37: Generate Models for Release From Glass

The rate constant for SRL-165 glass obtained from the flow-through tests was incorporated into the EQ3/6 glass model. The rate constant was programmed into the code as a function of pH and temperature.

Work continues on developing a calculational methodology for evaluating glass performance in a repository. A calculation of the effect of host rock, metal container, and cement on glass performance was performed using EQ3/6. The calculation showed a small negative effect for cement in the repository due to its reaction with water to increase the pH of the system. Glass dissolution rates increase with pH at high pH conditions.

1.2.2.3.2 Metal Barriers

With projections of a very reduced budget in FY92, work in the Metal Barrier Task was redirected to completing certain technical activities.

E-20-16: Model Development

The following paper was presented at the FOCUS '91, Nuclear Waste Packaging Conference held in Las Vegas, September 29-October 2, 1991:

"Stochastic Models for Predicting Pitting Corrosion Damage of HLRW Containers," G. A. Henshall.

E-20-17: Technique Development

The following paper was presented at the FOCUS '91, Nuclear Waste Packaging Conference held in Las Vegas, September 29-October 2, 1991:

"Electrochemical Polarization Measurements on Pitting Corrosion Susceptibility of Nickel-Rich Alloy 825 ", R. D. McCright and D. L. Fleming.

E-20-18: Parametric Studies

Work is proceeding at ANL on radiation induced effects in the near field environment and the changes in the performance of the container material. The present effort is divided into two parts:

- 1) Yield of NO_x/NH₃ in high water vapor to air systems, and
- 2) modeling/calculation of radiolytic yields in the waste package.

The following papers were presented at the FOCUS '91, Nuclear Waste Packaging Conference held in Las Vegas, September 29-October 2, 1991:

"Progress in Evaluating the Corrosion of Candidate HLW Container Metals in Irradiated Air-Steam Mixtures ", D. T. Reed and R. A. Van Konynenburg.

"Progress in Assessing the Effect of Ionizing Radiation on the Anticipated Waste Package Environment at Yucca Mountain", D. T. Reed.

E-20-19: Container Material Selection

The following papers were presented at the FOCUS '91, Nuclear Waste Packaging Conference held in Las Vegas, September 29-October 2, 1991:

"Status Report - Fabrication and Closure Development of Nuclear Waste Disposal Containers for the Yucca Mountain Project", H. A. Domian, E. S. Robitz, C. C. Conrardy, D. F. LaCount, M. D. McAninch, R. L. Fish, E. W. Russell.

"Candidate Container Materials for Yucca Mountain Waste Package Designs", W. L. Clarke, W. G. Halsey, and R. D. McCright.

A more detailed report on the recommendations of materials for advanced study during the ACD design phase is planned. This report will supplement the conference paper by Clarke, et al. The materials recommended are nickel-base Alloy 825, nickel-base Alloy C-4, and titanium grade 12. These materials are recommended for use as single container materials in the SCP-CD thin-walled container design. Alloy 825 is from the list of six candidate materials, and C-4 and Ti-12 have been added based on quantitative ranking of a large group of materials. Other materials and design configurations will also be studied during ACD.

1.2.2.3.4.1 Integrated Radionuclide Release

Input was provided for the Near Field Environment Report.

The response to the software audit findings was completed.

The following Technical Implementing Procedures were submitted for review and approval:

"Depth Profiling on the Ion Microscope"

"Data Reduction for Depth Profiles"

Source Term Model Development

Work proceeded on characterization of goethite surface chemical properties in the temperature range 25°C to 75°C. The literature search was completed on the adsorptive behavior of goethite at elevated temperatures.

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

Sensitivity factors were measured for uranium in silicate as part of the calibration effort.

Interactions of Actinide-bearing Solutions with Rock Core Samples

Samples of tuff wafers and fractured core were prepared and submitted for characterization of pore structures and sizes.

A computerized instrument-control and data acquisition was begun by connecting to a MacIntosh II computer with the program LABVIEW.

The testing of the pressurized components was delayed due to slow replacement by the manufacturer of a failed diaphragm.

Work continued on the flow testing of the flow-through system which is designed to study the adsorption and hydrology of water with radionuclide tracers. The entire system has been assembled, and preliminary flow testing has begun.

