

U.S. DEPARTMENT OF ENERGY  
OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT  
OFFICE OF QUALITY ASSURANCE

AUDIT REPORT  
OF THE  
CIVILIAN RADIOACTIVE WASTE MANAGEMENT SYSTEM  
MANAGEMENT AND OPERATING CONTRACTOR  
AT  
LOS ALAMOS NATIONAL LABORATORY  
LOS ALAMOS, NEW MEXICO

AUDIT NUMBER YM-ARP-96-06  
FEBRUARY 26 THROUGH FEBRUARY 29, 1996

Prepared by: Richard L. Weeks Date: 3/28/96  
Richard L. Weeks  
Audit Team Leader  
Yucca Mountain Quality  
Assurance Division

Approved by: D. G. Horton Date: 3/28/96  
Donald G. Horton  
Director  
Office of Quality Assurance

## **1.0 EXECUTIVE SUMMARY**

As a result of Performance-Based Quality Assurance (QA) Audit YM-ARP-96-06, the audit team determined that the Civilian Radioactive Waste Management System Management and Operating Contractor (CRWMS M&O) at the Los Alamos National Laboratory (Los Alamos) is satisfactorily implementing an adequate and effective QA program and process controls with regards to work performed under Work Breakdown Structure (WBS) 1.2.3.4.1.5.1, "Retardation Sensitivity Analysis." The Los Alamos program examined during this audit is in accordance with the U.S. Department of Energy (DOE) Office of Civilian Radioactive Waste Management Quality Assurance Requirements and Description (QARD) document DOE/RW-0333P, Revision 4.

This audit was performed on the activities associated with the development of the draft report, "An Unsaturated Zone Flow and Transport Model of Yucca Mountain" (Milestone 3468). This draft report was submitted to the CRWMS M&O in October 1995. Major input came from the hydrostratigraphic framework model of the Unsaturated Zone Flow Model developed by the Lawrence Berkeley National Laboratory/U.S. Geological Survey (LBNL/USGS), as revised through input from the Los Alamos mineralogy/petrology group. Specifically, the utilization of mineralogical and petrographic data to construct a model in support of the aforementioned WBS was evaluated.

The audit team identified one deficiency during the audit that was corrected the last day of the audit and is described in Section 5.5.4 of this report. Additionally, there were two recommendations resulting from the audit which are presented in Section 6.0 of this report.

## **2.0 SCOPE**

The audit was conducted to evaluate the adequacy and effectiveness of Los Alamos's controls for generating Milestone 3468, "An Unsaturated Zone Flow and Transport Model of Yucca Mountain." The audit was intended to determine the degree to which the resultant products meet the program requirements and management commitments and expectations, as well as to determine that Los Alamos completed the work in accordance with the pertinent sections of the QARD.

The process/activities/end-products evaluated during the audit, in accordance with the approved audit plan, are as follows:

### PROCESS/ACTIVITY/END-PRODUCT

Based on discussions with the Assistant Manager for Scientific Programs, one deliverable from WBS 1.2.3.4.1.5.1, "Retardation Sensitivity Analysis," was selected for evaluation. The specific deliverable evaluated was the draft report, "An Unsaturated Zone Flow and Transport Model of Yucca Mountain" (Milestone 3468).

The performance-based evaluation of process effectiveness and product acceptability was based on:

1. Satisfactory completion of the critical process steps
2. Acceptable results and quality of the end products
3. Documentation that substantiates quality of products
4. Performance of trained and qualified personnel
5. Implementation of applicable QA program elements

In addition, a sample of the applicable QA program requirements and controls as they applied to the deliverable was examined to evaluate the degree of compliance. The following QA program elements and supplements selected are directly related to Los Alamos's activities in generating Milestone 3468. These elements and supplements were evaluated for applicability and compliance:

- 2.0 QA Program
- 5.0 Implementing Documents
- 6.0 Document Control
- 12.0 Control of Measuring & Test Equipment
- 15.0 Nonconformances
- Supplement I, Software
- Supplement II, Sample Control
- Supplement III, Scientific Investigations

### TECHNICAL AREAS

The technical evaluation of the mineralogy/petrology activities associated with the generation of this draft report, Milestone 3468, are as follows:

1. Input from LBNL/USGS Hydrostratigraphic Framework Model
2. Hydrostratigraphic Framework Model Revision Based on Mineralogy/Petrology Input
3. Mineralogy/Petrology Input - Sampling
4. Mineralogy/Petrology Input - Sample Preparation
5. Mineralogy/Petrology Input - Quantitative X-Ray Diffraction

### 3.0 AUDIT TEAM AND OBSERVERS

The following is a list of the audit team members and their assigned areas of responsibility:

<u>Name/Title/Organization</u>	<u>QA Program Elements/Requirements, Processes, Activities, or End-Products</u>
Richard L. Weeks, Audit Team Leader (ATL), Yucca Mountain Quality Assurance Division (YMQAD)	QA Elements 2.0, 5.0, 6.0; and Supplements II and III
Patout H. Cotter, ATL in Training, YMQAD	QA Elements 2.0, 12.0, 15.0; and Supplement I
Mark T. Peters, Technical Specialist, CRWMS M&O	Milestone 3468, Mineralogical and Petrographic Activities

There were no observers present at the audit.

