

U.S. NUCLEAR REGULATORY COMMISSION  
OBSERVATION AUDIT REPORT OA-96-01  
OF THE YUCCA MOUNTAIN QUALITY ASSURANCE DIVISION  
AUDIT YM-ARP-96-01  
OF THE U.S. GEOLOGICAL SURVEY

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ENCLOSURE 1

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ENCLOSURE 1

## 1.0 INTRODUCTION

Members of the U.S. 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) audit of selected technical activities of the U.S. Geological Survey (USGS). The audit, YM-ARP-96-01, was conducted at the University of Nevada, Reno, Seismological Laboratory (UNRSL), Reno, Nevada on October 23-24, 1995, and at the USGS offices in Lakewood, Colorado on October 25-27, 1995.

The objective of the audit by YMQAD was to evaluate USGS scientific investigation activities and the quality of the resultant end products associated with the seismic data collection and analysis. These activities are identified in Section 4.1 of this report.

The NRC staff objective was to gain confidence that YMQAD and the USGS 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 (10 CFR), 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 USGS QA program.

## 2.0 MANAGEMENT SUMMARY

This audit evaluated the implementation of the USGS QA program for activities associated with seismic data collection and its use to support seismicity and earthquake studies. The State of Nevada was not represented at this audit.

Although the NRC staff determined that the audit was effective, several weaknesses in the audit process were identified (see Section 4.6.2). The audit team found that the USGS QA program had been effectively implemented in the areas audited. The NRC staff agrees with these conclusions. Four preliminary Deficiency Reports (DRs) were initiated by the audit team.

During this audit, the NRC staff recognized that the DOE QARD does not require the qualification of scientific methods which are not generally accepted by the technical community involved. Requirements for scientific method qualification should be equivalent to those for qualifying data and software. This condition is identified as an open item, and it will be tracked in the NRC Open Item Tracking System until satisfactorily resolved.

## 3.0 AUDIT PARTICIPANTS

### 3.1 NRC

John Spraul  
Abou-Bakr Ibrahim  
Robert Briant

QA Observer  
Technical Observer  
QA Observer

Center for Nuclear Waste  
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### 3.2 DOE

Donald Harris	Audit Team Leader (ATL)	YMQAD
Robert Harpster	Lead Technical Specialist	YMQAD
Jeff McCleary	Technical Specialist (Geology)	OCRWM Management and Operating Contractor (M&O)
James Agnew	Technical Specialist (Geophysics)	M&O

### 4.0 REVIEW OF THE AUDIT AND AUDITED ORGANIZATION

This YMQAD audit of USGS was conducted in accordance with OCRWM Quality Assurance Administrative Procedure (QAAP) 18.2, "Audit Program." AP 16.1, "Performance/Deficiency Reporting" was used to report deficiencies. 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 technical areas concerned with seismicity were identified in the Audit Plan and were audited by the YMQAD audit team:

- Work Breakdown Structure 1.2.3.2.8.3.1 - Relevant Earthquake Sources
- Work Breakdown Structure 1.2.3.2.8.4.1 - Historical and Current Seismicity

The following technical documents were audited by the YMQAD audit team:

- "Seismicity for the Southern Great Basin of Nevada and California in 1994," UNRSL, Preliminary Draft, Revised July 17, 1995 (YMP Activity Number 8.3.1.17.4.1.2)
- "Precarious Rocks and Seismic Shaking at Yucca Mountain, Nevada," USGS, Preliminary Draft, 1995 (Interagency Agreement DE-AI08-92NV10874)
- "Initial Summary of Geologic, Geophysical, and Seismic Data to Support Earthquake Source Characterization for Seismic Hazard Analyses at the Proposed Nuclear Waste Repository, Yucca Mountain, Nevada," USGS, Review Draft, July, 1995 (Report for Activity 1.2.3.2.8.3.1)

In addition, the following six QA program elements were audited:

<u>Criterion</u>	<u>Subject</u>
2.0	Quality Assurance Program (Personnel Qualification and Training)
4.0	Procurement Document Control
7.0	Control of Purchased Items and Services
12.0	Control of Measuring and Test Equipment
15.0	Nonconformance Control
16.0	Corrective Action

The NRC's Key Technical Issue associated with the audit is "Structural Deformation and Seismicity."

#### 4.2 Conduct Of Audit

The audit was performed in a professional manner, and the audit team was well prepared. The audit plan identified this audit as being performance-based in which the evaluation of process effectiveness and product acceptability would be based upon 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.

