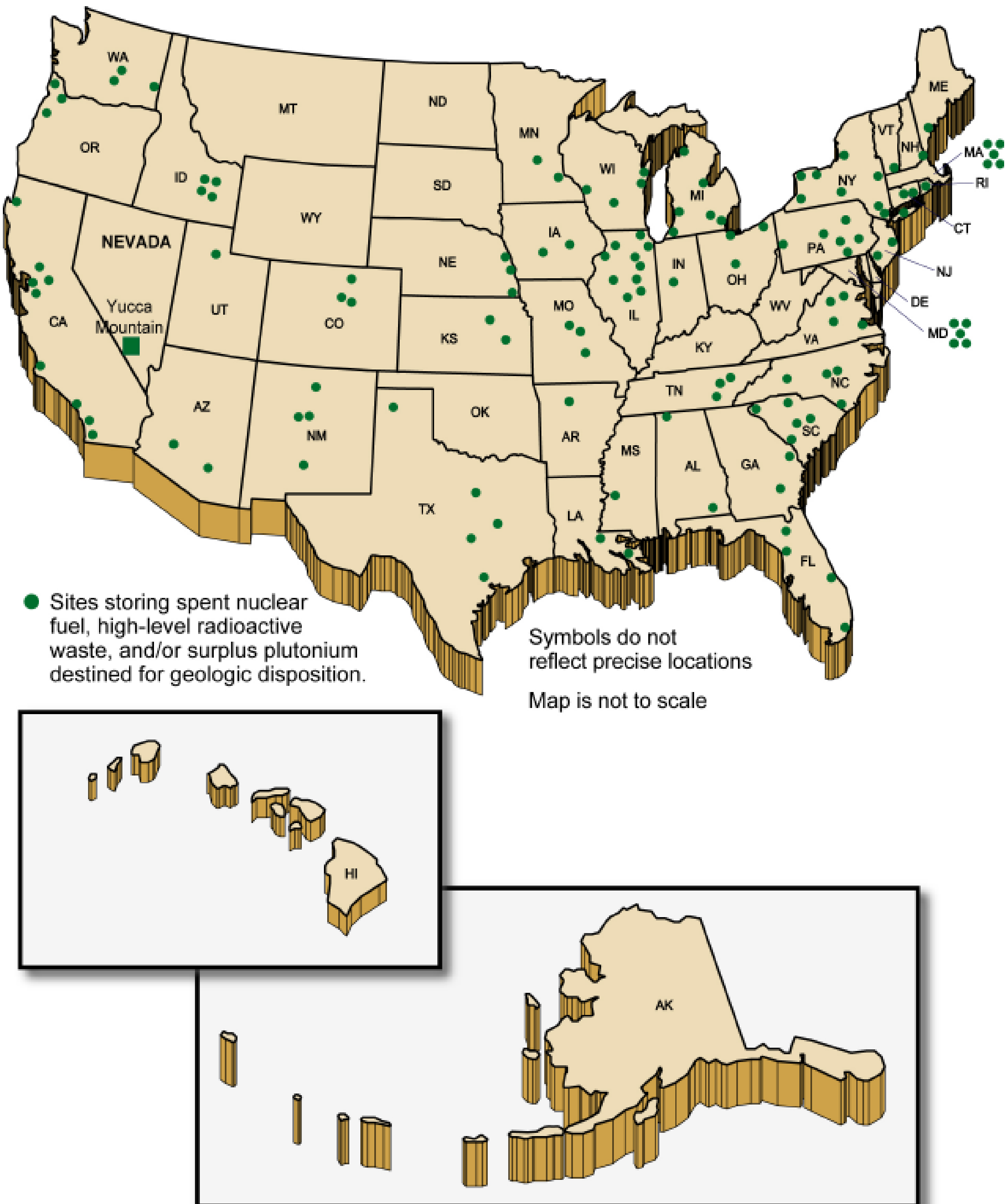
Why Yucca Mountain?

Frequently Asked Questions

U.S. Department of Energy
Office of Public Affairs
www.energy.gov

At present, spent nuclear fuel and high-level radioactive waste are temporarily stored at 131 locations in 39 states.



Introduction

The purpose of this question-and-answer document is to provide information to the general public on the possible use of Yucca Mountain as an isolated geological repository for the nation's nuclear waste. This waste has been generated over the past 50 years by defense activities and the U.S. military, the cleanup of World War II-era nuclear weapons plants, nuclear power plants, and the reduction of the nation's nuclear arsenal. In an effort to work towards a solution to the nuclear waste issue, Congress passed the Nuclear Waste Policy Act in 1982, and in 1987 amended the Act, directing the Department of Energy (DOE) to study only Yucca Mountain.

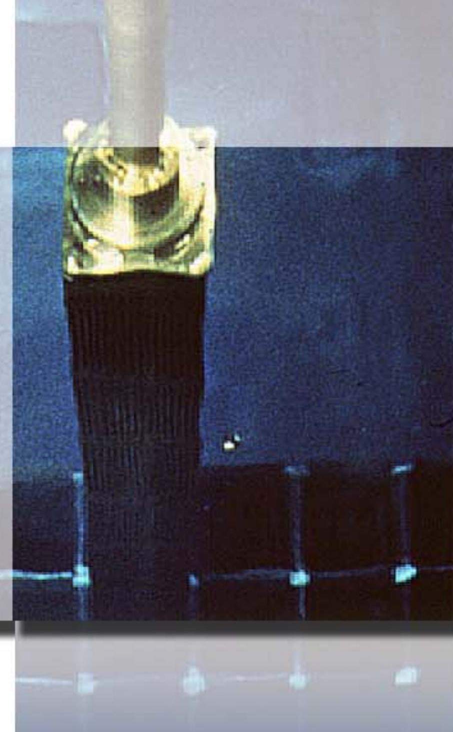
The federal government has spent over 20 years and $8 billion dollars analyzing and studying potential sites for disposal of nuclear waste. Throughout the scientific inquiry, there has been no evidence that disqualifies Yucca Mountain to serve as the nation's underground nuclear waste repository.

Yucca Mountain is located in Nevada, in a remote desert environment far from any population center, and on federally protected land. The site sits adjacent to the Nevada Test Site, the ground-zero location of over 800 nuclear bomb tests conducted up until the early 1990s. If a repository at Yucca Mountain were built, nuclear waste currently stored in temporary surface facilities at 131 sites in 39 states would be secured 1,000 feet beneath the desert surface.

Topics covered in this document reflect the primary issues and concerns raised by the general public over the course of studying Yucca Mountain, including those topics raised in the past year during public participation in more than 66 public hearings on the Secretary's consideration of whether or not to recommend Yucca Mountain for development as a repository.

The discussion topics in this pamphlet include answers to the following questions:

1. What is radiation? How do we control our exposure? What are spent nuclear fuel and high-level radioactive waste?
2. Why is the DOE studying only Yucca Mountain?
3. What makes Yucca Mountain a good place to store waste?
4. Would a repository at Yucca Mountain protect public health and safety?
5. Can radioactive waste from the repository contaminate the groundwater in Las Vegas?
6. Would a repository at Yucca Mountain withstand earthquakes?
7. Would volcanoes affect repository safety?
8. Is the repository protected from sabotage?
9. Can waste be transported safely to a repository?
10. How do we protect shipments of high-level radioactive waste from sabotage?
11. Is my property insured against potential damage resulting from transporting high-level radioactive waste?
12. What direction, review, and oversight have been provided for the project?
13. How can the DOE be certain that its calculations of events thousands of years in the future are accurate?
14. Will taxpayers subsidize large utilities for the disposal of high-level radioactive waste?
15. Does the DOE plan to monitor the repository after its closure?
16. What alternative technologies might eliminate the need for a repository?
17. What are some of the public policy issues associated with a repository the Secretary is considering?
18. Why have the DOE's siting guidelines changed?
19. What steps of the repository development process would follow a recommendation by the Secretary?
20. Where are the wastes that would be placed in a repository?
21. How can the DOE move forward with a site recommendation if there are a number of technical items yet to complete for the NRC?



