Report on

Audit of Management of the Site Characterization Program at Yucca Mountain

MASTER

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

This report can be obtained from the
U.S. Department of Energy
Office of Scientific and Technical Information
P.O. Box 62
Oak Ridge, Tennessee 37831

Printed with soy ink on recycled paper

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, make any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

United States Government

Department of Energy

memorandum

DATE: February 15, 1995

REPLY TO

ATTN OF: IG-1

SUBJECT: INFORMATION: "Audit of Management of the Site Characterization Program at Yucca Mountain"

TO: The Secretary

BACKGROUND:

The Department of Energy (Department) is responsible for establishing an underground repository to store high-level nuclear waste. In accordance with the amended Nuclear Waste Policy Act of 1982, the Department began characterization of the Yucca Mountain site to assess the feasibility of safely storing spent fuel and high-level waste for 10,000 years. Site characterization was originally scheduled to be completed in 1995. Subsequently, your predecessor, Admiral Watkins, changed the plan completion date to 2001. The purpose of our audit was to determine if the Department is making adequate progress in characterizing the Yucca Mountain project.

DISCUSSION:

We found that above-ground testing, which requires the drilling of deep boreholes to obtain data for analyzing rock and characterizing the site, will not be completed until 2022, given current rates of progress. Similarly, below-ground tests, necessary to provide data for characterizing the site at the level of the repository, will not be finalized until 2006. We recommended a critical path analysis and establishment of project priorities.

The Director, Office of Civilian Radioactive Waste Management, agreed with the intent of our recommendations and described a new "program approach" to the Yucca Mountain project. The Director believes that the new approach will resolve the concerns raised in this report. Although we did not audit the program approach, the intended actions described are responsive to the concerns raised in our report and to the recommendations.

We note, however, that the program's ultimate success will depend on acceptance by the Nuclear Regulatory Commission, which must approve the license application for repository construction.

John C. Layton
Inspector General

Attachment

cc: Deputy Secretary
Under Secretary
Assistant Secretary for Defense Programs
Director, Office of Civilian Radioactive
Waste Management

U. S. DEPARTMENT OF ENERGY
OFFICE OF INSPECTOR GENERAL

AUDIT OF MANAGEMENT OF THE SITE
CHARACTERIZATION PROGRAM AT YUCCA MOUNTAIN

The Office of Audit Services wants to make the distribution of its audit reports as customer friendly and cost effective as possible. As a consequence, this report is available electronically through the Internet at the following alternative addresses:

Department of Energy Headquarters Gopher
gopher.hr.doe.gov

Department of Energy Headquarters Anonymous FTP
vml.hqadmin.doe.gov

We are experimenting with various options to facilitate audit report distribution. Your comments would be appreciated and can be provided on the Customer Comment Form attached to the Audit Report.

Report Number: DOE/IG-0366
Date of Issue: February 15, 1995

Western Regional Audit Office
Albuquerque, New Mexico 87185

MASTER

AUDIT OF MANAGEMENT OF THE SITE
CHARACTERIZATION PROGRAM AT YUCCA MOUNTAIN

TABLE OF CONTENTS

	<u>Page</u>
PREFACE	i
SUMMARY	1
PART I - APPROACH AND OVERVIEW	3
Introduction	3
Scope and Methodology	3
Background	4
Observations and Conclusions	5
PART II - FINDING AND RECOMMENDATIONS	6
Site Characterization at Yucca Mountain	6
PART III - MANAGEMENT AND AUDITOR COMMENTS	13

U.S. DEPARTMENT OF ENERGY
OFFICE OF INSPECTOR GENERAL
OFFICE OF AUDIT SERVICES

AUDIT OF MANAGEMENT OF THE SITE
CHARACTERIZATION PROGRAM AT YUCCA MOUNTAIN

PREFACE

The Office of Inspector General completed field work for this audit in August 1994. According to Office of Civilian Radioactive Waste Management officials, the Department was concurrently developing a new program approach for site characterization at Yucca Mountain. Elements of this approach were first presented to Congress during the Fiscal Year 1995 budget hearings (in March 1994). According to the Department, Congress supported the effort by increasing the program budget by 37 percent over the 1994 funding level.

