

## YUCCA MOUNTAIN, NEVADA: IS IT A SAFE PLACE FOR ISOLATION OF HIGH-LEVEL RADIOACTIVE WASTE?

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### ABSTRACT

As mandated by Congress in the amended Nuclear Waste Policy Act, Yucca Mountain, Nevada is currently being studied by the U.S. Department of Energy to determine if it is a suitable location for the nation's first geologic repository for disposal of high-level radioactive waste and spent nuclear fuel. While the site has attributes that suggest it may be suitable, DOE must spend the next five to seven years and up to \$2 billion to find out if the site would be able to isolate radioactive materials for 10,000 years. Site characterization studies are being conducted to determine the geologic, hydrologic and environmental characteristics of the Yucca Mountain site. The DOE is planning to start construction of an underground laboratory in 1989 and to implement an extensive surface-based study program. The next five to seven years of study will determine if Yucca Mountain can meet regulations for waste isolation and qualify for a Nuclear Regulatory Commission license for repository construction and operation.

The answer to the question posed in the title of this paper runs the gamut from yes to no, depending on who's telling the story. Some would suggest the U.S. Department of Energy (DOE) and other interested parties say "yes", and that they are proceeding to build a high-level radioactive waste repository at Yucca Mountain, some 100 miles northwest of Las Vegas, Nevada. In a recent article critical of the repository project, a respected major newspaper stated that there remain serious questions about the suitability of the proposed site. On that point, they were correct: there are indeed many questions to be answered. Nobody knows if Yucca Mountain is the right place to build a repository. Based on the knowledge we have now, the proposed site appears to be a favorable candidate, however we are nowhere near a final conclusion. The next five to seven years and \$1 billion to \$2 billion of study at Yucca Mountain will provide the answers to many questions. If it is not a safe location, we certainly do not want to recommend construction of a repository at Yucca Mountain.

The objective of a repository is to utilize natural and engineered barriers to isolate radioactive materials from the environment for 10,000 years. By regulation, we cannot count on the integrity of engineered barriers beyond 1,000 years. Therefore, the performance of a repository is going to rely heavily on natural barriers, primarily a formation of volcanic welded tuff at Yucca Mountain.

We must prove that radionuclides packaged approximately 1,000 feet below the surface and approximately 1,000 feet above the water table will not migrate to the accessible environment (5 km from repository) for 10,000 years. We are looking at the tuff formation and dry climate of Yucca Mountain to meet this objective. Water travel is the mechanism that could carry radioactive materials to the accessible environment. We presently believe it takes from 20,000 to 80,000 years for water to move from the unsaturated geology in the proposed repository horizon to the water table below. Site characterization studies are planned to give us an understanding of the unsaturated zone and other components of the proposed repository.

The Yucca Mountain Project site characterization phase officially began May 28, 1986, when President Reagan recommended Yucca Mountain be studied as a potential site for a high-level nuclear repository. The program schedule calls for issuance of an environmental impact

statement in 1994, submission of a license application in 1995, and a U.S. Nuclear Regulatory Commission (NRC) review from 1995 to 1998, followed by a five-year construction period and the capability to receive waste shipments in 2003. This represents an extremely aggressive schedule, with many challenges along the way. If at any point it is determined that Yucca Mountain will not meet NRC regulations, DOE must turn to Congress for further direction.

The Yucca Mountain Project employs 1,400 scientists, engineers, and support personnel working with a fiscal year 1989 budget of over \$200 million. Less than 100 project staff are DOE employees. The majority of project employees work for contractor companies and national laboratories. Sandia National Laboratories is responsible for repository facility design and performance assessment. Lawrence Livermore National Laboratory is working on waste package design, while Los Alamos National Laboratory is conducting geochemical investigations, volcanism studies, and is responsible for underground test implementation. The U.S. Geological Survey is performing geologic, hydrologic and climate investigations. Design of the mined exploratory shaft facility (ESF), the underground laboratory used in site characterization, is being prepared by Fenix & Scisson and Holmes & Narver. Construction of the ESF and general site support will be provided by Reynolds Electrical and Engineering Company. Science Applications International Corporation is responsible for project management and integration, regulatory compliance, institutional affairs, and project quality assurance (QA). Mac Technical Services provides QA consulting services.