Q: *What is radiation? How do we control our exposure? What are spent nuclear fuel and high-level radioactive waste?*

A: Put quite simply, radiation is energy traveling through space. Radiation can take the form of particles or waves — such as ultraviolet light or x-rays. "Ionizing radiation" is a category of radiation that causes changes to the structure of atoms it comes in contact with — it removes electrons, thereby creating "ions," which are charged particles. An atom that emits ionizing radiation is described as "radioactive." As this radiation is released over time, the atom becomes less radioactive, and more stable.

The atoms of most elements in our universe are stable. They don't lose energy on their own, and their atomic structure never changes. But certain elements are naturally radioactive; the atoms of such elements are called "radionuclides." When radionuclides lose excess energy and decay to a more stable atom with less energy, the energy released in the process is radiation.

The three major, commonly recognized types of ionizing radiation are alpha, beta, and gamma radiation. Alpha and beta radiation are emitted in the form of tiny, electrically charged particles. Gamma radiation is electromagnetic rays, similar to light and X-rays. An alpha particle is identical to the nucleus of a helium atom (i.e., two neutrons and two protons) and is positively charged. Beta particles are usually electrons (and thus negatively charged), but they can be positrons (positively charged particles of the size and weight of an electron).

Everyone is exposed to "natural background" and man-made sources of radiation (e.g., cosmic rays, radon, building materials, food, and medical procedures). The average American receives an annual radiation dose of about 360 millirem from these sources. A millirem is a standard measurement of radiation dose absorbed by the human body.

Radiation is energy, similar to light.

Exposure controlled by time, distance, and shielding.

There are three types of nuclear materials that could be disposed of at Yucca Mountain:

1) solidified high-level waste created by past, current, and future national defense activities,

2) surplus plutonium from nuclear weapons, and

3) spent nuclear fuel from defense and civilian reactors.

How do we control our exposure?

We can manage our exposure to radiation by controlling time, distance, and shielding. The less time we spend near materials emitting radiation, and the farther away we stay, the lower our exposure. Alpha particles are comparatively large and can travel only a short distance in air before being stopped or blocked. Alpha particles can also be stopped or blocked by something as thin as a sheet of paper. Beta particles are smaller than alpha particles and travel a longer distance in air before being stopped, but, again, they can be blocked by something as ordinary as a sheet of aluminum foil. Like X-rays, gamma radiation can be blocked by sufficiently thick pieces of steel, concrete, or lead.

What are spent nuclear fuel, surplus plutonium, and high-level radioactive waste?

"Nuclear fuel" is made of solid ceramic pellets containing both uranium-235 and uranium-238. The more important isotope for the large-scale release of energy through fission is uranium-235, because it more readily releases energy. To make nuclear fuel, the pellets are enriched (made to have a higher concentration of uranium-235 than found in nature) and sealed in corrosion-resistant metal tubes called cladding. These tubes are then bundled together to form a fuel assembly. The energy released from the uranium pellets produces heat, which makes steam for turning turbines that are connected to electrical generators. After the fuel is no longer efficient at generating heat, it is considered "spent" or used.

Natural uranium is an alpha-emitter, and the metal cladding surrounding the pellets is sufficient to stop the alpha particles. When the fuel is used in the reactor, the uranium nuclei are broken apart by neutrons into fragments in a process called "fission." Some of these fragments produce gamma radiation, which can penetrate the cladding. Storage and transportation casks containing several inches of steel and lead protect workers and the public from unsafe levels of gamma radiation.

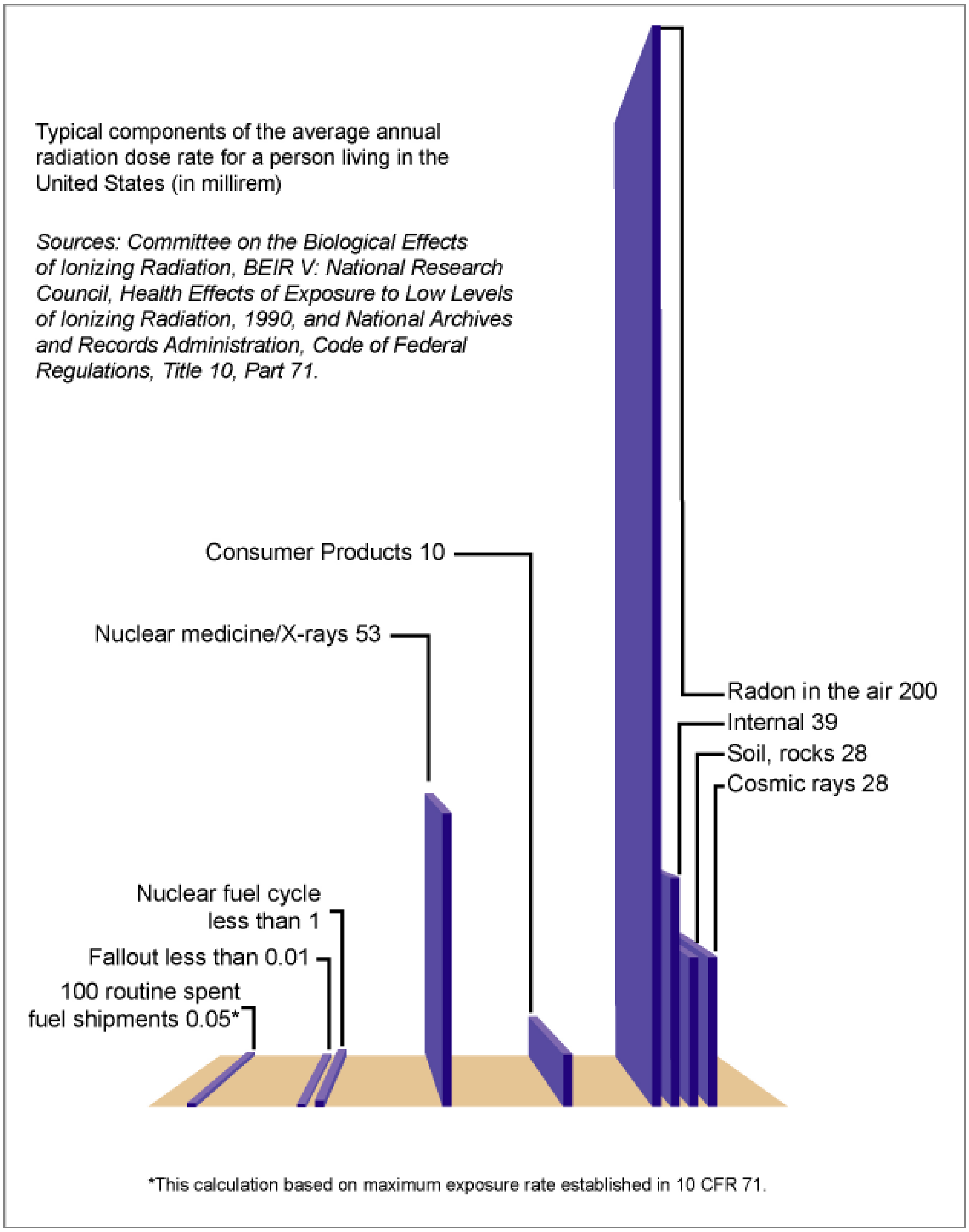
"Surplus plutonium" is plutonium from dismantled nuclear weapons; it is considered surplus because of arms-reduction treaties.