A "Civilian Radioactive Waste Management Program Plan," dated December 19, 1994, stated that implementation of the program approach was initiated on October 1, 1994. This document described a completely revised methodology, referred to as the "program approach," for determining the suitability of the Yucca Mountain site as an underground repository. The program approach differs significantly from the original 1988 site characterization plan which was in place at the time of our audit work. According to the Department's draft plan, the new program approach does not require all measurements and analyses in the site characterization plan before evaluating suitability, selecting a final design, and submitting a license application to the Nuclear Regulatory Commission. Instead, it distinguishes three sets of investigations:

- o those required for evaluating site suitability;
- o those required for a license application and the completion of cost-effective design; and,
- o those required for confirming postclosure repository performance.

This distinction, according to the Department, permits the phasing of tests to achieve the early technical site suitability evaluation and preserves the schedule for licensing, constructing, and operating the repository should the site be determined to be suitable.

Major milestones included in the program approach include completion of a technical site suitability evaluation by the end of Fiscal Year 1998 and delivery (if the site is determined to be suitable) of a site recommendation report to the President during Fiscal Year 2000. The revised schedule also calls for submittal to the Nuclear Regulatory Commission of a license application for repository construction in 2001, the commencement of construction in 2004, and the Nuclear Regulatory Commission's issuance of a license to operate the repository in 2008.

The finding and recommendations in our audit report relative to above- and below-ground testing clearly support the need for a re-designed approach to site characterization. We agree with the Director, Office of Civilian Radioactive Waste Management who stated, in recent testimony before the Nuclear Regulatory Commission, that Yucca Mountain's original site characterization program was no longer supportable since it had no apparent possibility of being funded at required levels and there was inadequate means for measuring annual cost and progress. Moreover, we commend the Office of Civilian Radioactive Waste Management for acknowledging the serious problems that existed in the site characterization program and for taking action aimed at returning the program to a schedule that preserves critical milestones.

Although no audit verification of the December 19 program approach documentation was performed, the intended actions described are responsive to the concerns raised in our report and to the recommendations. We note, however, that the program approach's ultimate success will depend on acceptance by the Nuclear Regulatory Commission, which must approve the license application for repository construction.

U.S. DEPARTMENT OF ENERGY
OFFICE OF INSPECTOR GENERAL
OFFICE OF AUDIT SERVICES

AUDIT OF MANAGEMENT OF THE SITE
CHARACTERIZATION PROGRAM AT YUCCA MOUNTAIN

Audit Report Number: DOE/IG-0366

SUMMARY

The Department of Energy (Department) is responsible for establishing an underground repository to store high-level nuclear waste. In accordance with the amended Nuclear Waste Policy Act of 1982, the Department began characterization of the Yucca Mountain site to assess the feasibility of safely storing spent fuel and high-level waste for 10,000 years. Site characterization was originally scheduled to be completed in 1995. Subsequently, the Secretary of Energy changed the planned completion date to 2001. The purpose of our audit was to determine if the Department was making adequate progress in characterizing the Yucca Mountain project.

We found that above-ground testing, which requires the drilling of deep boreholes to obtain data for analyzing rock and characterizing the site, would not be completed until 2022, given rates of progress and funding as of Fiscal Year 1994. Similarly, under these assumptions, below-ground tests, necessary to provide data for characterizing the site at the level of the repository, would not be finalized until 2006.

Causes of the delays included insufficient funding and inadequate prioritization of available resources. The project baseline, approved in Fiscal Year 1991, included about \$1.8 billion for Fiscal Years 1991 through 1994. Only about \$809 million, or 45 percent of the approved baseline, however, was funded. Given the magnitude of this project and the competition among Departmental programs for available resources, funding shortfalls were understandable. The Department, however, should have prioritized project activities more effectively to minimize delays. Since resources are likely to remain scarce, an effective prioritization of site characterization activities is needed to assure that the project stays as close to schedule as possible.

We recommended that the Department conduct a critical path analysis of project activities, establish priorities based on the analysis, and allocate sufficient resources to accomplish those activities most critical to the project. Such a process should lead to the formulation of completion dates for critical project activities and an approved adjusted baseline for the project.

The Director, Office of Civilian Radioactive Waste Management, agreed with the intent of our recommendations and explained the new program approach to the Yucca Mountain project, as discussed in the Preface to this report.