In December 1988, a major program milestone was achieved when the Site Characterization Plan (SCP) was released on schedule to the NRC, State of Nevada, and the public. The SCP contains a description of the site as we know it today and an outline of design for the repository facility and waste package. Chapter 8 comprises about one half of the document's 6,300 pages, describing the studies necessary to determine if Yucca Mountain is a suitable place for a high-level nuclear waste repository and to provide the needed information for a construction and operation license application to the NRC. The document is essentially a map of where we are, and a blueprint where we're going and how we're going to spend up to \$2 billion to understand the Yucca Mountain site.

The release of the SCP was noted in the Federal Register on December 28, 1988. The public, NRC, State of Nevada, local governments, and nuclear utilities are expected to comment on the SCP in writing. The Yucca Mountain Project Office held four public update meetings in Nevada during February, which included discussion of the SCP. At those meetings, project scientists answered citizens' questions about the document. Public hearings will be held at three locations next month as part of the formal comment process.

The site characterization testing program includes activities to establish the geologic conditions and history of the site. We intend to break ground for construction of the ESF in 1989, and we are planning to conduct extensive surface-based tests.

The ESF will be an underground laboratory where tests will be conducted to study the processes and phenomena contributing to waste isolation performance, the effects of ESF construction, and underground conditions at the ESF location. The ESF will consist of two 12 foot diameter, 1100 foot deep shafts, two miles of horizontal drifts and tunnels, and a variety of demonstration and testing rooms. The facility will be constructed using drill, blast, and muck mining techniques. While the ESF construction activities will appear much like a conventional mining operation, there are unique and important differences. Progress will be slow, with miners working one shift followed by scientists who will take two shifts or longer to study the geology as the excavation progresses. It is going to be a mining operation with high-technology science in between, where science takes precedent over mining activities. Figure I shows what types of test will be performed at various levels of the ESF.

The surface-based testing program is a series of investigations designed to characterize the geologic environment throughout the repository area. The types of investigations include geology, volcanology, hydrology, tectonics, and geoengineering studies. The investigations will be conducted through a series of drill holes, trenches, non-destructive geophysical measurements, seismic reflection surveys, and laboratory work.

The major part of surface-based testing is the drilling program. There are 329 drill holes planned, with emphasis placed on the unsaturated zone that lies above the proposed repository depth. The holes will be from 4 inches to 12 inches in diameter and will be bored as deep as 5000 feet below the surface of Yucca Mountain. The surfaced-based program includes seismic, stream flow, and meteorological monitoring activities that are currently under way.

Another activity planned for the surface-based testing program involves trenching to investigate surface traces of geologic faults. Data from the trenches will characterize the magnitude and history of past movement on faults throughout the site area that may have been active in the last 10,000 to 2 million years. Trenching will also be used to investigate the nature of potential faulting at the proposed site for repository surface facilities.

While limited field work has been performed, most activity to date on the Yucca Mountain Project has involved

planning and preparation for actual hands-on work. Our primary short range goal is to "move dirt" in 1989, an objective that has several hurdles to cross before it is realized. In order to break ground for the exploratory shaft facility (ESF), there are six prerequisites that must be met.

