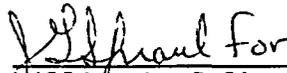
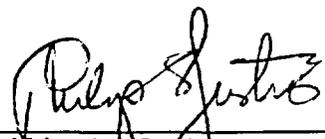
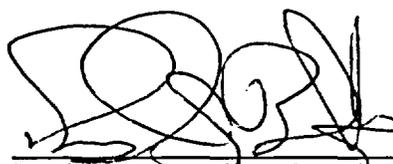
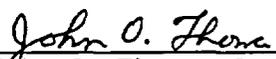


U.S. NUCLEAR REGULATORY COMMISSION  
OBSERVATION AUDIT REPORT OA-96-03  
OF THE YUCCA MOUNTAIN QUALITY ASSURANCE DIVISION  
AUDIT YM-ARP-96-07  
OF THE CIVILIAN RADIOACTIVE WASTE MANAGEMENT  
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ENCLOSURE

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## 1.0 INTRODUCTION

Members of the Nuclear Regulatory Commission Division of Waste Management quality assurance (QA) and geosciences staff observed the U. S Department of Energy (DOE), Office of Civilian Radioactive Waste Management (OCRWM), Office of Quality Assurance, Yucca Mountain Quality Assurance Division (YMQAD) performance-based audit of the Civilian Radioactive Waste Management System Management and Operating Contractor (M&O). The audit, YM-ARP-96-07 was conducted on February 26 through March 1, 1996, for work being performed at the Sandia National Laboratories (SNL) offices in Albuquerque, New Mexico, and for work being performed at the M&O offices in Las Vegas, Nevada. The State of Nevada participated as an observer at this audit and submitted five Audit Observer Inquiries (Attached).

The objective of this performance-based audit by YMQAD was to evaluate the implementation of the M&O QA program requirements and the technical activities associated with the generation of the "Three-Dimensional Rock Characteristics Models" (Work Breakdown Structure 1.2.3.9.5).

The NRC staff's objective was to gain confidence that YMQAD and the M&O are properly implementing the requirements of their QA programs in accordance with the OCRWM Quality Assurance Requirements and Description (QARD: DOE/RW-0333P) and Title 10 of the Code of Federal Regulations (10CFR), Part 60, Subpart G (which references 10 CFR Part 50, Appendix B).

This report addresses the effectiveness of the YMQAD audit and the adequacy of implementation of QA controls in the audited areas of the M&O QA program.

## 2.0 MANAGEMENT SUMMARY

The NRC staff has determined that YMQAD Audit YM-ARP-96-07 was useful and effective. The audit was organized and conducted in a professional manner. Audit team members were independent of the activities they audited. The audit team was well qualified in the QA and technical disciplines, and its assignments and checklist items were adequately described in the audit plan.

The audit team concluded that the M&O QA program had been satisfactorily implemented. Three preliminary minor deficiencies were reported at the exit meeting. The audit team also made seven recommendations. The NRC staff agrees with the audit team conclusion, findings, and recommendations. The NRC staff determined that this audit was effective and that the M&O QA program implementation for the three-dimensional geologic modeling effort was adequate.

## 3.0 AUDIT PARTICIPANTS

### 3.1 NRC

William L. Belke	Observer (QA)
Philip S. Justus	Observer (Technical Specialist)

### 3.2 DOE/YMQAD

Dennis C. Threatt	Audit Team Leader (ATL)	YMQAD/Quality Assurance Technical and Support Services(QATSS)/ Science Applications International Corp. (SAIC)
Daniel A. Klimas	ATL in training	YMQAD/QATSS/CER Corporation
Stephen D. Harris	Auditor	YMQAD/QATSS/SAIC
Jefferson R. McCleary	Technical Specialist	M&O/Woodward and Clyde Federal Services

### 3.3 State of Nevada

Susan W. Zimmerman      Observer

### 4.0 REVIEW OF THE AUDIT AND AUDITED ORGANIZATION

This YMQAD audit of the M&O was conducted in accordance with OCRWM Quality Assurance Procedure (QAP) 18.2, "Internal Audit Program" and QAP 16.1Q., "Performance/Deficiency Reporting." The NRC staff observation of this audit was based on the NRC procedure, "Conduct of Observation Audits," issued October 6, 1989.

#### 4.1 Scope of the Audit

The following six QA program elements were audited:

<u>Criterion</u>	<u>Subject</u>
1.0	Organization
2.0	QA Program
5.0	Implementing Documents
6.0	Document Control
16.0	Corrective Action
17.0	QA Records
Supplement I	Software QA
Supplement III	Scientific Investigation

The technical area audited was the development of the three-dimensional geologic model using 'ynx software.