"High-level radioactive waste" that would be disposed of in a repository at Yucca Mountain is 1) solidified high-level waste containing byproducts from past processing of spent fuel to extract plutonium for nuclear weapons for defense needs, and 2) other highly radioactive material that requires permanent isolation, consistent with existing law.

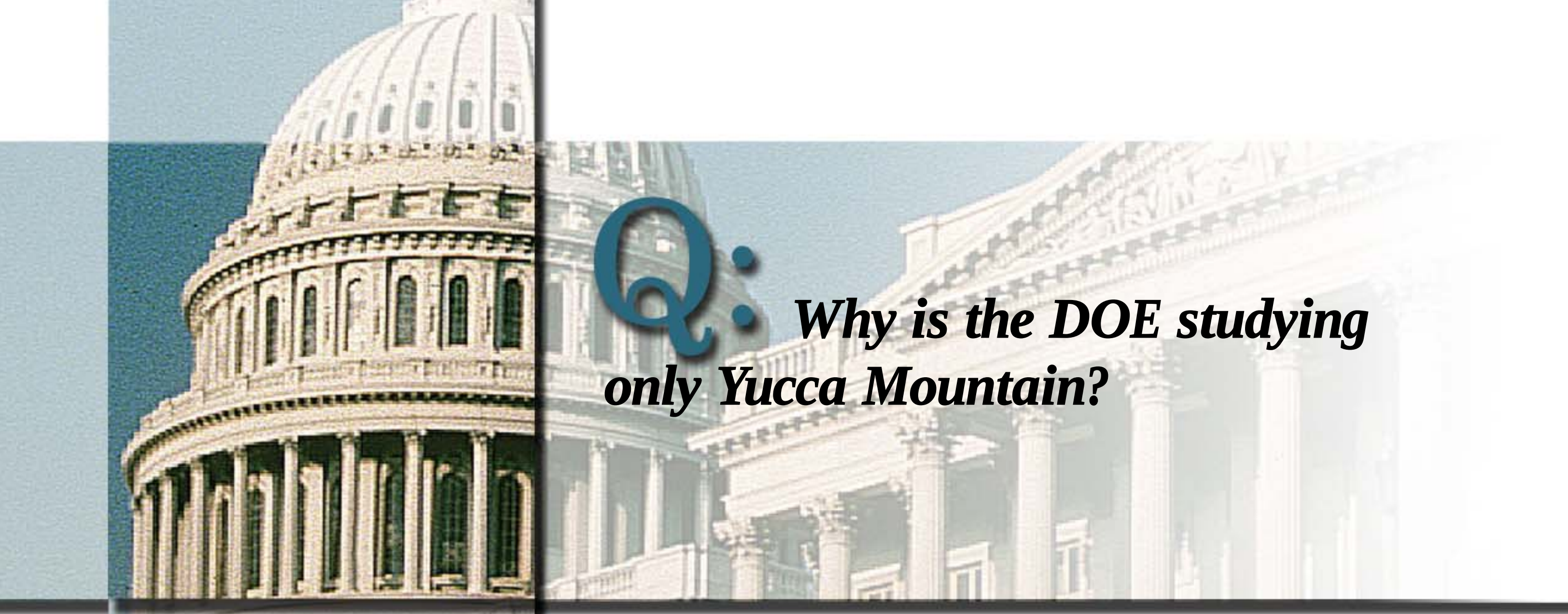
Radioactive materials are routinely managed and handled for medical, industrial, and defense purposes. Safe techniques and procedures for handling these materials are well understood and well established.

Solid ceramic nuclear fuel pellets, each slightly larger than a pencil eraser, containing both uranium-235 and uranium-238.

Comparison of natural and man-made radiation doses



The average American receives about 360 millirem of background (i.e., normal and expected) radiation every year from both natural and man-made sources.



Q: *Why is the DOE studying only Yucca Mountain?*

Congress in 1987 directed the DOE to study only Yucca Mountain.

A: In 1987 Congress directed the DOE to study only Yucca Mountain after it was consistently ranked as the site that possessed the best technical and scientific characteristics to serve as a repository.

Some suggest that the site was picked on the basis of "politics" in that the State of Nevada is represented in Congress by a relatively small congressional delegation, and is outnumbered by other states. The fact is that years of scientific study, culminating in a 1986 comparison and ranking of the nine sites then under consideration for characterization, led the DOE to conclude that Yucca Mountain ranked at the top of all sites studied. The DOE also examined a number of ways of combining the components of the ranking scheme; this only confirmed the conclusion that Yucca Mountain came out in first place.

Shortly thereafter, in 1987, Congress directed the DOE to concentrate ***only*** on Yucca Mountain. As noted, at the time of the 1987 congressional decision, scientists had already collected much information about Yucca Mountain from field and laboratory studies. Additionally, the U.S. Geological Survey and national laboratories had already been studying the area's geology and hydrology since the start of atomic testing; beginning in January 1951 over 800 U.S. nuclear weapon tests have been conducted at the Nevada Test Site, in support of the weapons program.

In-depth follow-up studies have confirmed that Yucca Mountain has many positive attributes that would contribute to safe geologic disposal, including the site's remoteness, arid climate, multiple natural barriers, great depth to water table, and an isolated hydrologic basin. Yucca Mountain is located in a desert, isolated from population, in a region where the land is controlled by the federal government, including the U.S. military. Most of the land in this region is under federally restricted access. In contrast, all major nuclear power generation facilities in the United States are located near large metropolitan centers, in order to reduce the amount of power that is lost during transmission. In fact, most metropolitan centers — and more than 161 million Americans — reside within 75 miles of a major nuclear facility (commercial, and/or defense). Yucca Mountain would truly be one of the few nuclear facilities to be located in a remote setting, more than 90 miles from the nearest population center.

Additionally, Yucca Mountain would not be the first repository for radioactive waste to be developed by the DOE. After more than 20 years of scientific study, the Environmental Protection Agency certified the Waste Isolation Pilot Plant (WIPP) in Carlsbad, New Mexico. WIPP began receiving a specific class of defense-generated waste on March 26, 1999. However, the high-level waste and spent nuclear fuel contemplated for disposal at Yucca Mountain cannot, by law, be stored in WIPP.

Q: What makes Yucca Mountain a good place to store waste?

A: Yucca Mountain is located in a desert, isolated from population centers, in a region where the land is controlled by the federal government, including the U.S. military. Most of the land in this region is under federally restricted access. Waste placed in Yucca Mountain would be located 1,000 feet underground — compared to its current location in temporary surface facilities at 131 sites in 39 states. Natural and engineered barriers would work in concert to isolate radionuclides from the accessible environment for tens of thousands of years.

Yucca Mountain has five key attributes that are important to long-term performance:

Limited Water Entering Emplacement Tunnels - The climate at Yucca Mountain is arid, with precipitation averaging about 7.5 inches per year. Future climates during the regulatory compliance period are expected to be slightly cooler and produce a higher mean annual precipitation of about 12.5 inches. Little of this precipitation percolates (seeps) into the mountain; nearly all of it (about 95 percent) either runs off, is picked up by the root systems of vegetation, or is lost to evaporation. This significantly limits the amount of water available to infiltrate the surface, move down through the thousand feet of unsaturated rock, and seep into emplacement tunnels.