1.2.2.3.4.2 Thermodynamic Data Determination

This activity is closing down due to lack of funding.

1.2.2.4. Design, Fabrication, and Prototype Testing

1.2.2.4.1 Waste Package Design

No significant activities.

1.2.2.4.2 Container Fabrication and Closure Development

No significant activities.

1.2.2.4.3 Container/Waste Package Interface Analysis

Drift emplacements were studied to support a repository using 114 kW/acre loadings of 60 year old spent fuel. Such a repository would require only 15% of the footprint of the SCP-CD layout and would remain above the boiling point of water

for eleven thousand of years and remain dry for thirty thousand years, based on conservative hydrology calculations by T. Buscheck (WBS 1.2.2.2.2.).

The following paper was presented at the FOCUS '91, Nuclear Waste Packaging Conference held in Las Vegas, September 29-October 2, 1991:

"Engineered Barrier System and Waste Package Design Concepts for a Potential Geological Repository at Yucca Mountain", D. Short, D. Ruffner and L. Jardine.

1.2.5 REGULATORY AND INSTITUTIONAL

1.2.5.2.1 NRC Interaction Support

LLNL reviewed the draft NRC staff Technical Position on Thermal Loads.

D. Ruffner, W. Lin, J. Blink and T. Buscheck attended the dry run in Las Vegas on September 11 for the Thermal Loading NWTRB presentation to be held in Las Vegas, October 8-9. D. Wilder, W. Lin, T. Buscheck and J. Blink attended another dry run on September 24-25.

1.2.5.2.2 Site Characterization Program

No significant activities.

1.2.5.2.4 Technical Support Documentation

No significant activities.

1.2.5.2.5 Study Plan Coordination

No significant activities.

1.2.5.2.6 Semi-Annual Progress Reports

The guidance package for the Progress Report (PR) covering the reporting period April 1 through September 30, was received on September 10.

1.2.9 PROJECT MANAGEMENT

1.2.9.1 Management

L. Jardine resigned as TPO on September 3 to accept a position developing additional nuclear engineering programs within the LLNL Energy Program. W. Clarke, TAL for Container Materials, was appointed Acting TPO/YMP Leader.

J. Blink attended a meeting of the Quality Integration Group (QIG) on September 26 to review the draft QARD revisions with D. Horton and R. Spence.

J. Blink completed the YMPO General Employee Training (GET) program.

1.2.9.1.4 Records

J. Blink and B. Bryan developed a matrix of RECOMP requirements implemented in the LLNL YMP QPs and APs. Several requirements were moved to LLNL's QP.

Document Control issued eleven Change Notices and seven new issues under controlled distributions. Routine follow-up for receipt acknowledgements continues.

A total of 181 items were logged into the LLNL-YMP tracking system. This includes 95 records/records packages that were processed through to the CRF. Ten action items were closed.

B. Bryan attended the quarterly Records Coordinator's Workshop in Las Vegas on September 11-12.

1.2.9.2 Project Control

The FTE Report and Cost Plan were submitted to YMPO. The variance analysis reports for August 1991 PACS activities were submitted. Variances occurred in 27 P&S accounts.

Actual costs, latest revised estimates, and actual schedule data were submitted to the YMPO PACS system. The FY91 budget analysis was updated, and it was projected that there will be a \$1.5M underrun.

LLNL is continuing to prepare FY92 budget/workscope based on changes in guidance from YMPO. The PACS planning for FY92 based on current funding/workscope guidance from YMPO and LLNL management is continuing.

J. Podobnik attended the YMPO project control steering meeting in Las Vegas on September 10. Modifications to the current PACS reporting system, expanding the committee to include M&O representation, and identifying actions required for the FY92 PACS preparation were discussed.

Staff attended meetings with the GAO auditors. Planning guidance received from YMPO, funding patterns for FY90, QA audits, capital equipment and the PACS system were discussed. Additional meetings will be held in October.

1.2.9.3 Quality Assurance

The following Audit Reports were transmitted to YMPO:

- 1) 91-02 "QA Program Management (NCRs, CARs, Audits/Surveillances & Program Management";
- 2) 91-06 "Engineering and Systems Analyses";
- 3) 91-07 "LLNL Procurement, Document Control & QA Records"; and
- 4) 91-010 "LLNL-YMP Handling, Storage, and Shipping, Identification, and Control of Items".