### 4.0 AUDIT MEETINGS AND PERSONNEL CONTACTED

A preaudit meeting was held with Los Alamos's management and staff at the Los Alamos Technical Associates (LATA) conference room in Los Alamos, New Mexico, on February 26, 1996. A daily debriefing and coordination meeting was held with Los Alamos management and staff, and daily audit team meetings were held to discuss issues and potential deficiencies. The audit was concluded with a postaudit meeting held at LATA's conference room in Los Alamos, New Mexico, on February 29, 1996. Personnel contacted during the audit are listed in Attachment 1. The list includes those who attended the preaudit and postaudit meetings.

### 5.0 SUMMARY OF AUDIT RESULTS

#### 5.1 Program Effectiveness

The audit team concluded that, in general, the Los Alamos process controls are adequately and effectively being implemented for areas identified in the scope of this audit. The process controls for the generation of the draft report, "An

Unsaturated Zone Flow and Transport Model of Yucca Mountain" (Milestone 3468), were found to be effective and the products are adequate for the needs of the project. Control of software changes could not be evaluated due to lack of activity in this area.

**5.2 Stop Work or Immediate Corrective Actions Taken**

There were no Stop Work Orders, immediate corrective actions, or related additional items resulting from this audit.

**5.3 QA Program Audit Activities**

A summary table of audit results is provided in Attachment 2. The details of the audit evaluation, along with the objective evidence reviewed, are contained within the audit checklists. The checklists are kept and maintained as QA records.

**5.4 Technical Audit Activities**

The product, draft report Milestone 3468, from WBS 1.2.3.4.1.5.1, "Retardation Sensitivity Analysis," and the supporting mineralogy/petrology activities are determined to be technically adequate and satisfactory. The evaluation of an individual activity's adequacy is presented in detail in the Quality Assurance Checklist. A brief synopsis of audit team activities is presented below.

**Input From LBNL/USGS Hydrostratigraphic Framework Model:**

The LBNL/USGS data files were reviewed on the computer. The process of using the data to construct a framework model was also followed, along with discussion of reasons for revision of the provided model. Revisions were required in order to more clearly represent the units below the repository for the purpose of transport calculations. This process and its product are satisfactory.

**Hydrostratigraphic Framework Model Revision Based on Mineralogy/Petrology Input:**

The data files provided by the Los Alamos mineralogy/petrology group to revise the framework model were reviewed on the computer. The activity of using the data to construct a framework model was also followed. Uncertainties in the transport model due to the framework model input were also discussed in detail. The uncertainties were related mainly to limited borehole coverage in the western part of the repository area. These uncertainties will be reduced somewhat by quantitative analyses of core (SD-7, SD-9, and SD-12) by Los Alamos's mineralogy/petrology staff in fiscal year 1996, which will be provided to the modeling group. This activity and its product are satisfactory.

**Mineralogy/Petrology Input - Sampling:**

The sampling methodology, and how it has evolved over time, was followed in detail. The source and representativeness of samples was also discussed. Uncertainties in the framework and transport models due to sampling density within boreholes and overall borehole coverage were also discussed. The conclusions related to uncertainties are discussed in the previous section. This activity and its product are satisfactory.

**Mineralogy/Petrology Input - Sample Preparation:**

The sample preparation process was reviewed. The process includes crushing to a homogeneous powder and mixing with the internal standard (corundum) used for quantitative X-ray diffraction. There was not sufficient time to follow the entire process with an actual sample; however, the process was summarized in the laboratory by personnel that prepared samples. Detailed Los Alamos procedures (identified on the checklist) for this process were also reviewed and found to be adequate. This process and its product are satisfactory.

**Mineralogy/Petrology Input - Quantitative X-Ray Diffraction:**

The entire process was followed from analysis to data reduction. Details of the technique were discussed, as well as the use of alternative techniques to verify the results. Source and treatment of errors were also presented in detail. Los Alamos procedures (identified on checklist) for data collection and reduction were also reviewed and found to be adequate. This process and its product are satisfactory.