The Key Technical Issue (KTI) associated with the audit is Structural Deformation and Seismicity. The technical portion of this audit provided insight into DOE's program that will facilitate resolution of this KTI.

#### 4.2 Conduct of Audit

The audit was performed in a professional manner. Audit team personnel were well prepared and demonstrated a sound knowledge of the M&O and DOE QA programs. Audit team personnel were persistent in their interviews, challenged responses when appropriate, and performed an acceptable audit. The audit plan identified this as a performance-based audit in which the

evaluation process and product acceptability would be based on 1) satisfactory completion of the critical process steps, 2) acceptable results and quality of the end product, 3) documentation that substantiates quality of products, 4) performance of trained and qualified personnel, and 5) implementation of applicable QA program elements. The audit included the technical evaluation of the data selected and input to the model, the authenticity of the data, the completeness of the database, the process of reconciling conflicting data, the documenting of data used and data not used, and the modeling results.

The DOE audit team and observers caucused at the end of each day. Also, meetings of the audit team and SNL management (with an NRC observer present) were held each morning to discuss the then-current audit status and preliminary findings.

#### **4.3 Timing of the Audit**

The NRC staff believes the general timing of the audit was appropriate for YMQAD to evaluate the pertinent M&O and SNL activities associated with the ongoing modeling process and implementation of the respective QA programs. YMQAD performed this audit while modeling activities were still being conducted. Therefore, in the absence of a final report, items 2) and 3) in Section 4.2 could not be verified during this audit.

#### **4.4 Examination of QA Programmatic Elements**

The majority of the auditing effort focused on the technical aspects of the three-dimensional geologic modeling. The NRC staff observed that each of the audit team members reviewed pertinent documentation and interviewed a representative sample of SNL personnel to determine their understanding of implementing procedures. Checklists were used effectively, and issues were pursued beyond the checklists when appropriate. NRC observers were provided ample opportunity to provide comments and ask questions.

The audit team reviewed the training, education, and experience records of involved personnel to ensure the personnel met their individual position descriptions. Objective evidence was provided and reviewed. The audit team concluded that all personnel were in compliance with the exception of one individual whose experience could not be verified. Objective evidence was submitted subsequently such that this minor deficiency was corrected during the audit.

The audit checklist referenced a Planning and Control System (PACS) sheet as one of the controlling documents for this audit. Discussions between audit team personnel and those audited indicated that the PACS sheet did not reflect the current activities included in the Work Breakdown Structure Statement of Work. The audit team recommended that applicable PACS documents be evaluated and updated to reflect the current Statement of Work and the actual work activities.

The Study Plan for the Rock Characteristics Model had been reviewed by appropriate individuals. The completed review package was audited to determine whether the review process was in accordance with procedures. The

package included reviewer comments and indicated that the comments had been incorporated or resolved. However, the package did not describe how a particular comment was resolved and why it was or was not incorporated into the package. The audit team recommended that the comment resolution information be included in the package in order to improve the process from a "lessons learned" perspective.

The scientific notebook for the modeling process was audited to ensure completeness, accuracy, and adequate documentation. The audit team found that all pages were properly numbered, legible, and appeared to be readily understandable by another user. Although not a departure from an established requirement, this scientific notebook was in loose-leaf form as opposed to the conventional bound book used by most scientists in the high-level waste program. Since these were loose pages and since the notebook could be used for an extended period of time, there should be assurance that no pages are lost or misplaced. Therefore, the audit team recommended that the Principal Investigator reproduce and archive completed pages of the notebook approximately monthly to guard against loss during the development process.

#### 4.5 Examination of Technical Activities

The report on the site geologic model is scheduled for issue to DOE by the M&O on June 1, 1996. It is to depict most of the Tertiary stratigraphic units (about 40 surfaces), extend to the top of the Paleozoic surface, and show faults that are more than 2 miles long in surface trace that have more than 100 feet displacement anywhere along their mapped length. The site geologic model is being developed by SNL personnel using the Lynx code. The input to the site geologic model consists of fault and stratigraphic data derived from U.S. Geological Survey (USGS) data. Meetings have been held at USGS to obtain new data to be input to the model and to reconcile data discrepancies. Decisions made at these meetings have not been documented in scientific notebooks. The audit team recommended that this be done. A significant limitation of the model is that the faults included in it are all plotted with 90 degree dips, regardless of their actual dip. The M&O stated it plans to correct this. Other simplifications intended to facilitate modeling were noted by the M&O. For example, Ghost Dance Fault is depicted as one plane, even though it is considered to be a system of faults. Also, closely-spaced faults are depicted as one fault with the total displacement represented by the one fault.