Adverse Finding Reports 006, 007, 010, and 011 initiated by LLNL-YMP as a result of LLNL Internal Audits 91-03, 91-04, 91-08, and 91-09 were transmitted to YMPO. The corrective action has now been completed and verified to close these AFRs.

QAPP Change Notice 033-YMP-R 17-0-2 "Quality Assurance Records" was transmitted to YMPO for approval.

LAWRENCE LIVERMORE NATIONAL LABORATORY YUCA MOUNTAIN PROJECT
OCTOBER 1971 TECHNICAL HIGHLIGHTS AND STATUS REPORT

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

OCTOBER 1991

EXECUTIVE SUMMARY

(Items Proposed for Reporting in YMPO or OGD Reports)

- 1) Two of the four user manuals for the EQ3/6 geochemistry code family have been completed and are ready for technical review. EQ3/6 is used by LLNL, LANL, and USGS as well as other DOE organizations including Fernald, Rocky Flats, and WIPP. These manuals are an important step in qualifying codes to meet the NRC licensing guidance in NUREG-0856.
- 2) LLNL has completed the initial version of the Yucca Mountain Integrating Model (YMIM). Written in C, YMIM runs on a MAC-II using EXCELL for input/output. Results from detailed mechanistic models are input as data tables; YMIM provides a framework to couple the processes. Because all mechanistic models may not be used in a given run, YMIM is most useful for sensitivity analyses.
- 3) LLNL has completed initial thermal-hydrology calculations of the impact of higher waste heat loadings on the performance of the potential Yucca Mountain repository site. For heat loads of 114 kW/acre of 60 year old spent fuel in drift emplacements, the footprint of the waste could only be 15% of the SCP-CD layout, and the waste emplacement region would remain above the boiling point of water for eleven thousand years and remain dry for at least thirty thousand years. These results were reported at the NWTRB meeting in Las Vegas October 8-10.
- 4) Canadian CANDU fuel data indicate most cesium and iodine fission gas release is in the gap inventory. Recent experiments by PNL for one U.S. LWR fuel find only about one-fourth of the cesium fission gas release in the gap inventory and about 1% in the grain-boundary inventory. Additional experiments are necessary to determine if the reduced rapid-release inventory in these experiments is an anomaly or is a difference between LWR and CANDU fuel.

1.2.1 SYSTEMS

1.2.1.1 Management and Integration

Staff prioritized activities proposed as candidates for carryover funding.

1.2.1.2.4 Systems Engineering Implementation

W. Lin and J. Blink reviewed the ESF Construction Implementation Plan and provided document review sheets to YMPO.

1.2.1.2.6 YMP Support Management Systems Improvement Strategy

No significant activities.

1.2.1.3.5 Technical Database Input

Co-author comments were resolved on the LLNL input to the TDB Quarterly Report. The LLNL input describes the Geologic and Engineering Materials Bibliography of Chemical Species (GEMBOCHS) database. The 80 page input includes a comprehensive set of references, a data dictionary, and audit tables for the third quarter and for the upgrade from Version R9 to R10.

Because the input to GEMBOCHS has been largely from LLNL sources and since it predates AP-5.2Q, a set of interface forms has not been developed to facilitate input from other organizations. Instead, an electronic database management program, CNGBOCHS, was written; CNGBOCHS produces an audit trail of all database changes, including the review process. The process of using CNGBOCHS will be illustrated in the next version of the YMP TDB Handbook.

J. Blink attended a meeting of the Technical Data Advisory Group (TDAG) in Las Vegas on October 17.

1.2.1.4.2 Waste Package Performance Assessment

W. Halsey attended a performance assessment meeting with Alan Lamont in Las Vegas on October 29. R. Dyer, J. Boak and several T&MSS and M&O staff members were briefed on the Yucca Mountain Integrating Model (YMIM). Written in C, YMIM runs on a MAC-II using EXCELL for input/output. Results from detailed mechanistic models are input as data tables; YMIM provides a framework to couple the processes. Because all mechanistic models may not be used in a given run, YMIM is most useful for sensitivity analyses. YMIM complements PANDORA, a more detailed model designed to produce quantitative source terms for the YMP total system PA model.

