Yucca Mountain –
A Potential Geologic Repository

The Department of Energy (DOE) is studying Yucca Mountain as a potential repository for radioactive waste. If approved, the site would be the nation's first geological repository for disposal of spent nuclear fuel and high-level radioactive waste. Yucca Mountain is located in Nye County, Nevada, about 100 miles northwest of Las Vegas on federally owned land on the western edge of the Nevada Test Site. The northwestern part of the site is located on the Nellis Air Force Range, and the southwestern portion is owned by the Bureau of Land Management.

The design goals of the potential repository are as follows:

- To protect the health and safety of both the workers and the public during the period of repository operations
- To minimize the amount of radioactive material that may eventually reach the accessible environment
- To maintain costs at an acceptable level, without jeopardizing public health, safety, and the environment

The repository would store as much as 70,000 metric tons of radioactive waste from 72 commercial and 43 research reactor sites in 43 states across the country.

A Brief Chronology of Yucca Mountain-Related Events

1955 More than 40 years ago the U.S. Atomic Energy Commission (AEC) asked the National Academy of Sciences (NAS) to study disposal methods for radioactive wastes from nuclear weapons production in the United States. (AEC was disbanded in 1974, and some of its functions eventually became the responsibility of the Department of Energy (DOE), the Nuclear Regulatory Commission (NRC), and the Environmental Protection Agency (EPA).)

1957 A NAS report to the AEC recommended that transuranic and high-level radioactive wastes be buried in geologic formations and that the feasibility of using salt beds or salt domes as a disposal medium be investigated.

1970 The AEC tentatively selected a nuclear waste repository site in salt deposits near Lyons, Kansas.

1972 The federal government withdrew the Lyons, Kansas, site from consideration for the repository because of concerns that drilling in the vicinity had compromised the salt deposits' geologic integrity.

1982 The Nuclear Waste Policy Act (NWPA) was passed to help resolve the issue of long-term safe disposal of radioactive waste. The Act established geologic disposal as the United States' long-term strategy for isolation of spent nuclear fuel and high-level radioactive waste. The Act confirmed the federal government's responsibility for managing and disposing of commercial spent nuclear fuel and identified specific roles for federal agencies. DOE would design, build, operate, and close the underground geologic repository. EPA would develop generally applicable or generic public health and safety standards. NRC would license the repository, incorporate EPA's Yucca Mountain standards into its regulations, and implement them.

1983 DOE selected nine sites in six states for study as potential sites for a first repository. In accordance with the NWPA, DOE identified sites in 17 eastern states as potential locations for a second repository.

1986 The Secretary of Energy nominated five of the nine sites for further consideration, and the President approved three sites (Hanford, Washington; Deaf Smith County, Texas; and Yucca Mountain, Nevada) for further study (i.e., site characterizations).
Based, in part, on a desire to keep costs down, Congress amended the Nuclear Waste Policy Act to direct DOE to study only Yucca Mountain.

The 1990s brought a wave of Congressional and constituent dissatisfaction, regulatory modifications, court cases, legislative mandates, and projected cost increases that caused DOE’s Office of Civilian Radioactive Waste Management to reorganize and redirect a series of programs. The scientific and regulatory issues had become much more complex than most had anticipated. In addition, projected costs were significantly higher than initial expectations. Initial cost estimates of site characterization were less than $1 billion, but by 1996, $4 billion had already been spent on the Yucca Mountain program.

The Energy Policy Act was enacted, requiring EPA to develop site-specific public health and safety standards for Yucca Mountain, Nevada.

The Energy and Water Development Appropriations Act directed that by September 30, 1998, the Secretary of Energy provide to the President and Congress a Yucca Mountain Viability Assessment.

DOE completed construction of the Exploratory Studies Facility at the site.