Yucca Mountain consists of alternating layers of welded tuff (volcanic ash that was laid down when it was very hot and welded itself into a solid mass of rock) and nonwelded tuff (volcanic ash that was laid down when it was cool and became a cohesive mass when compressed by overlying rock). The mountain is layered with welded tuff at the surface, welded tuff at the level of the repository, and an intervening layer of nonwelded tuffs. These nonwelded units contain few fractures; thus, they delay the downward flow of moisture into the welded tuff layer below, where the repository would be located. At the repository level, a significant portion of what little water is

A repository at Yucca Mountain would be:

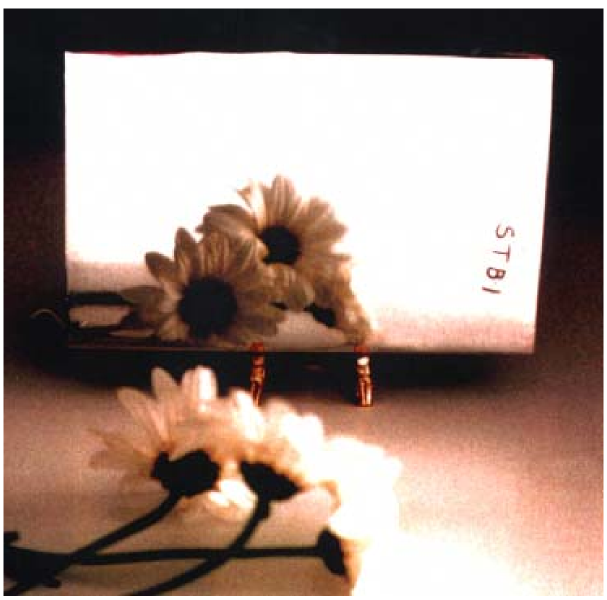
- In a desert location
- Isolated away from population centers
- Secured 1,000 feet under the surface
- In a closed hydrologic basin
- Surrounded by military and other federal land
- Protected by natural geologic barriers
- Protected by robust engineered barriers and a flexible design

available in small fractures has a tendency to remain in the fractures rather than flow into larger openings, such as tunnels, due to capillary action. Just as water poured slowly from a glass tends to run slowly down its side, rather than drip straight down, what little water does seep into a tunnel could run down its side walls — and not drip on waste packages.

Long-Lived Waste Package and Drip Shield – Chemical conditions that would promote corrosion are not expected to occur in the repository environment, and both the titanium drip shield and the nickel-based alloy (Alloy 22) outer barrier of the waste package are expected to have extremely long lifetimes. In the repository environment, Alloy 22 is very corrosion-resistant, with general corrosion penetrating only about 0.03 inches in 10,000 years. The Titanium Grade 7 is also corrosion-resistant, with general corrosion penetrating only about 0.08 inches in 10,000 years. Only about 1 percent of the waste packages are projected to lose some of their integrity during the first 80,000 years.

Limited Release of Radionuclides from the Engineered Barriers – Even though the waste packages and drip shields are expected to be long-lived in the repository environment, the advanced computer simulations predict some eventual loss of waste package integrity. If water were to penetrate a breached waste package, several characteristics of the waste forms and the repository would limit radionuclide releases. First, because of the warm temperatures of the waste, much of the water that might penetrate the waste package will evaporate before it can dissolve or transport radionuclides. Neither spent nuclear fuel nor glass waste forms will dissolve rapidly in the water expected in the repository environment. In addition, the invert, part of the engineered barrier system under the waste package and support pallet, would contain crushed tuff that would also delay the transport of radionuclides into the unsaturated host rock.

Delay and Dilution of Radionuclide Concentrations by the Natural Barriers - Eventually, the engineered barrier systems could experience a decrease in their integrity, and small amounts of water could contact waste, dissolve it, and carry some radionuclides out of the repository and into the rock below. As water flows through fractures,



This piece of corrosion-resistant stainless steel still has a mirror-like finish after 60 years' exposure to the corrosive salt-waves and blasting winds of the Atlantic Ocean. The stainless steel for waste packages is even more corrosion resistant.

This picture shows samples of Alloy 22 and a high-quality steel, after exposure to an accelerated aging corrosion experiment. Alloy 22 is expected to lose its integrity very slowly in the repository environment.

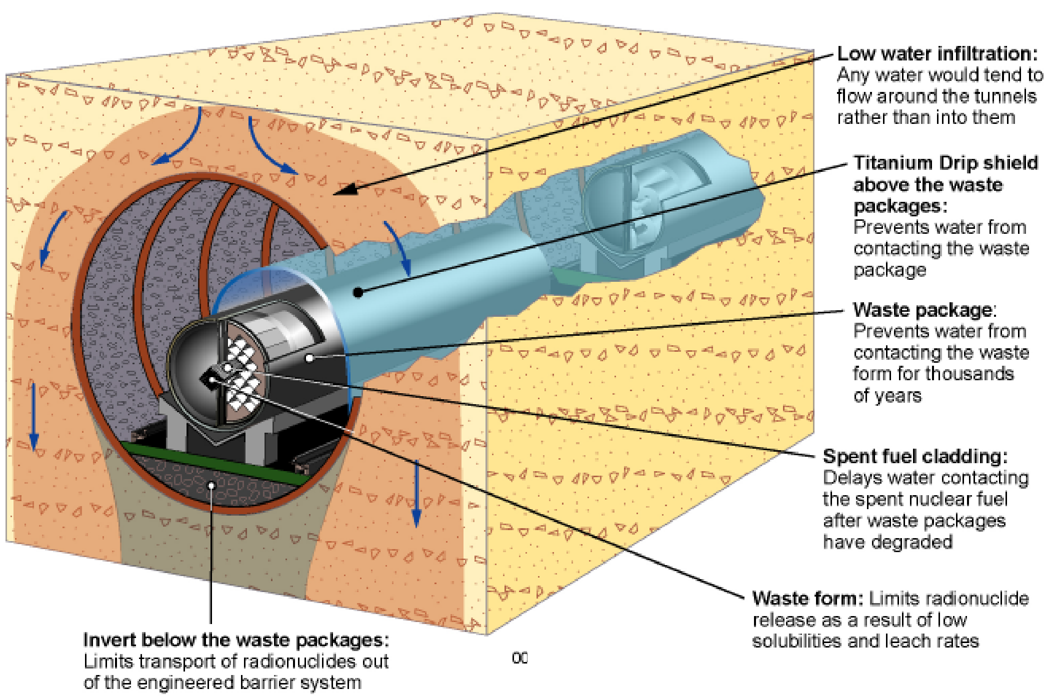
dissolved radionuclides would diffuse into and out of the pores of the rock matrix, increasing both the time it takes for radionuclides to move from the repository and the likelihood that radionuclides will be exposed to sorbing minerals (minerals that attract and hold them).

Radionuclide migration through the unsaturated and saturated zone is affected in two ways. First, radionuclides are exposed to minerals in the rocks called "zeolites" that trap many species of the radioactive waste; this delays the transport of radionuclides. Second, dispersive processes that occur during transport through the saturated zone dilute and reduce radionuclide concentrations in groundwater.

Once the saturated zone, which is about 1,000 feet below the repository, is reached the flow paths are generally southerly toward the Amargosa Desert and Death Valley. Yucca Mountain is located in a closed hydrologic basin. The boundaries of this basin are defined and understood. Water in this basin does not flow into any rivers or oceans, and is isolated from the aquifer systems of Las Vegas and Pahrump, the largest community in Nye County. Isolated hydrologic basins are a relatively rare geologic feature. The groundwater system in this basin conforms to the mountainous topography, and drains inward.

Low Likelihood of Potentially Disruptive Events - The DOE considered three specific disruptive processes and events (i.e., volcanism, seismic events, and nuclear criticality) that could impact the performance of a repository at Yucca Mountain. Seismicity is considered as a nominal, or expected, event and is treated as such in the analyses. Criticality was found to have such a low likelihood that it is not necessary to consider further, according to the regulations.

Of the three, volcanism resulted in a low but calculable dose when considering the remote probability of a volcanic disruption. The likelihood of the repository being disrupted by a volcano is extremely small (about 1 in 70 million, or a chance of 0.0000014 percent, per year). Following regulatory guidelines, the calculated peak dose would be less than one percent of the radiation protection standards set by the Nuclear Regulatory Commission and the Environmental Protection Agency.