W. O'Connell reviewed the draft Waste Form Characteristics Report.

A draft report is being prepared on the "Simplified Source Term" for the YMP total system PA model being assembled by SNL. The report expands on information provided to SNL informally.

1.2.1.4.5 Geochemical Modeling and Database Development

The EQ6 Package Overview/Installation Manual was submitted for technical review. The EQ3NR User Manual was previously submitted for technical review. The EQ6 User Manual will be completed in mid-November. The EQPT User Manual, the last of the four manual series, will be completed in December.

1.2.1.4.7 Supporting Calculations for Postclosure Performance Analyses

This WBS element has not been funded in FY92.

1.2.2 WASTE PACKAGE

1.2.2.1 Management and Integration

Staff prioritized activities proposed as candidates for carryover funding.

1.2.2.2 Waste Package Environment

1.2.2.2.1 Chemical and Mineralogical Properties of the Waste Package Environment

FY92 funding for this WBS element only permits interaction with other participants; technical work is not supported at this time. Carryover funding has been requested in this WBS element.

1.2.2.2.2 Hydrologic Properties of the Waste Package Environment

The chemical testing of the high pressure and high temperature system using deionized water at room temperature continued with the system full of water. Water samples are being collected periodically for chemical analysis.

The SIP for the laboratory study of the hydrologic properties of the near field environment has completed internal review and is now being reviewed by QA. It will soon be submitted to YMPO.

Work continues to revise the Study Plan for the same activity.

W. Lin attended the Sample Overview Committee meeting in the Sample Management Facility at NTS on October 16.

The paper by T. Buscheck, J. Nitao and D. Chesnut entitled "The Impact of Episodic Nonequilibrium Fracture-Matrix Flow on Repository Performance at the Potential Yucca Mountain Site" was approved by YMPO on October 28 and will be presented at the XV International Symposium on the Scientific Basis for Nuclear Waste Management to be held in Strasbourg, France, November 4-7, 1991.

1.2.2.2.3 Mechanical Attributes of the Waste Package Environment

The Study Plan 8.3.4.2.4.3 for Characterization of the Geomechanical Attributes of the Waste Package Environment was transmitted by YMPO to headquarters on October 15 for final verification of the comment resolutions.

1.2.2.2.4 EBS Field Tests/ESF Test Design

D. Wilder attended the OCRWM IHLRWM paper review in Arlington, VA on October 7. He will be the chairman for one of the technical sessions.

1.2.2.2.5 Man-Made Materials

This WBS element has not been funded in FY92.

1.2.2.3 Waste Form and Materials Testing

1.2.2.3.1.1 Waste Form Testing - Spent Fuel

The Waste Form Characterization Report has been distributed for internal review.

Spent Fuel Oxidation

Carryover funding was requested to restart TGA spent fuel oxidation testing at PNL. ThermoGravimetric Apparatus tests are capable of higher temperatures (200-300°C) than dry bath tests.

R. Einziger of PNL attended the OCRWM IHLRWM paper review in Arlington, VA on October 7. He is preparing a paper entitled "Influence of an Oxidizing Atmosphere in a Spent Fuel Packaging Facility" for presentation at the International High Level Radioactive Waste Conference (IHLRWM) to be held in Las Vegas, April 12-16, 1992.

Dry Bath Test

An Interim exam was conducted on limited samples at 195 and 175°C. Subsamples were removed for future examination. Analyses of image analysis data from spent fuel samples examined in FY91 is continuing.

Spent Fuel Dissolution

Flow-Through Dissolution Tests on Unirradiated UO₂

The room temperature UO₂ dissolution part of the LLNL experimental matrix is nearly complete. There are a few discrepancies with the PNL results on UO₂, but in general, there is fair agreement. A fit of the LLNL data to an empirical polynomial yields an excellent description of the experimental results.

The extended summary by H. Leider, S. Nguyen, H. Weed, and S. Steward entitled "The Dissolution Rate of UO₂ in the Alkaline Regime Under Oxidizing Conditions Using a Simplified Ground Water Analog" was approved by YMPO on October 30. A full paper will be written for presentation at the International High Level Radioactive Waste Conference (IHLRWM) to be held in Las Vegas, April 12-16, 1992.