SNL had alerted the M&O to inconsistent use of the term, "lithophysae," in rock descriptions. For example, some geologists described borehole core as lithophysae only if it had unfilled voids, others used the term to describe core with filled voids. Also, SNL was occasionally faced with ambiguities in how to depict certain fault-strata relationships. It was noted that certain faults around Dune Wash and the Bow Ridge fault near Drill Hole Wash could be interpreted as having alternative relationships when plotted in the 3-D model. Meetings to reconcile alternative concepts were held between SNL and USGS. The results of these meetings are recorded in scientific notebooks. In one instance, SNL apparently stimulated thinking about the concept of a fault in Crater Flat being a through-going fault, where scattered field observations

had not led to that conclusion. This apparent synergism between the SNL modeler and the USGS field observers is a credit to the project.

The scientific notebooks of the field observers and interpreters and the modeler currently are the only place where future reviewers of the model can evaluate the three-dimensional geologic modeling work. Documentation needed to modify the model is found mainly in scientific notebooks. This reinforces the importance of the audit team's recommendation that the scientific notebooks be reproduced and archived approximately monthly.

SNL pointed out that no volume can be left "undecided" in its three-dimensional geologic model. Thus, the geologic model is a set of surfaces, volumes and measured data that can be put together in different ways and it is not an actual depiction or picture of the site. Therefore, users of this model should not take it literally (pictorially), but should delve into the scientific notebooks to determine the model's flexibility. Internal consistency of the fault-strata relationships is a goal. To meet this goal, sometimes field observers' impressions are modified and sometimes the modeler's concept is modified. Reviewers and users of the model output (for example, NRC and DOE) should be aware that such modifications are not necessarily recorded with the original source of the data or position in the notebook. For example, SNL pointed out one parameter (location of particular fault terminations in the subsurface) that is beyond the observation powers of the field observer. This audit could not proceed to the question of how such data are verified because the product was still being developed.

A relatively new database, the Numerical Model Warehouse (NMW), was mentioned. Software codes and files are stored in the NMW, but software cannot be distributed from it. One will need to go to the Principle Investigator to obtain a model or code. Computer files currently go to the NMW rather than to the Geographic Nodal Information Study and Evaluation System (GENISES).

The M&O noted that stratigraphic data have been compiled in a "Stratigraphic Compendium." Inconsistencies in reporting data on various strata are now documented therein. The M&O pointed out that the compendium will be an administrative reference (and not a data source) until it is incorporated into GENISES at the end of Fiscal Year 1996. This may explain inconsistencies noted by individuals reviewing stratigraphic data from sources other than the compendium.

The three-dimensional geologic model was described as one of six models that will form the bases for DOE's assessment of site performance. Future audits may want to consider the integration of the geologic model with the other models, any loss or oversimplification of data in its transfer from one model to another, and the efficacy of feedback from one model to another.

The examination of technical activities was greatly facilitated by the candidness of involved SNL and M&O personnel. Using its checklist, and additional questions when appropriate, the audit team evaluated the development of the three-dimensional geologic model as regards data selection, data input, data reduction, data output, and data revisions.

One important point made by the audit team was that the code has its limits on how much and what kind of detail can be included. The audit team noted that certain data just cannot be handled by the present code. Users must determine whether the data in the three-dimensional geologic model represent adequate bases for making decisions, particularly because uncertainties associated with the data displayed may not be obvious from the printouts.

#### 4.6 Audit Team Qualification and Independence

The qualifications of the ATL and audit team members were found to be acceptable in that they each met the requirements of QAP 18.1, "Auditor Qualification."

Audit team personnel did not have prior responsibility for performing the activities they audited. The technical specialist was employed by Woodward-Clyde Federal Services and his portion of the audit included auditing the work of another Woodward-Clyde Federal Services employee. The technical specialist was geographically located in Utah whereas the audited individual was located in Las Vegas, Nevada. Although both individuals were from the same company, the NRC observers found the technical specialist to be totally objective in his questioning and evaluations during the audit process.

The audit team members were prepared in the areas they were assigned to audit and were knowledgeable of applicable procedures. The checklist was adequately formulated and covered the subject matter well. Checklist items based on erroneous PACS descriptions were discounted appropriately.

#### 4.7 NRC Staff Findings

The QA programmatic and technical portions of the audit were conducted in a professional manner and the audit team adequately evaluated activities and objective evidence. The ATL was extremely effective in his daily presentations to the management of the audited organizations and in providing guidance to the audit team members.

The checklist questions provided a sound basis from which to conduct the audit and reach an accurate conclusion on the three-dimensional geologic modeling process. The audit team personnel and audited personnel were all knowledgeable in their respective disciplines.

The audit team placed appropriate significance on recommendations designed to protect the currency and availability of the scientific notebooks which document all aspects of the development of and controlled changes to the model.

The apparent synergism between the SNL modeler and the USGS field observers is a credit to the project.