Natural features work with engineered features to limit the amount of water that can contact waste forms, dissolve them, and transport radionuclides out of the repository. Natural forces cause the very small amount of available water to flow around, rather than into, the tunnels. Drip shields, waste packages, and cladding (metal tubes holding ceramic fuel pellets) are made of metals that resist corrosion, further protecting the waste forms, which are ceramic and glass.

Q: *Would a repository at Yucca Mountain protect public health and safety?*

A: The Environmental Protection Agency and the Nuclear Regulatory Commission have established stringent standards that protect the health and safety of individuals working and living in the vicinity of Yucca Mountain. The results of repository performance analyses indicate that a repository at Yucca Mountain would likely protect the health and safety of the public, for at least 10,000 years in the future.

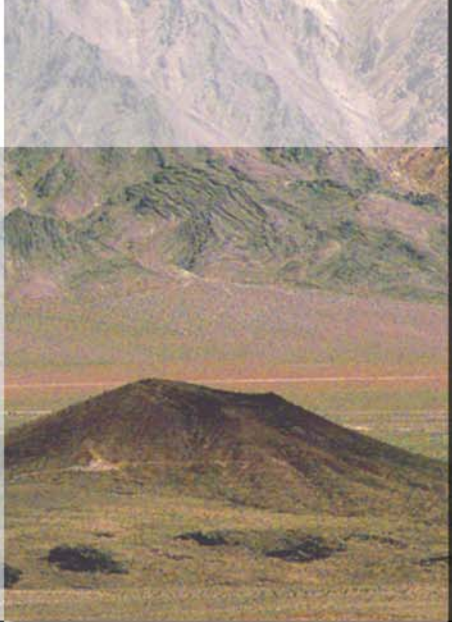
Before it will grant a license to construct or operate a repository, the Nuclear Regulatory Commission will require assurance that the repository would be safe for current and future generations. In addition, the Environmental Protection Agency and Nuclear Regulatory Commission standards that apply after closure of the repository would preserve the quality of the environment by establishing strict protection requirements for the groundwater.

The DOE has evaluated the safety of workers and the public for the time that the repository would be operating. The DOE also has conducted a safety evaluation for the period after the closure of the repository. Considering the results of these safety evaluations, the Secretary believes that a repository at Yucca Mountain will perform in a manner that protects public health and safety.

The average American receives an annual dose of about 360 millirem from both natural and man-made sources (cosmic radiation, radon, food, medical and dental procedures, etc.). Even after 10,000 years, the potential exposure to the public from a repository at Yucca Mountain is estimated to be less than 1 percent (less than 1/10 of a millirem) of the dose limit allowed by federal regulation. The potential dose from the repository is so small that when combined with the area's natural and other man-made sources it would be indistinguishable from the doses in other nearby communities.

As required by law, any repository would be monitored even after closure. This monitoring would provide additional assurances that the health and safety of future generations will be preserved.

Any repository for high-level waste and spent fuel must meet the stringent standards of the Environmental Protection Agency, be licensed by the Nuclear Regulatory Commission, and ultimately be subject to continuing congressional oversight. The Secretary believes a repository at Yucca Mountain would meet these rigorous tests.



Q: *Would volcanoes affect repository safety?*

No. The likelihood of a volcano disrupting the repository is extremely low (one in about 70 million, or a chance of 0.0000014 percent, per year).

A: The DOE has relied upon the careful evaluation of the relevant data by a team of world-class experts, in order to assess the possibility of volcanic activity that might have an impact on how well a repository would contain and isolate the waste. Volcanologists started with a careful analysis of the entire geologic setting of Yucca Mountain. Then, with abundant data on regional volcanoes, they used computer modeling to understand each volcanic center's controlling structures. The DOE estimates the likelihood of such an event occurring during the first 10,000 years after repository closure to be one in about 70 million, or a chance of 0.0000014 percent, per year.

Between about 15 and 12 million years ago, a series of large-scale volcanic eruptions, located well to the north, deposited the materials that have formed Yucca Mountain. Hundreds of thousands of years ago, small-volume volcanoes (known as cinder cones), unrelated to the events that formed Yucca Mountain, erupted lava flows and cinders to the west of the site. These eruptions moved in a westward direction, away from the proposed repository. Volcanic activity in the Yucca Mountain region has been waning since then, with the last small eruption nearly 80,000 years ago. Because the conditions necessary for renewed volcanic activity have been reduced so much at Yucca Mountain, experts consider the chance of a volcano disrupting a repository to be virtually nonexistent.

Q: *Would a repository at Yucca Mountain withstand earthquakes?*

A: The repository would be located about 1,000 feet underground in a relatively stable block of solid rock, which would keep its contents safe from any significant impacts of any earthquake. Because vibratory ground motion decreases with depth, earthquakes have much less impact underground than on or near the surface. Underground inspections at Yucca Mountain and the tunnels at the Nevada Test Site, some of which are over 40 years old, have revealed little disturbance from historic seismic events. This phenomenon is not unique to the Yucca Mountain area; worldwide, inspections of subsurface structures after major earthquakes have reinforced this observation.

Nuclear Regulatory Commission regulations require that all facilities it licenses be designed and constructed to withstand the effects of natural phenomena, including earthquakes, without representing a threat to public health and safety from their operations.

Sudden movement in rock along ruptures or faults causes earthquakes. Scientists' extensive knowledge of the faults in this area allows them to estimate the frequency and size of future earthquakes, the potential intensity of ground movement, and the possible effects on the area's geologic features and man-made structures. Scientists expect future earthquakes to occur in the Yucca Mountain area. However, engineers can and will design the facilities to withstand any severe earthquake considered likely to occur at Yucca Mountain.

Additionally, extensive experience and proven techniques allow building the repository's surface structures so that they perform their safety functions both during and after an earthquake.

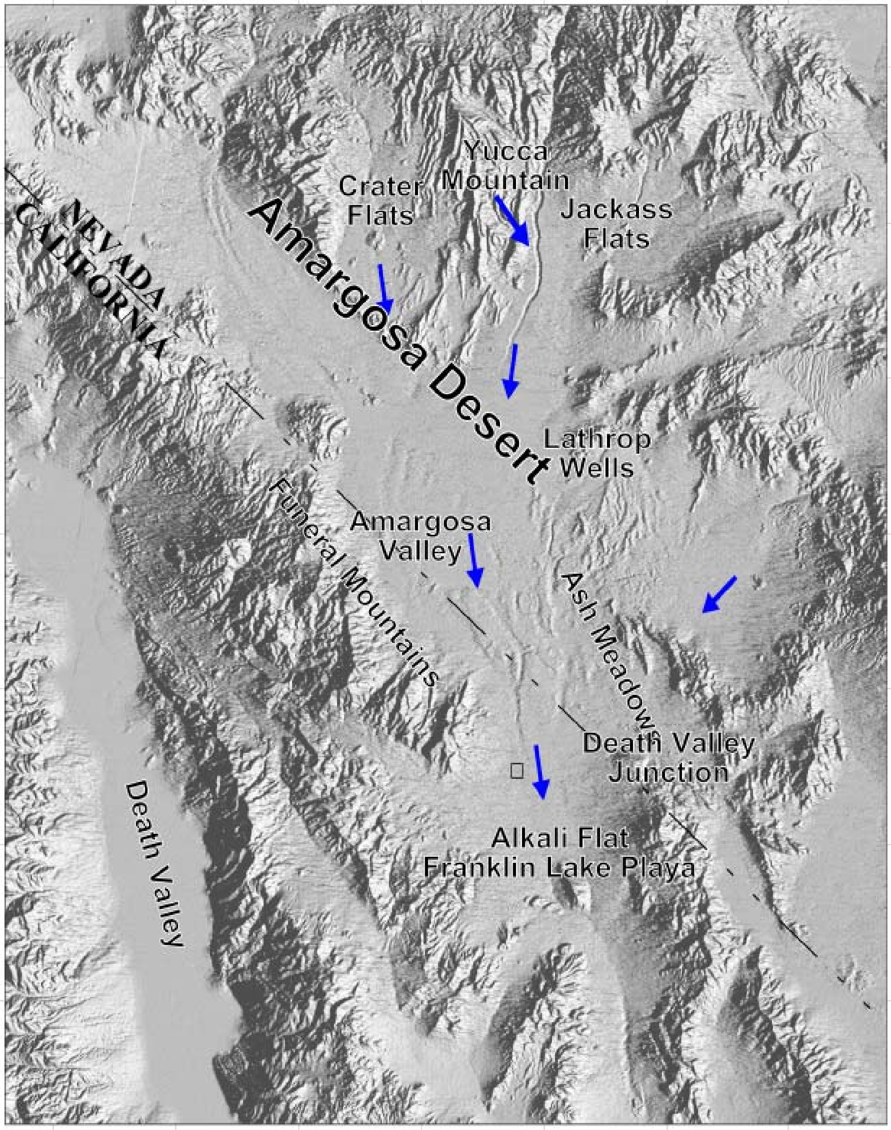
Yes. Geologic evidence shows that the mountain has resisted earthquakes for hundreds of thousands of years. Engineers will be able to design facilities to withstand severe earthquakes considered likely at Yucca Mountain.

