

LAWRENCE LIVERMORE NATIONAL LABORATORY YCCA MOUNTAIN PROJECT
OCTOBER 1991 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 to 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 UO₂ 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, Tc 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. Chariot 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. Biwer 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 the 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 Core Samples

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/Waste 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. Viani.

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