In addition to being performance-based, this audit was also primarily a technical audit; the technical evaluations being lead by the Technical Specialists. The five bases noted above for evaluating the process effectiveness and product acceptability were addressed. However, the evaluation of satisfactory completion of the critical process steps was handled separately from other technical portions of the audit. In the opinion of the NRC staff, the evaluation of the critical process steps during this audit contributed little to the audit and the determination of QA program effectiveness. This is identified as an audit weakness (see Section 4.6.2). As noted in Observation Audit Report 95-11 for USGS, the NRC staff believes that DOE should review the objectives of, implementation of, and training for its performance-based audits. This is recommended by the NRC staff in Section 4.6.3 of this report.

The NRC staff also observed that important QA issues were slow to be recognized during the technical portions of the audit. The audits of the technical areas were conducted primarily by the Technical Specialists accompanied by the Lead Technical Specialist. While the Lead Technical Specialist has QA experience, QA programmatic issues that surfaced during technical discussions were generally not pursued. In one case, the NRC staff was compelled to prompt the Lead Technical Specialist to recognize a records control issue that resulted in a preliminary DR. Overall, the integration of QA into the technical portion of the audit was poor. This issue is considered an audit weakness (see Section 4.6.2) and should also be considered in DOE's re-evaluation of performance-based audits.

Caucuses were held daily between the audit team and the observers. Also, meetings of the ATL and USGS management (with an NRC observer present) were held as required to discuss the then-current audit status and preliminary findings.

#### 4.3 Examination of Audited Areas

Sections 4.3.1 through 4.3.3 of this report address the audit of the three technical reports listed in Section 4.1. The first two reports, discussed in Sections 4.3.1 and 4.3.2, were audited at the University of Nevada, Reno with follow-up at USGS in Lakewood, Colorado. The third report, discussed in Section 4.3.3, was audited at USGS offices in Lakewood, Colorado. Section 4.3.4 covers the audit of the six QA program elements listed in Section 4.1.

UNRSL assumed operation of the Southern Great Basin Seismic Network on October 1, 1992 under a subcontract from USGS. The network had been operated prior to that time (from 1987) by the USGS. The network continued to be controlled under the USGS QA program while operated by UNRSL. Beginning in October, 1995, UNRSL will be contracted directly by the M&O. At the time of the audit, the transition to M&O procedures had not been completed, and UNRSL continued to work under USGS procedures.

#### 4.3.1 Seismicity of the Southern Great Basin of Nevada and California in 1994

This report contains a catalog of the seismic data collected in 1994 by the Southern Great Basin Seismic Network. This portion of the audit evaluated the catalog and the data recorded by the seismic network and investigated whether the personnel who had performed the work were properly trained and qualified.

The Technical Specialist (geophysics) was the primary interviewer during the technical portion of this audit, using the checklist while interviewing the Principal Investigator (PI) and other UNRSL staff members. In addition to the checklist questions, the audit team posed several questions to the PI and UNRSL staff responsible for reading and recording the times of arrival of compressional and shear seismic waves. The audit team questioned the PI about the criteria used to differentiate between seismic and non-seismic events, the threshold of detection, the time drift on the clock, the procedures used, and the accuracy of the focal depth determination of the seismic events. The UNRSL staff interviewed were receptive to the questions and comments of the audit team and were open and frank in their responses.

A question was raised about whether the UNRSL staff plans to convert the duration magnitude ( $M_b$ ) and local magnitude ( $M_L$ ) values into the moment magnitude ( $M_w$ ) which is the parameter needed by the probabilistic seismic hazard team. The staff responded that, because of the lack of funding, this would probably not be done for this report.

The UNRSL staff described how the operation of the 56 analog stations will be discontinued and will be replaced by the operation of 24 digital stations. At the time of the audit, 12 of these digital stations were operating, and the installation of the other 12 was expected to be completed shortly. A procedure for operating the digital stations had not yet been completed, so scientific notebooks were being used to document the methods and results. However, the audit team noted that the scientific notebooks had loose sheets and were incomplete. Therefore, the audit team initiated a DR (see Section 4.7.2). In addition, the NRC staff noticed that interpretation sheets were completed in pencil and had numerous erasures. This was pointed out to the audit team, and another DR (see Section 4.7.1) was initiated. Since this deficiency had not been identified by the audit team, the NRC staff identified an audit weakness concerning poor integration of the technical and QA portions of the audit (see Section 4.6.2).