Q: *Can radioactive waste from the repository contaminate the groundwater in Las Vegas?*

A: Yucca Mountain is located in the Death Valley hydrologic basin, the boundaries of which are defined and understood. Water in this basin does not flow into any rivers or oceans and is isolated from the aquifer systems of Las Vegas and Pahrump (the largest community in Nye County).

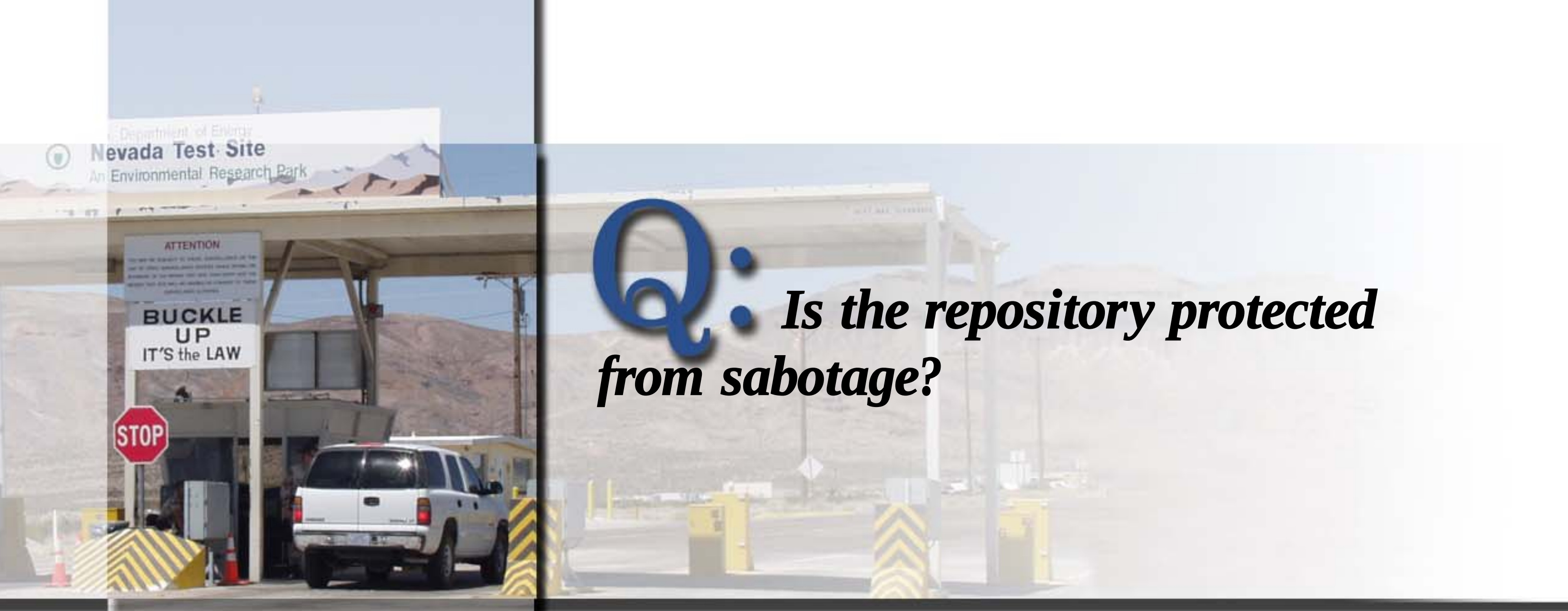
Isolated hydrologic basins are a relatively rare geologic feature. The groundwater systems in this region correlate well to the mountainous topography and have been stable for millions of years.

No. It is geologically impossible for the groundwater from Yucca Mountain to reach Las Vegas. The groundwater system below Yucca Mountain is not connected to the groundwater system serving Las Vegas. These groundwater basins have been separated for millions of years.



Yucca Mountain is approximately 90 miles from Las Vegas

Yucca Mountain is located in a closed hydrologic basin. The groundwater system in this basin conforms to the mountainous topography, and drains inward. Water in this basin does not flow into any rivers or oceans, and is isolated from the aquifer systems of Las Vegas and Pahrump, the largest community in Nye County.



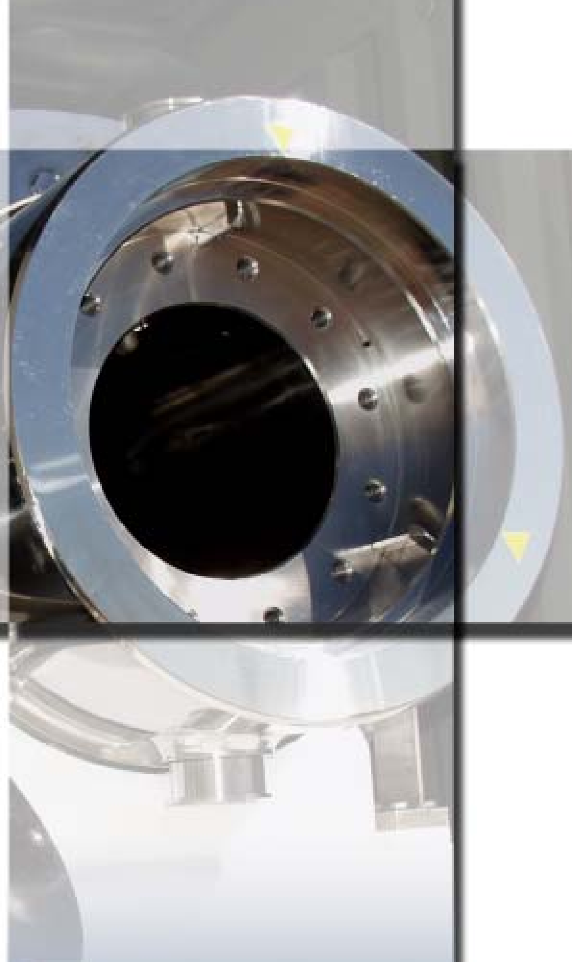
Q: *Is the repository protected from sabotage?*

A: A repository at Yucca Mountain would safeguard radioactive materials from acts of terrorism or sabotage. Being 1,000 feet under the desert surface makes it highly unlikely that an attack at the surface of a repository could have a significant impact on the extremely durable waste packages that contain the spent nuclear fuel and high-level radioactive waste. In addition, the Yucca Mountain site is remotely located on federal land more than 90 miles from any major population center. The Nellis Air Force Range surrounds the Nevada Test Site on three sides; the site has a highly effective rapid-response security force; and the airspace above Yucca Mountain is restricted.