**5.5 Summary of Deficiencies**

The audit team identified one deficiency that was corrected the last day of the audit. A description of the deficiency and remedial action taken to correct it are presented below:

**5.5.1 Corrective Action Requests (CAR)**

None

**5.5.2 Deficiency Reports (DR)**

None

**5.5.3 Performance Reports (PR)**

None

#### **5.5.4 Deficiencies Corrected During the Audit**

Deficiencies which are considered isolated in nature and only requiring remedial action can be corrected during the audit. The following deficiency was identified and corrected during the audit:

1. A Technical Reviewer Qualifications form could not be found in the Training Coordinator's files as required by procedure LANL-YMP-QP-03.23, R3, "Preparation and Review of Technical Information Products and Study Plans." A form was completed and submitted to the file on the last day of the audit. Los Alamos documented this condition and its resolution on PR LANL-96-003.

#### **5.5.5 Follow-up of Previously Identified CARs and DRs**

There were no previously issued CARs or DRs that were determined to be applicable to the scope of this audit.

### **6.0 RECOMMENDATIONS**

The following recommendations resulted from the audit and are presented for consideration by Los Alamos management:

1. This recommendation is of an editorial nature concerning Milestone 3468. The source(s) of the differences between the nominal and maximum zeolite cases for the Calico Hills stratigraphy should be explained in more detail in order to clearly describe the differences.
2. This recommendation is more general and concerns the conservative modeling approach used by Los Alamos. The approach is appropriate and should be continued; however, the draft milestone report (and future tasks) should mention explicitly the degree of conservatism utilized in the task. This will help identify other attributes of the natural system that might enhance radionuclide retardation, which are not accounted for in the model.

### **7.0 LIST OF ATTACHMENTS**

Attachment 1: Personnel Contacted During the Audit  
Attachment 2: Summary Table of Audit Results

## ATTACHMENT 1

### Personnel Contacted During the Audit

<u>Name</u>	<u>Organization/Title</u>	<u>Preaudit Meeting</u>	<u>Contacted During Audit</u>	<u>Postaudit Meeting</u>
Bish, D.	LANL/Mineralogy - Petrology - Rock Chemistry Technical Coordinator		X	
Bussod, G.	LANL - Project Leader		X	X
Canepa, J.	LANL - Technical Project Officer	X	X	
Clevenger, M.	LANL - QAPL	X	X	X
Chipera, S.	LANL - Associate Investigator		X	
Day, J.	LANL/LATA - Project Quality Liaison	X		
Gable, C.	LANL - Associate Investigator		X	
Gallegos, A.	LANL/LATA - QA Liaison	X	X	X
Gillespie, P.	LANL/LATA - Verification Coordinator	X	X	X
Gundlach, B.	LANL/LATA - Software Configuration Coordinator		X	X
Martinez, S.	LANL/Records/Training/Document Control	X	X	X
Robinson, B.	LANL - PI	X	X	X
Vaniman, D.	LANL - PI	X	X	X
West, K.	LANL - Administration and Control Project Leader	X	X	X
Wichman, L.	LANL/LATA - QA Liaison	X	X	X
Wolfsberg, A.	LANL - Associate Investigator		X	
Young, J.	LANL/LATA - Technical Data Coordinator	X		

#### LEGEND:

QAPL ..... Quality Assurance Project Leader

PI ..... Principal Investigator



**ATTACHMENT 2**  
**Summary Table of Audit Results**

**AUDIT YM-ARP-96-06 DETAIL SUMMARY**

**PROGRAMMATIC DETAILS**

QA ELEMENT/ ACTIVITIES	PROCESS STEPS/ DOCUMENTS REVIEWED	CHECKLIST DETAILS YM-ARP-96-06	CAR (5.5.1)	DR (5.5.2)	PR (5.5.3)	CDA (5.5.4)	REC (6.0)	ADE- QUACY	COM- PLIANCE	OVER- ALL
2.0 Quality Assurance Program	QA Oversight Activities	Page 2 of 26	N	N	N	N	N	SAT	SAT	SAT
	Personnel Conducting Work are Qualified and Trained	Pages 2 & 3 of 26	N	N	N	N	N	SAT	SAT	
	Control of Interfaces	Page 8 of 26	N	N	N	N	N	SAT	SAT	
	Planning	Page 8 of 26	N	N	N	N	N	SAT	SAT	
	Document Review	Page 9 of 26	N	N	N	N	N	SAT	SAT	
5.0 Implement- ing Documents	Work was Accomplished in Accordance with Implementing Documents	Page 10 of 26	N	N	N	#1	N	SAT	SAT	SAT
	Appropriate Procedures	Page 10 of 26	N	N	N	N	N	SAT	SAT	
6.0 Document Control	Documents and Changes are Reviewed	Pages 10 & 11 of 26	N	N	N	N	N	SAT	SAT	SAT