The Yucca Mountain Viability Assessment was issued in December. It addressed the design of the repository, how it would work, what would be required to license it, and its expected cost. It did not include a formal site recommendation. Following submission of the Viability Assessment, Energy Secretary Bill Richardson told the news media that the assessment “reveals that no showstoppers have been identified to date,” although a number of independent oversight entities criticized the data and analysis.

DOE issued its proposed Environmental Impact Statement for the facility in August.

EPA proposed site-specific environmental radiation protection standards for Yucca Mountain, Nevada, in August.

Whether Yucca Mountain, Nevada will be the location of the first geologic repository for disposal of high-level radioactive waste and spent nuclear fuel remains unclear. The following steps are required:

- EPA must finalize its environmental radiation protection standards for Yucca Mountain (expected June 2001)
- DOE must prepare the Final Environmental Impact Statement (expected in 2001) and Site Recommendation Considerations Report (expected in Fall 2001).
- The Secretary of Energy must decide whether to recommend to the President if Yucca Mountain should be established as a commercial nuclear waste disposal site.
- If the Secretary of Energy recommends the site and issues a Site Recommendation Statement, the President must decide whether to recommend the site to Congress.
- If the President recommends the site to Congress, the Governor of Nevada or the Nevada Legislature has the right to submit a “Notice of Disapproval.”
- If the state does submit a Notice, Congress can then decide to override the “Notice of Disapproval” and approve the Yucca Mountain site, or concur with the Notice and disapprove the site.
- If Congress, through a simple majority vote of both the House and Senate, approves the Yucca Mountain site, DOE is to submit an application to the NRC to construct the repository.
If NRC approves the application, DOE is to construct the repository and apply to the NRC for a license to accept waste. Under this schedule, if DOE receives the license, waste disposal could begin as early as 2010.

The total cost estimate to complete the design, and to license, construct, operate and monitor a geologic repository at Yucca Mountain over the next century is $43 billion, according to Jon Christensen of the New York Times.

**Site Characteristics**

As early as 1957, the National Academy of Sciences recommended burying radioactive waste in geologic formations. After more than two decades of additional study, DOE concluded that disposal in an underground mined geologic repository is the preferred approach. Optimum characteristics of a geologic repository would be high stability, no circulating groundwater, location where severe earthquakes or volcanic eruptions are highly unlikely, and deep enough to allow for buffers of the same rock above and below storage.

Yucca Mountain is a 1,200-foot-high, flat-topped volcanic ridge extending six miles from north to south. The mountain is comprised of “tuff,” a rock made from compacted volcanic ash formed approximately 13 million years ago. Yucca Mountain has a desert climate and receives about six to seven inches of precipitation per year. The mountain has a deep water table. The repository would be built approximately 1,000 feet below the land surface and 1,000 feet above the water table.

**Site Characterization and Environmental Impact Statement**

DOE is conducting site characterization activities and preparing an Environmental Impact Statement (EIS), as required by the Nuclear Waste Policy Act.

DOE’s site characterization is an intensive scientific study that will evaluate whether Yucca Mountain is a suitable site for developing a geologic repository for spent nuclear fuel and high-level radioactive waste. As part of this evaluation, scientists are studying Yucca Mountain’s geology, hydrology, biology, and climate to determine whether any adverse conditions exist that would disqualify the site.

In April 1997, DOE completed construction of the Exploratory Studies Facility — a five-mile-long, north-south horseshoe-shaped tunnel; a smaller east-west drift off the main tunnel; and a series of test alcoves that will permit scientists to conduct seismological, geological, hydrological, hydrochemical, and thermo-mechanical studies. Scientists have also simulated the reaction of rock and water to the heat that would be released by the spent nuclear fuel placed in the repository. These data will assist scientists in designing the repository and analyzing its performance. The Site Characterization Report is to be completed in 2001. DOE will also issue a Site Recommendation Considerations Report open to public comment for 90 days. If DOE determines the site is suitable and plans to recommend it for repository development, a Site Recommendation Statement will be prepared and submitted to the President in 2001.