In developing a repository, the United States will set an example for other countries to follow in the safe and secure disposition of radioactive materials. This could encourage other countries to follow the lead of the United States, and clean up contaminated sites and dispose of nuclear materials safely.

Yes. Disposal of nuclear waste in a geologic repository 1000 feet underground renders it virtually impenetrable to acts of terrorism or sabotage.

Q: *Can waste be transported safely to a repository?*



A: The U.S. history of transportation of nuclear materials is impressive, as for the last 30 years, the nation has undeniably demonstrated that it can safely transport high-level nuclear materials. There has never been a transportation accident that has resulted in the release of any amount of radioactive material that has been harmful to the public or the environment.

For example, since 1965, government and industry groups have transported more than 10,000 spent fuel assemblies in more than 2,700 shipments over more than 1.6 million miles. While there have been a few accidents (four highway and four rail) involving the transport vehicles, none has resulted in the breach of a cask or the release of radioactive materials.

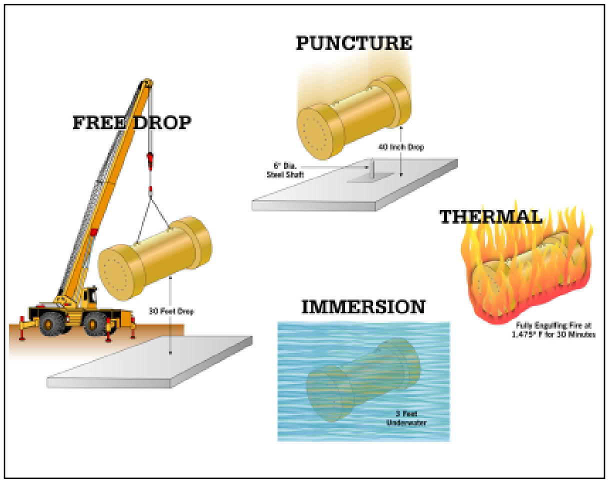
The DOE would use extremely durable and massive transportation casks whose designs are certified by the Nuclear Regulatory Commission for all waste shipments to the repository. To be certified by the Nuclear Regulatory Commission, casks must be designed to withstand severe accidents without release of their radioactive contents. To be certified by the Nuclear Regulatory Commission, each transportation cask design must be able to withstand ***all*** of the following tests, in the given sequence:

- A drop from 30 feet onto an unyielding surface (a surface so hard and resistant that it absorbs essentially none of the energy, causing the damaging energy to be absorbed by the cask itself at its weakest point). The forces that a cask experiences from this drop test are equivalent to hitting a bridge abutment at 120 m.p.h., followed by
- A drop from 40 inches onto a shaft 6 inches in diameter, followed by

The safety record for spent fuel shipments in the U.S. and other industrialized nations is enviable. Of the thousands of shipments completed over the last 30 years, none has resulted in an identifiable injury through the release of radioactive material.

- A fully engulfing fire at 1475 °F for 30 minutes, followed by
- Immersion in 3 feet of water

A separate cask must also be able to withstand immersion in about 650 feet of water for at least one hour.



To be certified by the Nuclear Regulatory Commission, every type of transportation cask must be able to withstand all of the tests shown above.

A legal-weight truck carries a cask containing spent nuclear fuel. Drivers are specially trained and certified, must be accompanied by at least one escort, must report in with the DOE every two hours, and are continuously monitored and tracked by satellite.

Q: How do we protect shipments of high-level radioactive waste from sabotage?

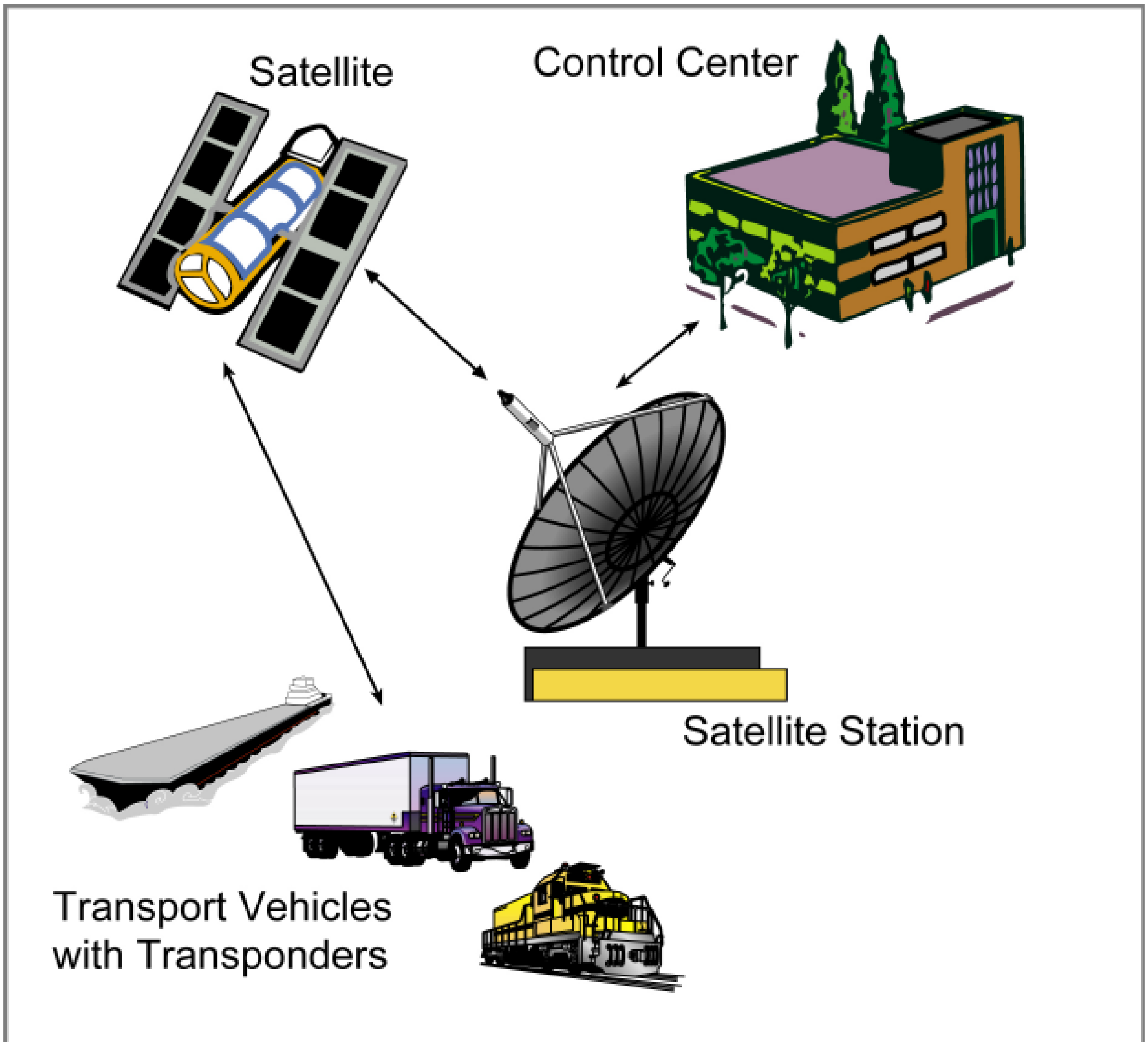
A: The same design features that make transportation casks capable of surviving severe accidents also limit their vulnerability to sabotage. In addition, the Nuclear Regulatory Commission surveys and must approve all routes. The governor of each state would be notified in advance, and shipments would be monitored around the clock through a satellite-based tracking system. All shipments would also be coordinated with local and federal law enforcement agencies.