As a separate portion of the audit, the critical process steps were evaluated. These steps were listed on a Performance Based Audit Flowchart. The flowchart included blank spaces for identifying the Objective and Measurement Criteria

for each critical process step. The steps listed were to 1) identify the product of the activity, 2) identify data needs, 3) collect data, 4) analyze data, 5) draft the report, 6) peer review the draft report, and 7) respond to review comments and submit the final report. These steps are generic, and could be applied to virtually any scientific investigation. The steps had been identified by USGS management and YMQAD staff for application in an earlier USGS audit.

The audit team had difficulty completing the flowchart. The first two steps involved planning that was not the responsibility of UNRSL, so they had little significance regarding UNRSL performance. The other steps were so general that the responses seemed trivial. This audit activity did not appear to assist the evaluation of QA program implementation and compliance or of product acceptability, and this is identified as an audit weakness (see Section 4.6.2).

#### 4.3.2 Precarious Rocks and Seismic Shaking at Yucca Mountain, Nevada

The purpose of the work described in this report was to develop a methodology for using precariously balanced rocks to provide information about the historical ground motion acceleration and seismic hazard at Yucca mountain. The Technical Specialist (geophysics) was again the primary interviewer during the technical portion of this audit. After a brief presentation by the PI, the audit team again utilized the checklist during the PI interview. In addition, the audit team posed several questions about the criteria used in deciding where to look for precarious rocks and the area(s) searched for precarious rocks. The discussion and questions centered on how applicable this work is to the Yucca Mountain Project and whether similar research has been conducted anywhere else on this subject. The PI responded that this is the first time the technique has been used in an attempt to identify the maximum ground acceleration that could occur at a site.

The audit team raised a question regarding the uranium trend and rock varnish cation ratio age dating methods to estimate the age of the balanced rocks and whether these methods used had been accepted by the scientific community. The PI indicated that he believed the rock varnish cation ratio age dating method he used is accepted by the scientific community. The NRC staff does not believe that the uranium trend and rock varnish cation ratio dating techniques are sufficiently well accepted by the geologic community to be used for regulatory compliance demonstrations. Upon investigation, the NRC staff determined that the QARD does not establish any qualification requirements for the methods employed in scientific investigations, whether or not those methods are generally accepted by the involved scientific community. In addition to QARD requirements for acceptable calculational methods and software, the QARD should also require the use of acceptable scientific investigation methods to ensure data quality. This issue is identified as an Open Item (see Enclosure 2).

In order to verify the estimates made in the field about the force needed to topple balanced rocks, the PI performed model studies in the laboratory using styrofoam blocks representing precarious rocks. The audit team and observers visited the laboratory where the model studies were conducted. The PI

demonstrated how the force was applied and the resulting acceleration needed to topple the balanced styrofoam model. There were several questions about the software used to estimate the acceleration in the laboratory and whether this software has been validated. The PI indicated that the software is based on existing scientific formulas and, since no new development or change in the formulas was made, validation beyond hand calculations was not required. The software was not used to manipulate field data. It was used only to predict the ranges of forces need to topple rocks in the field.

Based on the results from these laboratory and field experiments, the PI concluded in the report that seismic accelerations at Yucca Mountain have not exceeded 0.3g (gravitational acceleration) for the last several tens of thousands of years. The audit team did not express disagreement with the PI's conclusions. The NRC staff believes the PIs should have been questioned in more depth regarding the rationale and justification for choosing certain parameters in the PI's analyses and models. This is identified as an audit weakness (see Section 4.6.2).

During this portion of the audit, the PI provided the data package, published separately from the report, which contained results from the field experiments on a number of precariously balanced rocks and from the laboratory experiments on the models. The audit team indicated that if the information in the data package had been submitted with the report, most of the questions raised during the audit could have been eliminated.

Although this was the first YMQAD audit in which the Technical Specialist (geophysics) participated, he was well prepared for conducting the audit with a reasonable checklist and questions. The audit checklist was adequately formulated and covered the subject matter well. The Technical Specialist (geophysics) posed several questions during the audit indicating that he has familiarity with the subject matter and was well prepared for the audit. He made several suggestions that should be reflected in the procedure.

The Performance Based Audit Flowchart was completed for this activity, with the same results and significance to the audit process as reported in Section 4.3.1.