The Environmental Impact Statement will assess the potential environmental impact if the Yucca Mountain facility serves as a repository for spent nuclear fuel and high-level radioactive waste, including the
transportation and disposal of the waste. It will also assess the impact of the alternative of not building the facility and leaving the waste at 72 commercial sites and 43 research sites in 43 states across the country. DOE published the Draft EIS on August 13, 1999, and accepted public comments through February 26, 2000. The Final Environmental Impact Statement is expected to be completed in 2001.

The Disposal System

The goal for the potential repository at Yucca Mountain is to isolate the waste from the environment in the following ways:

- Position the waste above the water table where the relative dryness of rocks would minimize exposure to groundwater
- Contain the waste in thick, corrosion-resistant packages
- Bury the waste deep — approximately 1,000 feet below the land surface — preventing most kinds of accidental contact with the waste from natural causes such as severe weather

The facility is being designed with an engineered barrier system that will work with the natural geologic barriers. The current design includes long-lived waste packages supported by concrete and steel and covered by inverted U-shaped drip shields, host rock, and a concrete tunnel floor.

Under current DOE plans in the Viability Assessment, the underground repository would consist of about 100 miles of tunnels. The main tunnels would allow for moving workers, equipment, and waste packages. Ventilation tunnels would supply air to the workers in the underground repository. The emplacement tunnels (or drifts) would accommodate the waste packages. Two sloping access ramps and two vertical ventilation shafts would connect the underground and surface areas.

The current waste package design would have two layers: an outer layer of a corrosion-resistant high-nickel alloy that is two centimeters thick, and an inner layer of stainless steel, five centimeters thick that provides physical

Figure 2. Artist’s Sketch of Yucca Mountain


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Figure 3. Yucca Mountain Potential Disposal System

Source: Department of Energy and the Nuclear Energy Institute
strength to the package. Inside the waste package would be additional barriers. Most spent nuclear fuel would be encased in zircaloy, a metal cladding that is highly resistant to corrosion. The high-level radioactive waste would be inside a cover to protect against the possibility of dripping water contacting the waste package directly, and it would be made out of a high grade of metal titanium, which is also highly corrosion resistant. Because of the excessive heat from the high-level radiation, a remotely-operated rail car would carry the canisters down a ramp into a network of tunnels and robots would position the canisters.

The facility could hold up to 70,000 metric tons of waste, the limit imposed by Congress in the Nuclear Waste Policy Act of 1982. However, if authorized by Congress, the site could accept additional waste. DOE estimates that by 2010, approximately 64,000 metric tons of spent nuclear fuel and 286,600 cubic meters of high-level radioactive waste will be in temporary storage in the United States.

Issues and Concerns About Yucca Mountain

There is ongoing debate over whether the geologic features and proposed manmade barriers at Yucca Mountain will provide sufficient isolation. A number of interested parties believe Yucca Mountain has certain characteristics that pose a concern for long-term isolation of highly radioactive material. Others point to Yucca Mountain’s location in an active seismic (earthquake) region; the presence of numerous earthquake faults (at least 33 in and around the site) and volcanic cinder cones near the site; evidence of hydrothermal activity within the proposed repository block; and the presence of pathways (numerous interconnecting faults and fractures) that could allow the rapid movement of groundwater (and any escaping radioactive material) through the site to the aquifer beneath and from there to the accessible environment.

Water flow is a critical factor. Some groups maintain that using chlorine-36 (a chemical isotope left by atmospheric atomic bomb testing) as a tracer, rainwater residues less than 50 years old have been detected at the level of the proposed repository.

Another concern surrounding water is the identification of calcite crystals. Some believe the crystals may have been fed by minerals carried by rainwater descending through the volcanic rock. Water in the tunnels could corrode the canisters and help to spread the radioactive material through the rocks and into the local water table, where it would threaten future residents in the area.

Still others question whether the site can remain stable for 10,000 years. And barriers could be damaged from drilling new tunnels.