Office of Inspector General
Office of Inspector General

PART I

APPROACH AND OVERVIEW

INTRODUCTION

The accumulation of highly radioactive waste at over 70 civilian and Department of Energy (Department) nuclear facility sites in 34 states created an environmental problem addressed in the Nuclear Waste Policy Act of 1982. The Act made the Department responsible for developing an underground repository that was expected to be operational in 1998. In 1991, the Department estimated that its scientific investigation of a site at Yucca Mountain, Nevada, could be completed by 2001 at a cost of about \$6.3 billion dollars and that, if the site proved to be suitable, a repository could be in operation by 2010.

The audit assessed the effectiveness of two of the major activities in achieving the milestones for completing site characterization by the year 2001. Those activities were the above- and below-ground testing. Specifically, we looked at the drilling of deep boreholes to obtain information for above-ground testing, and at tunneling and excavation for the Exploratory Studies Facility for below-ground testing.

SCOPE AND METHODOLOGY

The audit was conducted from June 1993 through August 1994, at the Yucca Mountain Site Characterization Office and at Yucca Mountain, located about 100 miles northwest of Las Vegas. Meetings were also held with the Office of Civilian Radioactive Waste Management in Washington, D.C. and with major participants in the project, including Department contractors and other government agencies. During the audit, we reviewed the progress of the project in relation to the funding and the Nuclear Waste Policy Act.

To accomplish the audit objective, we:

- o reviewed budget information for Fiscal Years 1983-1994;
- o reviewed the project plans to meet the requirements of the Nuclear Waste Policy Act;
- o interviewed Department, project, contractor and Government laboratory personnel;

- o analyzed available information on the types of boreholes and the time required to drill them; and,
- o reviewed prior work of other oversight groups on the management of the program.

The audit was performed according to generally accepted Government auditing standards for performance audits and included tests of internal controls and compliance with laws and regulations to the extent necessary to satisfy audit objectives. We limited the review of internal controls because the audit focused on project management in two of the key activities in achieving the 2001 date for site characterization. Because the review was limited, it would not necessarily have disclosed all internal control deficiencies that may have existed at the time of our audit. We did not rely extensively on computer-processed data and, therefore, did not fully examine the reliability of that data. Conferences to discuss drafts of this report were held with the Director, Office of Civilian Radioactive Waste Management, or his staff, on October 4 and December 16, 1994.

BACKGROUND

In 1957, the National Academy of Sciences recommended that the country's high-level radioactive waste be disposed of by permanent burial in underground repositories. In 1982, the United States Congress passed the Nuclear Waste Policy Act establishing a process for evaluating sites for repositories. A number of potential sites were evaluated in the United States and the potential locations were eventually narrowed down to three: Nevada, Washington, and Texas. An amendment to the Act in 1987 further narrowed the siting for the potential repository to the Yucca Mountain site in Nevada. The Act assigned responsibility for full payment of disposal costs to those who generated and benefited from the services.

To carry out the law, the Department established the Office of Civilian Radioactive Waste Management. This Office, in turn, developed a program for a geologic disposal system which encompassed the transportation of waste, the development of casks for housing the waste during transport, determining a site for a Monitored Retrievable Storage System for interim storage, and determining a suitable location for a permanent repository. The proposed location for the permanent repository is Yucca Mountain. If site characterization shows that Yucca Mountain is acceptable, it would be licensed by the Nuclear Regulatory Commission before construction begins.

In June 1994, the Office of Inspector General issued a report on "Audit of Cost and Management of Yucca Mountain Project." The purpose of the audit was to examine how effectively funds were spent and to examine the costs and management of contracting for the project. The audit identified three areas for management's attention: Project Procurement Efforts, Management and Operating Contractor Structure, and Overhead Reduction Effort.

OBSERVATIONS AND CONCLUSIONS

Our audit showed that, given the rates of progress and funding as of Fiscal Year 1994 for above- and below-ground testing, the Department would not complete site characterization at Yucca Mountain by the target date of 2001. Above-ground testing requires the drilling of a number of deep boreholes to obtain data for analyzing the rock and characterizing the site. At the 1994 rate of progress, however, Department officials estimated that drilling would not be completed until the year 2022. Similarly, under the same assumptions, below-ground tests, necessary to provide data for characterizing the site at the level of the repository, would not be finalized until 2006.