#### 4.3.3 Initial Summary of Geologic, Geophysical, and Seismic Data to Support Earthquake Source Characterization for Seismic Hazard Analyses at the Proposed Nuclear Waste Repository, Yucca Mountain, Nevada

The purpose of this audit was to evaluate the report of the various data sets that will be used by the expert elicitation and probabilistic seismic hazard teams. The Technical Specialist (geology) was the primary interviewer during this portion of the audit, using his checklist while he interviewed the PI. The audit team inquired why the report does not include any interpretation of the data collected. The PI indicated that the purpose of this report was to provide the experts with all available data in the literature and identify other literature sources that contain data relevant to the subject matter. Also, the PI indicated that no interpretations were provided in order to avoid biasing the experts. The audit team inquired about the significance of the difference in the steps described in this report to calculate the seismic

hazard and those described in Topical Report YMP/TR-002-NP: "Methodology to Assess Fault Displacement and Vibratory Ground Motion Hazards at Yucca Mountain," June 1994. The PI indicated that the only difference is that the topical report elaborates on the steps more than does the initial summary.

The Technical Specialist called the attention of the PI to the fact that he (the PI) was mixing the definition of Geologic Setting with that of Geologic System and that he should be aware that the two terms have different meaning. The Technical Specialist questioned why the uranium-trend dating technique was still being used after having been noted as being considered flawed at the February 1995 Technical Program Review. The PI responded by saying that the presentation at the Program Review did not reflect the official position of the USGS. The PI was unable to respond to a question regarding the availability of geodetic leveling data surveys conducted since 1983 since he had only recently joined the Yucca Mountain Project.

The audit team noted that the initial summary covers several disciplines, but that only two individuals, both specializing in geology, technically reviewed the report. The audit team indicated that additional technical reviewers specializing in seismology, geomorphology, and geophysics should have reviewed it. The Project Manager responded that the review procedure requires only two reviewers.

A preliminary DR was generated by the audit team when it found that the work being done by USGS was not in accordance with the study plan for the work. Since study plans are the responsibility of DOE, this preliminary DR was written against OCRWM (see Section 4.7.3).

The Performance Based Audit Flowchart for this activity was completed by the Technical Specialist (geology) separately from the technical interviews.

This part of the audit went very well, aided by the fact that the Technical Specialist (geology) had previous experience in YMQAD audits. He was well prepared with an adequate checklist. The checklist contained a reasonable list of questions. He was able to integrate his experience in previous audits with this audit by cross-correlating information from this audit with that of previous audits. He asked questions about the detachment faults and ensured that all the comments of the reviewers were acceptably addressed in the draft initial summary report.

#### 4.3.4 QA Programmatic Elements

The audit checklist contained questions regarding the QA programmatic elements listed in Section 4.1. Both the ATL and the involved Technical Specialist reviewed the qualification and training of the authors of the reviewed reports and a sample of other individuals involved in the audited activities. No deficiencies were identified. The ATL audited the other QA programmatic elements, relatively independently of the technical auditors. During the audit of the other QA programmatic elements, one preliminary DR was generated concerning the use of seismometer calibration values from the manufacturer. The manufacturer was not qualified under the QARD to supply such data. The DR was initiated only after the NRC staff pointed out that the calibration value

was critical to all future calibrations and that it came from a supplier not on the list of qualified suppliers. This preliminary DR is discussed in Section 4.7.4 of this report. No other discrepancies regarding the QA programmatic elements were found.

This portion of the audit dealing with the QA programmatic elements was performed in an acceptable manner using the checklist questions prepared prior to the audit. The staff agrees with the preliminary audit team finding of adequate implementation of the QA programmatic elements audited.

#### **4.4 Audit Team Qualifications and Independence**

The qualifications of the ATL and auditors were found to be acceptable in that they each met the requirements of QAAP 18.1, "Qualification of Audit Personnel."

The audit team members did not have prior responsibility for performing the activities they audited. The two Technical Specialists were OCRWM Management and Operating Contractor employees. While they were very familiar with the technical activities audited, they had no prior direct or oversight responsibility for the audited activities. The audit team members had sufficient independence to carry out their assigned functions without adverse pressure or influence. The audit team members were well qualified in the QA and technical disciplines, and their assignments and checklist items were adequately described in the audit plan.

#### **4.5 Review of Previous Audit Findings**

There were no previously issued YMQAD deficiencies that had been closed and were applicable to the scope of this audit.

#### **4.6 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 audit was effective in determining the adequacy and degree of implementation of the USGS QA program as applied to seismological activities. The NRC staff agrees with the preliminary YMQAD audit team findings.