The paper by S. Nguyen, H. Weed, H. Leider and R. Stout entitled "Dissolution Kinetics of UO₂ Flow-Through Tests on UO_{2.00} Pellets and Polycrystalline Schoepite Samples in Oxygenated, Carbonate/Bicarbonate Buffer Solutions at 25°C" was approved by YMPO on October 28 and will be presented at the XV International Symposium on the Scientific Basis for Nuclear Waste Management to be held in Strasbourg, France, November 4-7, 1991.

Flow-Through Dissolution Tests on Spent Fuel and Unirradiated UO₂

A paper by W. Gray, D. Strachan and C. Wilson of PNL entitled "Inventories and Dissolution Rates of Soluble Radionuclides from the Grain Inventories of Spent LWR Fuel" was approved by YMPO on September 10 and will be presented at the

XV International Symposium on the Scientific Basis for Nuclear Waste Management to be held in Strasbourg, France, November 4-7, 1991.

Spent Fuel Characterization

A paper by W. Gray, D. Strachan and C. Wilson of PNL entitled "Gap and Grain-Boundary Inventories of Cs, Te and Sr in Spent LWR Fuel" was approved by YMPO on October 28 and will be presented at the XV International Symposium on the Scientific Basis for Nuclear Waste Management to be held in Strasbourg, France, November 4-7, 1991. This paper concluded that the Cs gap inventories for different rods from the Calvert Cliffs No. 1 reactor were only about one fourth of the fission gas release (FGR) over the range 7 to 18% FGR. The Cs grain-boundary inventories for these same rods were generally 1% or less of the total Cs inventory. Technetium and Sr gap and grain-boundary inventories were less than 0.2%. Sibling samples have been retained for measuring iodine inventories when an inductively coupled plasma/mass spectrometer (ICP/MS) adapted for handling radioactive samples becomes available in early 1992.

Data reported for Canadian CANDU fuels have indicated that most of the cesium and iodine fission gas release is in the gap inventory. Although the paper by Gray, et al of PNL concludes that only about one-fourth of the inventory of cesium fission gas release is in the gap inventory of one U.S. LWR fuel, it is premature to conclude that U.S. fuel cesium and iodine rapid-release inventories are only a fraction of the fission gas release. Measurements on additional fuels are needed before such general conclusions can be supported.

An abstract by L. Thomas, C. Beyer, L. Charlot and R. Guenther entitled "Microstructural Analysis of LWR Spent Fuels at High Burnup" was submitted to YMPO for presentation at the XV International Symposium on the Scientific Basis for Nuclear Waste Management to be held in Strasbourg, France, November 4-7, 1991.

Due to limited FY92 funding, the Materials Characterization Center (MCC) work has been limited to building maintenance and publication of documents.

1.2.2.3.1.2 Waste Form Testing - Glass

This WBS element has received limited funding in FY92, which will be used to maintain the N2 and N3 tests at ANL. Carryover funding has been requested to continue dissolution experiments at LLNL.

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

The N2 tests (SRL actinide-doped glass) continue with no sampling period occurring this month. These tests have been in progress for 296 weeks. The N3 tests (ATM-10, a West Valley actinide-doped glass) continue and have been in progress for 214 weeks.

A paper by J. Mazer, J. Bates, B. Blwer and C. Bradley of ANL entitled "AEM Analyses of SRL 131 Glass Altered as a Function of SA/V" was submitted to YMPO

for presentation at XV International Symposium on the Scientific Basis for Nuclear Waste Management to be held in Strasbourg, France, November 4-7, 1991.

The audit report No. 91-15 was completed for activities at ANL.

1.2.2.3.2 Metal Barriers

S. Hietanen, from the VTT Technical Research Centre of Finland, visited with the Metal Barrier staff on October 3. She described the program that is being carried out in Finland to dispose of spent nuclear fuel. The Finnish program is investigating five sites, all with granite as the host rock. A multiple barrier approach for the waste package is envisioned with, in one design, a 6 cm thick copper overpack surrounding a 5 cm thick carbon steel inner barrier. The copper barrier would be electron beam welded for closure, while a mechanical closure is planned for the carbon steel barrier. Some consideration is given to using a 0.1% silver alloyed copper for the outer barrier to improve resistance to creep and to stress corrosion. She discussed the corrosion and metallurgical testing program that is underway at the VTT laboratories in Espoo. She left reports and literature with the staff and requested copies of some of YMP reports. These were mailed to her on October 9.