**ATTACHMENT 2**  
**Summary Table of Audit Results**

QA ELEMENT/ ACTIVITIES	PROCESS STEPS/ DOCUMENTS REVIEWED	CHECKLIST DETAILS YM-ARP-96-06	CAR (5.5.1)	DR (5.5.2)	PR (5.5.3)	CDA (5.5.4)	REC (6.0)	ADE- QUACY	COM- PLIANCE	OVER- ALL
2.0 Control of Measuring and Test Equipment (M&TE)	M&TE Used is Identified and is Controlled	Page 4 of 26	N	N	N	N	N	SAT	SAT	SAT
	Malfunctioning and/or Out-of-Tolerance M&TE are Controlled	Page 5 of 26	N	N	N	N	N	SAT	SAT	
15.0 Noncon- formances	Nonconforming Samples are Controlled	Page 5 of 26	N	N	N	N	N	N/I	N/I	SAT
	Technical Justifications Adequate	Page 6 of 26	N	N	N	N	N	N/I	N/I	
Supplement Software	Review of Changes	Page 6 of 26	N	N	N	N	N	N/I	N/I	N/I
	Verification and Validation of Changes	Page 7 of 26	N	N	N	N	N	N/I	N/I	
	Software Defect Reporting and Resolution	Page 7 of 26	N	N	N	N	N	N/I	N/I	

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**Summary Table of Audit Results**

QA ELEMENT/ ACTIVITIES	PROCESS STEPS/ DOCUMENTS REVIEWED	CHECKLIST DETAILS YM-ARP-96-06	CAR (5.5.1)	DR (5.5.2)	PR (5.5.3)	CDA (5.5.4)	REC (6.0)	ADE- QUACY	COM- PLIANCE	OVER- ALL
Supplement II - Sample Control	Controls Developed for Tracking Samples Used	Page 11 of 26	N	N	N	N	N	SAT	SAT	SAT
	Storage is Adequate	Page 12 of 26	N	N	N	N	N	SAT	SAT	
	Samples are Controlled by Implementing Documents	Page 12 of 26	N	N	N	N	N	SAT	SAT	
Supplement III - Scientific Investiga- tions	Planning	Pages 8, 13 & 14 of 26	N	N	N	N	N	SAT	SAT	SAT
	Controlled Documents	Page 14 of 26	N	N	N	N	N	SAT	SAT	
	Data Traceability and Status	Pages 15 & 16 of 26	N	N	N	N	N	SAT	SAT	
	Independent Reviews	Page 15 of 26	N	N	N	N	N	SAT	SAT	

**TECHNICAL DETAILS**

Milestone 3468, "An Unsaturated Zone Flow and Transport Model of Yuucca Mountain"	Input from LBNL/USGS Hydrostratigraphic Framework Model	Pages 17, 19 & 20 of 26	N	N	N	N	N	SAT	SAT	SAT
	Hydrostratigraphic Framework Model Revision Based on Mineralogy/Petrology Input	Pages 18, 19, 20, 21, 22, 23 & 26 of 26	N	N	N	N	#1 & 2	SAT	SAT	

**ATTACHMENT 2**  
**Summary Table of Audit Results**

QA ELEMENT/ ACTIVITIES	PROCESS STEPS/ DOCUMENTS REVIEWED	CHECKLIST DETAILS YM-ARP-96-06	CAR (5.5.1)	DR (5.5.2)	PR (5.5.3)	CDA (5.5.4)	REC (6.0)	ADE- QUACY	COM- PLIANCE	OVER- ALL
Milestone 3468, An Unsaturated Zone Flow and Transport Model of Yucca Mountain" (Cont'd)	Mineralogy/Petrology Input - Sampling	Page 24 of 26	N	N	N	N	N	SAT	SAT	SAT
	Mineralogy/Petrology Input - Sample Preparation	Page 24 of 26	N	N	N	N	N	SAT	SAT	
	Mineralogy/Petrology Input - Quantitative X- Ray Diffraction	Page 25 of 26	N	N	N	N	N	SAT	SAT	

**Legend:**

CAR ..... Corrective Action Request  
 DR ..... Deficiency Report  
 PR ..... Performance Report  
 CDA ..... Corrected During Audit  
 REC ..... Recommendation  
 N ..... None  
 SAT ..... Satisfactory  
 N/I ..... No Implementation