Lack of adequate prioritization, in light of the limited funding available through Fiscal Year 1994, contributed to testing program delays. The project baseline, approved in Fiscal Year 1991, included about \$1.8 billion for Fiscal Years 1991 through 1994. However, only about \$809 million, or 45 percent of the approved baseline, was funded. Until the Department effectively prioritizes site characterization activities, the project will continue to fall further behind and cause an escalation of costs for the Department and the ratepayers involved.

We recommended that the Department conduct a critical path analysis of project activities, establish priorities based on the analysis, and allocate sufficient resources to accomplish those activities most critical to the project. Such a process should lead to the formulation of completion dates for critical project activities and an approved adjusted baseline for the project.

In October 1994, we met with the Director, Office of Civilian Radioactive Waste Management, who described a new Departmental approach to the Yucca Mountain project. The Director believes that the new approach, when finalized, will ultimately resolve the concerns raised in this report.

the repository. Other key areas may be delayed if the information from these activities is delayed.

MEETING THE CHARACTERIZATION SCHEDULE

We reviewed both the deep exploratory drilling program, an integral part of above-ground testing, and the construction of the Exploratory Studies Facility, necessary for below-ground testing. The results of our work indicated that, at the rates of progress and funding as of Fiscal Year 1994, the 2001 target date for site characterization would not be met.

Above-Ground Testing

Above-ground testing consists of tests performed on the surface, such as mapping, trenching, and geophysical surveys, as well as tests performed in boreholes. Exploratory drilling is used to characterize underground conditions from the surface. The site characterization plan indicated that as many as 500 boreholes may be needed for site characterization. Although a majority of these boreholes will be less than 100 feet, the plan also requires a program for drilling 34 deep boreholes, needed to characterize the rocks and ground water beneath the surface. The site characterization plan stated that the 34 deep boreholes would use a dry drilling method to minimize or avoid contaminating the surrounding rock in the borehole and the samples removed from it.

Management determined that the use of four special drill rigs were needed to complete the dry drilling of the deep boreholes. The first rig was acquired in 1992. The second rig was scheduled to be purchased in 1993 while the third and fourth rigs were to be purchased in 1994. The four rigs were to operate 24 hours per day 7 days a week, thereby allowing the drilling to be completed by 1998.

As of March 1994, however, very little progress had been made in the deep borehole program. The following chart compares feet drilled to feet planned for the first three years of the program.

<u>Fiscal</u> <u>Year</u>	<u>Planned</u>		<u>Accomplished</u> <u>in Total</u>
	<u>Per Year</u>	<u>in Total</u>	
1992	1,500	1,500	800
1993	5,600	7,100	2,900
1994	10,500	17,600	3,200

Although the first drill rig purchased, the LM-300, began operating in 1992, it was only operated one 8-hour shift per day, 5 days a week. Since 1992, the LM-300 had, as of March 1994, completed one borehole, partially completed another, (called UZ-14), and started on a third. Furthermore, the completed borehole, (UZ-16), was originally intended as a Vertical Seismic Profiling borehole and was not one of the deep UZ boreholes designated in the site characterization plan. Because this borehole was drilled with the LM-300, however, some of the objectives of the UZ program were accomplished.

Work on the partially-completed borehole, (UZ-14), began in April 1993. Although planned drilling was to the water table plus 40 feet, or about 2,000 feet, the LM 300 drill rig encountered water at a depth of about 1,250 feet. Tests were initiated to determine where the water was coming from, how fast the water was entering the borehole and the chemical composition of the water. Ultimately, workers were unable to stop the water from entering the borehole and in February 1994 the LM-300 rig was moved to a different site to begin drilling the third borehole. Subsequently, another drill rig was used to drill to a depth of about 2,200 feet. Current plans are for the LM-300 to be moved back to the hole at a later date to meet requirements for instrumentation and testing.

At the time of this review, the LM-300 had drilled about 3,200 feet, significantly behind the planned drilling schedule of 17,600 feet. Based on that rate of progress, project officials estimated that it would take over 28 years to complete the deep borehole drilling program.