Because of limited funding in the container materials area, all of the work on this task was halted at the end of the month. All of the Metal Barrier staff have been re-assigned to other projects. The Task Leader has taken a position in another project after having been associated with the YMP for a ten-year period. A very large number of notebooks, files, and experimental records, test specimens, and miscellaneous items remain to be turned over to the LRC.

Carryover funding was requested for this WBS element.

1.2.2.3.4.1 Integrated Radionuclide Release

The following TIPS have completed technical review and have begun administrative review:

- 1) "Depth Profiling on the Ion Microscope",
- 2) "Data Reduction for Depth Profiles", and
- 3) "Dektac 11A profiling system".

Hardware and software were installed for computer network access.

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

Standards were analyzed to identify, test, and make corrections for the deadtime, pulse height and noise.

Methods were researched for small particle analysis using Scanning Ion Mass Spectroscopy (SIMS).

Interactions of Actinide-bearing Solutions with Rock Corrosion Products

Bulk porosity, pore size distribution, and surface area were measured on samples of tuff wafers and fractured core. The data, which is currently being reduced, is necessary to characterize the physical structure of rocks used in diffusion and flow through experiments prior to modeling the transport rates measured in these experiments.

Work continued on the flow testing of the flow-through system which is designed to study the adsorption and hydrology of water with radionuclide tracers. Room temperature flow tests were conducted to fine-tune the equipment and determine the optimum operating parameters. Heating jackets were assembled and are ready for installation. The computerized instrument-control and data acquisition system was tested successfully. Construction of the solution-collection system continued.

Interaction of materials under repository conditions

A manuscript by J. Bates, J. Bradley, A. Teetsov, C. Bradley of ANL and M. Buchholtz ten Brink of LLNL entitled "Colloid Formation During Waste Form Reaction: Implications for Nuclear Waste Disposal" was submitted to LLNL and is now in technical review. This paper discusses the formation of insoluble Pu and Am-bearing colloidal particles during simulated weathering of a high-level nuclear waste glass. Nearly 100% of the total Pu and Am in test groundwater is concentrated in these submicron particles. Models of actinide mobility and repository integrity which assume complete solubility of actinides in groundwater underestimate the potential for radionuclide release into the environment. These findings underline the need to consider colloid transport and colloid trapping in performance assessments.

Data were analyzed pertaining to the concentration, size and composition of naturally occurring colloids in J-13 and nearby waters from the NTS.

1.2.2.3.4.2 Thermodynamic Data Determination

This WBS element has not been funded in FY92. Carryover funding has been requested to complete measurements started in FY91 of the hydrolysis and carbonate complexation constants for Americium at 50, 75, and 95°C. The carryover funding request also includes measurement of the solubility product constants at 50 and 75°C for uranyl silicate minerals that were identified in UO₂ dissolution experiments.

1.2.2.4. Design, Fabrication, and Prototype Testing

1.2.2.4.1 Waste Package Design

This WBS element has not been funded in FY92.

1.2.2.4.2 Container Fabrication and Closure Development

Carryover funding was requested to analyze the inertial welding samples produced in FY90.

1.2.2.4.3 Container/Water Package Interface Analysis

The draft Mission Plan Amendment was reviewed. Comments are being prepared for submission to OCWRM through YMPO.

1.2.5 REGULATORY AND INSTITUTIONAL

1.2.5.2.1 NRC Interaction Support

Several staff members participated in the NWTRB meeting held in Las Vegas, October 8-10. Presentations were made to the board by T. Buscheck, G. Gdowski, W. Lin, L. Ramspott, and B. Vianl.

J. Blink attended the dry run for the NWTRB meeting on seals.

L. Younker and J. Blink briefed R. Dyer and several other YMPO staff members on October 7. The presentation was focussed on the value of the near field in meeting regulatory radionuclide isolation requirements.

1.2.5.2.2 Site Characterization Program

M. Revelli and L. Ballou attended the Early Site Suitability Evaluation (ESSE) meeting in Salt Lake City on October 4. They met with W. Pariseau at the University of Utah to review the Postclosure Rock Characteristics Guideline Evaluation in the ESSE Report.