**4.6.1 Strength** - The Technical Specialists were well qualified and communicated well with UNRSL and USGS personnel.

##### **4.6.2 Weaknesses**

- The PIs should have been questioned in more depth regarding the rationale and justification for choosing certain parameters in the PI's analyses and models.
- The evaluation of the critical process steps during the audit contributed little to the audit and the determination of QA program effectiveness.

- The integration of QA into the technical portion of the audit was poor.

4.6.3 Recommendation - DOE should review the objectives of, implementation of, and training for its performance-based audits.

#### 4.7 Summary of YMQAD Audit Findings

The application of QA controls was determined to be effective. At the post-audit meeting the audit team presented the preliminary DRs listed below.

4.7.1. UNRSL seismological interpretation sheets (QA records in process) were completed in pencil and had erasures.

4.7.2. UNRSL scientific notebooks documenting the digital seismic network included many loose pages, and was incomplete.

4.7.3. The revised Study Plan covering the work reported in the "Initial Summary of Geologic, Geophysical, and Seismic Data to Support Earthquake Source Characterization for Seismic Hazard Analyses at the Proposed Nuclear Waste Repository, Yucca Mountain, Nevada" had not been issued by DOE to reflect the current direction of the investigations. The Study Plan is the principal document addressing QARD work control requirements. (This preliminary DR was written against OCRWM.)

4.7.4. Manufacturers' data was used in seismometer calibrations, however, seismometers were procured from an unqualified source.

**OPEN ITEM STANDARD REPORT**

**OITSID:** TBD

**LAST UPDATE:** November 2, 1995

**STATUS:** Open

**DATE RESOLVED:**

**TOPIC OF THE OPEN ITEM/UNCERTAINTY:** DOE's Quality Assurance Requirements and Description document (QARD - DOE/RW-0333P) does not establish requirements for the qualification of scientific investigation methods.

**RESPONSIBLE BRANCH/SECTION:** HLUR/HLW & Quality Assurance Section

**ACTION AGENCY:** DOE

**IDENTIFICATION DATE:** DATE TBD

**SOURCE TYPE:** NRC Observation of DOE Audit YM-ARP-96-01 of USGS

**SOURCE DOCUMENT:** U.S. Nuclear Regulatory Commission, 1995. Observation Audit Report OA-96-01. Washington DC: Nuclear Regulatory Commission, Office of Nuclear Material Safety and Safeguards, Division of Waste Management.

**DOE ACTIVITY CODE/WBS NO.:** 8.3.1.17.4.1; 8.3.1.17.4.2 / 1.2.3.2.8.3.1; 1.2.3.2.8.4.1

**UNCERTAINTY TYPE:** Technical

**SPECIFIC TECHNICAL TYPE:** Concerns with DOE Program - Question

**OPEN ITEM TEXT:** Section III.2.2.B of the Quality Assurance Requirements and Description document (QARD - DOE/RW-0333P, Rev. 4, Supplement III - "Scientific Investigation") requires that scientific notebooks contain: "Method(s) to be used." This is adequate when the methods are generally accepted by the technical community involved (e.g., those methods published by ASTM, IEEE, and ASME). However, when other methods are used, the QARD does not require verification of their acceptability. For example, uranium trend and rock varnish cation ratio age dating methods have been used in scientific investigations performed by USGS, but their validity has not been established, and the methods are not widely accepted in the geologic community.

**RATIONALE/BASIS:** The use of methods that are not generally accepted by the technical community involved will require justification during the licensing process.

**RECOMMENDATIONS:** The QARD should include requirements for verifying the acceptability of methods used to gather, generate, manipulate, interpret, analyze, and report information that will be used or referenced in the license application. Justification should be required for the selection and use of any method that is not generally accepted by the technical community involved. The justification should be equivalent to that necessary to qualify existing data and to validate computer models.

**UNCERTAINTY RESOLUTION METHOD TYPE:** Review DOE response.

**RATIONALE FOR UNCERTAINTY RESOLUTION METHOD SELECTION:** None

**HISTORY:** October 25-27, 1995 - NRC noted the deficiency during observation of DOE's audit of the USGS and reported it to the audit team leader.

**DATE TBD - Observation Audit Report OA-96-01 and this Open Item transmitted to DOE by letter from Holonich to Milner.**

**CROSS REFERENCE**

**CITATION:** §10 CFR 60, Subpart G

**LARP (REVIEW PLAN) NUMBER:** 10.0

**REFERENCES:** None