1. The DOE must gain full legal access to the federal lands on which the Yucca Mountain site lies. We already have a right-of-way (ROW) reservation for Bureau of Land Management (BLM) property, and the Nevada Test Site (NTS) portion has never posed an access problem. However, we are waiting for the BLM to grant a ROW for Nellis Air Force Base Bombing and Gunnery Range property. The U.S. Air Force must complete an environmental assessment and submit it to the BLM prior to a ROW being issued. We anticipate the process being completed in the near future and expect to have full land access shortly. ROW reservation access will permit studies to be conducted in the proposed repository area, but will not ensure DOE exclusive use of the properties. DOE has submitted a land withdrawal application to the BLM, which would allow DOE to control the properties. The State of Nevada filed suit against the BLM and the Department of Interior, asserting state approval is necessary for the DOE land withdrawal. A ruling last month by a U.S. District Court judge denied Nevada's right to approve the land withdrawal and the case was dismissed. The state attorney general's office has indicated the ruling will be challenged in the 9th U.S. Circuit Court of Appeals.

2. We are having difficulty obtaining environmental compliance permitting from the State of Nevada. DOE applied for an air quality permit for land disturbance over a year ago, but the state has taken no action as of this time.

3. Nuclear Regulatory Commission comments on the SCP must be considered prior to commencing ESF construction. The NRC said recently it needs until mid-August 1989 to review and comment on the SCP. Actual construction cannot begin until the DOE receives and considers the NRC comments, although site preparation work can start earlier.

4. The DOE must create Study Plans to help define an appropriate level of detail for characterization studies described in the SCP. The Study Plans must be reviewed by the NRC before those specific activities are undertaken. Five ESF Study Plans have been submitted to the NRC.

5. Another area requiring NRC acceptance is QA. The NRC recently approved the Yucca Mountain Quality Assurance Plan. A fully-qualified QA program should be in place by summertime, once all project participant organizations implement procedures and personnel training that will ensure adherence to the overall project QA plan. With a fully-qualified QA program in place, the project will be prepared to collect new site characterization data that is admissible for NRC licensing purposes. When