On October 3, M. Revelli participated in the ESSE telecon to plan the resolution of ESSE comments and review the schedule for completing revisions to the report.

1.2.5.2.4 Technical Support Documentation

No significant activities.

1.2.5.2.5 Study Plan Coordination

No significant activities.

1.2.5.2.6 Semi-Annual Progress Reports

The Progress Report (PR) covering the reporting period April 1 through September 30 was transmitted to YMPO on October 11.

1.2.9 PROJECT MANAGEMENT

1.2.9.1.1 Management

J. Blink and B. Bryan documented actions taken as a result of a LLNL-YMP Management Assessment.

J. Blink attended a Quality Integration Group meeting on October 3 to review the draft QARD revision.

W. Clarke and J. Blink attended the TPO meeting on October 11.

J. Blink acted as an exhibit guide at the October 23 Yucca Mountain Tour. He also assisted the Information Office at the Boy Scout Expo on October 19 and at the Boy Scout Atomic Energy Merit Badge workshop on October 26. Over 100 scouts participate in the Yucca Mountain activities at these two events, and about 50 boys earned the merit badge.

1.2.9.1.4 Records

Document Control issued eighteen Change Notices and one new issue under controlled distributions. Routine follow-up for receipt acknowledgements continues.

A total of 204 items were logged into the LLNL-YMP tracking system. This includes 35 records/records packages that were processed through to the CRF. Twenty action items were closed.

1.2.9.2 Project Control

The September FTE Report and Cost Plan were submitted to YMPO. The Quarterly Worker Data Report was completed.

Actual costs, latest revised estimates, and actual schedule data were submitted to the YMPO PACS system. The FY91 year-end closing activity was completed.

The variance analysis reports for September 1991 PACS activities were submitted. Variances occurred in 27 P&S accounts.

Requests for FY91 carryover funding were completed, prioritized, and transmitted to YMPO.

Work continued on planning for PACS for FY92 and FY93 based on current funding/workscope guidance from YMPO and LLNL management. Outyear activities are being consolidated into planning packages.

Continued to provide the GAO auditors with data from FY90 and FY91. The information gathering phase is projected to be complete at the end of October.

J. Podobnik attended the YMPO project control steering meeting in Albuquerque on October 22. Discussions were held on modifications to the current PACS reporting system; M&O project control techniques; and approved reports and progress of training, procedures and hardware/software subcommittees. J. Blink attended the PACS Training Subcommittee meeting in Las Vegas on October 17. The results of the training needs survey were analyzed at the meeting.

1.2.9.3 Quality Assurance

Three QAPP changes were transmitted to YMPO for approval:

- 1) Change Notice 033-YMP-R 18-0-1 "Audits",
- 2) 033-YMP-R 1, Rev. 1 "Organization", and
- 3) 033-YMP-R Appendix A, Rev. 1 "Terms and Definitions".

Audit Report 91-14, Pacific Northwest Laboratory, and Audit Report 91-15, Argonne National Laboratory, were transmitted to YMPO.

LLNL-YMP FY 1991 Quality Assurance Audit and Surveillance Schedules, Rev. 3 were transmitted to YMPO.

LLNL-YMP Quality Assurance Audit Schedules, both internal and external, for FY 1992 were transmitted to YMPO.

Adverse Finding Reports AFR-013, 014, 015, and 016 initiated by LLNL-YMP were transmitted to YMPO. The corrective action has now been completed and verified to close these AFRs.

The following QP changes were distributed:

QP Tab C, R2	CN QP 5.0-1-3
CN QP 2.1-3-1	CN QP 10.0-0-3
CN QP 2.6-1-2	CN QP 12.0-2-1
CN QP 2.7-0-2	CN QP 15.0-2-2
CN QP 2.8-1-4	QP 16.0, R3
CN QP 2.9-2-4	CN QP 16.1-2-2
CN QP 3.0-2-1	CN QP 16.2-2-1
CN QP 3.2-0-3	CN QP 17.0-2-3
CN QP 3.3-2-2	QP 18.0, R3
CN QP 3.4-2-3	QP 18.1, R3
CN QP 3.5-0-2	CN QP 18.2-1-4