The NRC staff agrees with the YMQAD audit team findings summarized below.

#### 4.8 Summary of YMQAD Findings

The audit team determined that the application of QA controls was effective for the three-dimensional geologic modeling effort. At the post audit meeting, the audit team presented the three preliminary deficiency reports described below.

1. Responses to one deficiency report and two performance reports that were issued at the Nevada Test Site were not received by the due dates.
2. SNL Quality Assurance Implementing Procedure QAIP 2-4, "Conducting and Documenting Analyses/Calculations," did not contain sufficient detail to express the process for model validation.
3. Activities associated with the study plan for the three-dimensional geologic model were performed prior to full approval of the study plan.

# **ATTACHMENT**

OCRWM  
AUDIT OBSERVER INQUIRY

Audit No. YM-ARP-96-07

Log No. \_\_\_\_\_

Name SUSAN ZIMMERMAN Organization State of Nevada

Requirement Reference \_\_\_\_\_

Question/Concern Were fractal analysis techniques considered for use in the 3-D model? If not, why not?

Response Not approp. for frame work - problem in "conducting" fractals to misused data

Susan Zimmerman  
Observer's Acknowledgement

Cleared for Submittal to Participant

Jeff McE...  
Lead Auditor / Lead Technical Specialist

Incorporated in Audit Checklist...Ref

Dennis Street  
Audit Team Leader

OCRWM  
AUDIT OBSERVER INQUIRY

Audit No. YM-ARP-96-07

Log No. \_\_\_\_\_

Name SUSAN ZIMMERMAN Organization State of Nevada

Requirement Reference \_\_\_\_\_

Question/Concern How are differences in the scale of data, e.g., microscopic vs. macroscopic; benchscale vs. repository scale, considered in the model?

Response not in framework - part of process modeling and PA

Susan Zimmerman  
Observer's Acknowledgement

Cleared for Submittal to Participant

Incorporated in Audit Checklist...Ref

Jeff M. C...  
Lead Auditor / Lead Technical Specialist

Dennis T. ...  
Audit Team Leader

OCRWM  
AUDIT OBSERVER INQUIRY

Audit No. YM-ARP-16-07

Log No. \_\_\_\_\_

Name SUSAN ZIMMERMAN Organization State of NEVADA

Requirement Reference \_\_\_\_\_

Question/Concern For the 3-D model, <sup>will</sup> Alluvium and wash deposits be included?  
What methods will be employed to portray post-Tertiary geologic data?  
Some faults such as the Midway Valley Fault supposedly cut Alluvium.  
How will this be portrayed in the 3-D model and with what level of uncertainty?

Response Yes - need to fill volume

Faults not cut alluvium not modeled  
unless > 100 ft offset and  
seven miles long

*Susan Zimmerman*  
Observer's Acknowledgement

Cleared for Submittal to Participant

*Jeff M. S. [Signature]*  
Lead Auditor/Lead Technical Specialist

Incorporated in Audit Checklist...Ref

*Dennis Threlkoff*  
Audit Team Leader

OCRWM  
AUDIT OBSERVER INQUIRY

Audit No. YM-ARP-96-07

Log No. \_\_\_\_\_

Name SUSAN ZIMMERNAN Organization State of Nevada

Requirement Reference \_\_\_\_\_

Question/Concern What is the basis for the Paleozoic surface used in the 3-D model, since only one borehole penetrates pre-Cenozoic stratigraphy. If geophysical survey interpretations are the basis, what is the level of uncertainty associated with these interpretations. How is this level of uncertainty treated in the 3-D model?

Response Geophysics - gravity is basis  
uncertainty is large

Susan Zimmerman  
Observer's Acknowledgement

Cleared for Submittal to Participant

Jeff McQuay  
Lead Auditor/Lead Technical Specialist

Incorporated in Audit Checklist...Ref

Dennis Threlkoff  
Audit Team Leader

OCRWM  
AUDIT OBSERVER INQUIRY

Audit No. YM-ARP-96-07

Log No. \_\_\_\_\_

Name SUSAN ZIMMERMAN Organization State of Nevada

Requirement Reference \_\_\_\_\_

Question/Concern Is the pre-Paleozoic basement stratigraphy included in the 3-D model? If so, how was this stratigraphic surface determined and with what uncertainty level? How are faults and basaltic <sup>intrusion</sup> ~~intrusions~~ rocks treated in the basement stratigraphy?

Response Not included

Basaltic dikes too small to model

Susan W. Zimmerman  
Observer's Acknowledgement

Cleared for Submittal to Participant

Jeff McE...  
Lead Auditor/Lead Technical Specialist

Incorporated in Audit Checklist...Ref

Dennis Threath  
Audit Team Leader