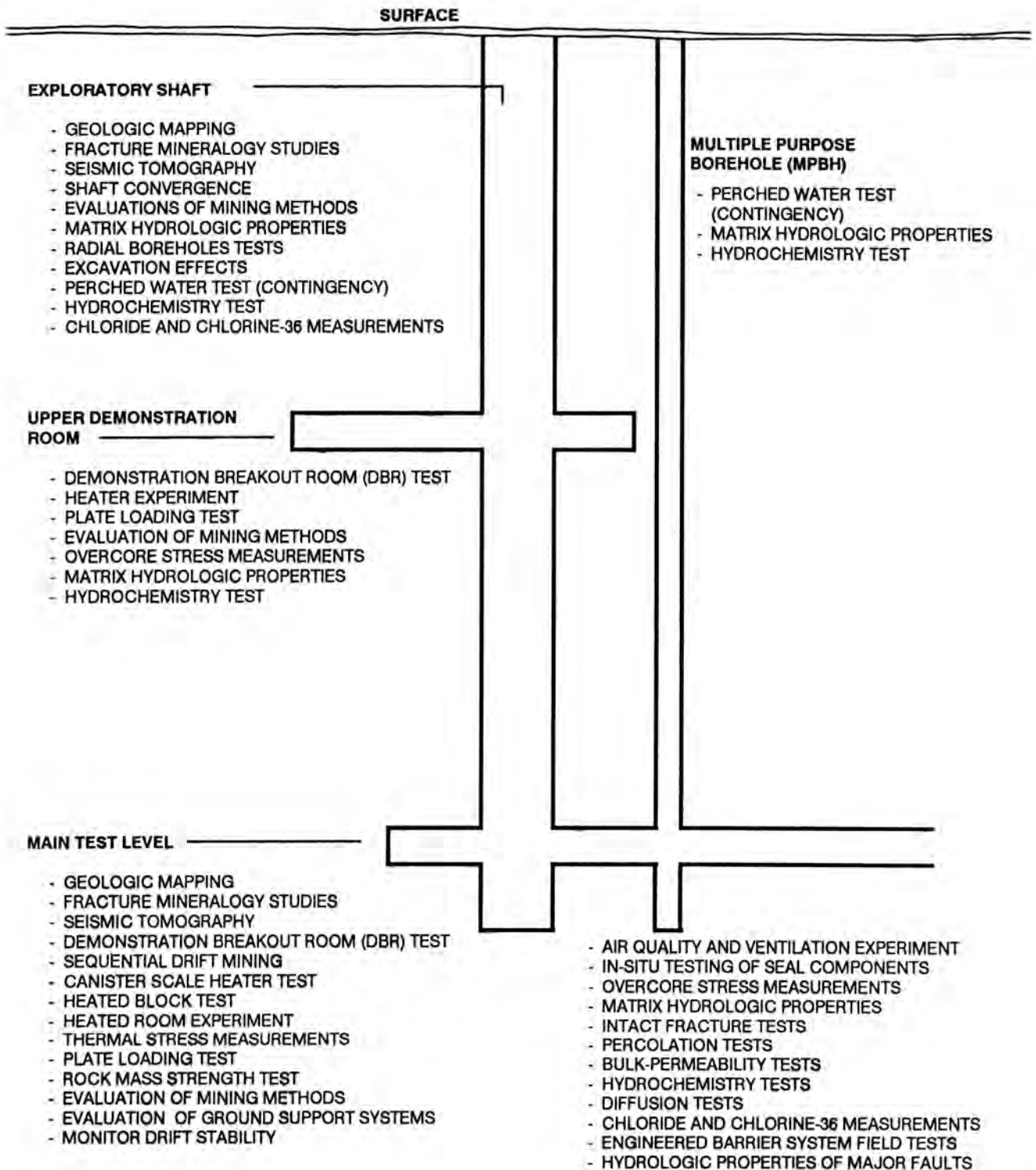


Fig. 1. Location and Type of Test in the Exploratory Shaft Facility.

entering the licensing arena, exemplary scientific work alone is not enough. The work must be of the highest quality and be performed under strict adherence to QA and technical procedures. The bottom line is that for licensing activities, our data is not data unless the NRC says it's data. We are implementing measures that will ensure our scientific activities produce usable data.

6. The final prerequisite DOE must meet is completion of the ESF design. An ESF Title I Design Report has been completed and Title II Design work is now under way. We should be able to start site preparation in May with road and pad construction.

As part of the effort to provide usable scientific data, DOE opened the Yucca Mountain Project Sample Management Facility (SMF) in July 1988. The facility is housed in two renovated, access-controlled 14,000 square foot warehouses near Yucca Mountain on the NTS. The SMF will use advanced technology to process, document, and preserve borehole core samples and samples taken from the ESF. The facility is designed to document where a geologic sample came from, who had access to it and what research was performed with the sample.

The national repository program is one of the most closely reviewed projects ever undertaken by the Federal government. The extensive oversight was called for by Congress and is necessary to ensure safety and public confidence. One of the strictest and most important oversight roles is served by the NRC. Not only does the NRC consider a license application when and if Yucca Mountain is found

suitable, they are a key player at all stages of the program. No major steps are taken without consultation with the NRC. The DOE interacts with the State of Nevada on a continuous basis. The state is operating on an \$11 million grant fund in 1989 for independent oversight, and three Nevada counties are receiving \$5 million for oversight. The state has a legislative committee and a nuclear projects commission that follow the program. A Nuclear Waste Technical Review Board has been nominated by the National Academy of Sciences and approved by the President to oversee the repository program. The nuclear electricity generation utility companies who are paying for the program have a significant role in monitoring the program's progress through the Edison Electrical Institute. Additionally, the U.S. General Accounting Office is an active participant and provides quarterly and yearly reports to Congress.

Is Yucca Mountain a safe place for a high-level nuclear waste repository? Data gathered in preliminary studies suggests that Yucca Mountain possesses many of the attributes that a repository site must have, but we can't begin to answer that question until we move forward with site characterization studies. In summary, the release of the SCP is the springboard for Yucca Mountain site characterization activities in 1989. We're looking forward with great anticipation to moving dirt at the site this year, so the process of answering questions and testing theories can begin.