Below-Ground Testing

Construction of the Exploratory Studies Facility (Facility) is required in order to perform the below-ground testing necessary to collect and analyze data at the proposed repository. The Facility will encompass about 13 miles of tunnels, 35 alcoves, and a main test area of about 18.5 acres. The plans for the Facility involved four milestones: tunneling was to start in 1992; access to the main tunnel was to be accomplished in 1994; large scale in-situ testing was to begin in 1995; and all tunnels, alcoves, and main test area were to be completed by 1997. Management planned to acquire and concurrently use four tunnel boring machines to meet the November 1997 completion date. Two large machines would concurrently excavate from both ends of the initial large tunnel, subsequently, two smaller tunnel machines would concurrently excavate the smaller tunnel.

During our review we found that the tunneling project started on schedule in 1992. The second milestone, access to the main tunnel, however, was delayed. This delay occurred because the first tunnel boring machine was not delivered until April 1994 and did not begin operating until August 1994. Since the first machine was needed to excavate access to the main tunnel and is only expected to bore about 30 meters by the end of the Fiscal Year 1994, the second milestone cannot be met.

Additionally, the level of funding provided in Fiscal Year 1993 did not permit simultaneous procurement of the two large tunnel boring machines and the revised plans no longer show the two tunnel boring machines working concurrently. Thus, the opportunity for concurrent excavation was lost. Based on project estimates as of 1994, it would take about 2 years to complete the first 5-mile loop of the tunnel, and might take as long as 12 years to complete all of the originally planned below-ground excavation. As a result, excavation activities which were scheduled for completion in 1997 would be delayed.

The third milestone, large scale in-situ testing to determine the effects of the stored waste on the rock characteristics, was to be conducted in the main test area beginning in 1995. However, because of tunneling delays, this testing would be at least 2 years behind schedule.

Prior reports, issued by the General Accounting Office and the Nuclear Waste Technical Review Board, similarly noted that the underground testing experiments, needed to provide critical information on the effects of heat from the waste, were falling behind schedule. The data from these tests are crucial for the repository license application to the Nuclear Regulatory Commission.

PRIORITIES AND RESOURCE ALLOCATIONS

The drilling and the tunnel boring activities were behind schedule as of 1994 because the Project Office had not prioritized its activities around the resources available. Additionally, management had neither requested nor received the level of funding needed to accomplish the project, as planned. From Fiscal Years 1991 through 1994, the project received about \$809 million, about 45 percent of the approved baseline funding level.

Furthermore, management had not revised its overall plans to adjust for a shortfall in resources. Instead, the Project Office continued to pursue the 2001 site characterization date without prioritizing the activities needed to be accomplished. For

example, the deep borehole drilling program spent about \$12 million in researching, developing, and purchasing the first drill rig. As stated earlier, drilling was a priority activity and the drill rig was expected to operate 7 days a week 24 hours per day. Due to the lack of prioritization of important activities, in light of limited funding, the drill rig was operated only one shift per day. This scheduling illustrates that sufficient funding has not always been applied to the critical activities.

In this respect, the General Accounting Office issued a report in May 1993 entitled "Yucca Mountain Project Behind Schedule and Facing Major Scientific Uncertainties." The report recommended that the Secretary of Energy review the program's goals and objectives in the context of the present program's low funding priority. The report suggested that such a review should focus on the project's emphasis on the scientific investigation and how the project can be conducted more efficiently without sacrificing the technical quality of the investigation.

The Director, Office of Civilian Radioactive Waste Management testified during the Fiscal Year 1995 budget hearings on the new program approach. According to the Department, the result of that testimony was that Congress increased the program's Fiscal Year 1995 funding by 37 percent over the Fiscal Year 1994 level.

EFFECTS OF DELAYS ON REPOSITORY PROGRAM

As a result of not establishing the priorities necessary to complete the site investigation activities discussed in this report, the Department was not going to meet the Secretary's goal of completing site characterization by the year 2001. Under the 1994 priority/funding approach, these activities would not be completed until 2022. Not completing the site investigation and subsequently the characterization by 2001 may result in the Department and the ratepayers incurring additional costs. In addition, the Department could be subject to litigation by the ratepayers for not complying with the Nuclear Waste Policy Act.

Although the total effect of delayed funding will not be known for years, it was clear that the project would cost more and take longer than originally planned. If priorities were not established, delays would occur not only in site investigation activities, but also in all repository activities. This combination of delays would ultimately result in increased costs.

During our audit, the Secretary announced the initiation of an independent financial review of the Yucca Mountain Site