The Nuclear Regulatory Commission has a special set of rules in place to address the physical protection of spent nuclear fuel in transit. These rules are designed to minimize the possibility of sabotage, and require the following:

- Notification of the Nuclear Regulatory Commission and relevant governors prior to transport
- Current safeguard procedures for the shipper to follow in emergencies
- Escort training on threat recognition and management
- Advance arrangements with law enforcement agencies along the route
- Advance route approval by the Nuclear Regulatory Commission
- At least one escort to maintain visual surveillance of the shipment
- Status reporting every 2 hours by the escort(s)
- The capability to immobilize the cab or cargo-carrying portion of the vehicle (for highway shipments)

Physical security measures and the exceptional strength and durability of the transportation casks would protect shipments of radioactive waste from acts of terrorism or sabotage.

- Armed escorts for any shipment through heavily populated areas
- Protection of specific information about any shipment

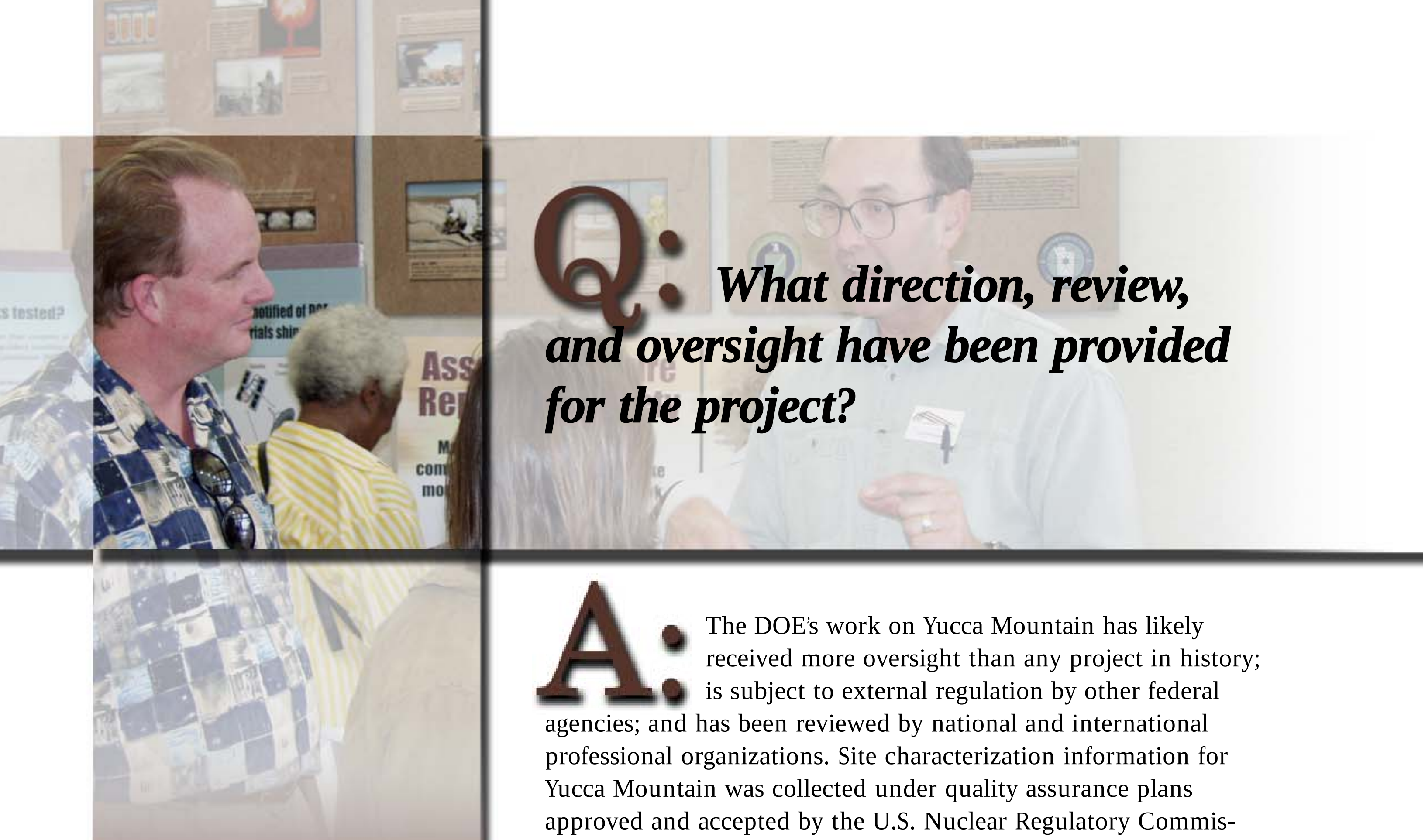


Transportation Tracking and Communications System

Q: *Is my property insured against potential damage resulting from transporting high-level radioactive waste?*

A: The Price-Anderson Act establishes a system of financial protection (compensation for damages, loss, or injury suffered) for the public in a nuclear accident, regardless of who causes the damage. The Act provides for indemnification of liability up to $9.43 billion to cover claims that might arise from an accident in which radioactive materials were released or one in which an authorized precautionary evacuation occurred. If the damage from a nuclear incident appeared likely to exceed the amount, the Price-Anderson Act contains a congressional commitment to thoroughly review the particular incident and take whatever action determined necessary to provide full and prompt compensation to the public. In addition, Department of Transportation regulations require motor carriers to have a minimum of $5 million in private insurance coverage that would be made available in the event of an accident that did not involve the release of nuclear material or a precautionary evacuation.

Yes. The existing Price-Anderson Act indemnifies Americans against damages and injury incurred from a nuclear incident or precautionary evacuation involving the transport of spent nuclear fuel or high-level radioactive waste.



Q: *What direction, review, and oversight have been provided for the project?*

A: The DOE's work on Yucca Mountain has likely received more oversight than any project in history; is subject to external regulation by other federal agencies; and has been reviewed by national and international professional organizations. Site characterization information for Yucca Mountain was collected under quality assurance plans approved and accepted by the U.S. Nuclear Regulatory Commission. Four U.S. national laboratories and the U.S. Geological Survey collected most of the field data and interpreted the results. These laboratories commissioned independent reviews of their results, as did the DOE, often as formal independent peer reviews. Since the start of data collection for site characterization, the DOE has engaged in informal consultation with the Nuclear Regulatory Commission, as contemplated by the Nuclear Waste Policy Act. Also, the amendments to the Act in 1987 created the Nuclear Waste Technical Review Board, which provides reviews of the Project's technical work. The DOE cannot proceed to develop a repository without getting authorization from the Nuclear Regulatory Commission, and will be under constant scrutiny by Congress and other elected officials throughout the life of the project.

The DOE is following the path recommended by nearly all the world's organizations of nuclear waste experts. Among these groups are the United Nations' International Atomic Energy Agency and the Nuclear Energy Agency of the International Organization for Economic Cooperation and Development. In 2001, the National Research Council of the National Academy of Sciences noted that after four decades of study, geologic disposal remains the only scientifically and technically credible long-term solution available to meet the need for safety without reliance on active management.

In more than 20 years of study, the DOE's work on Yucca Mountain has likely received more oversight than any project in history. Oversight bodies include:

- **Nuclear Regulatory Commission**
- **Nuclear Waste Technical Review Board**
- **Government Accounting Office**
- **Department of Energy Inspector General**
- **Congress**
- **National and international professional organizations**

Q: *How can the DOE be certain that its calculations of events thousands of years in the future are accurate?*

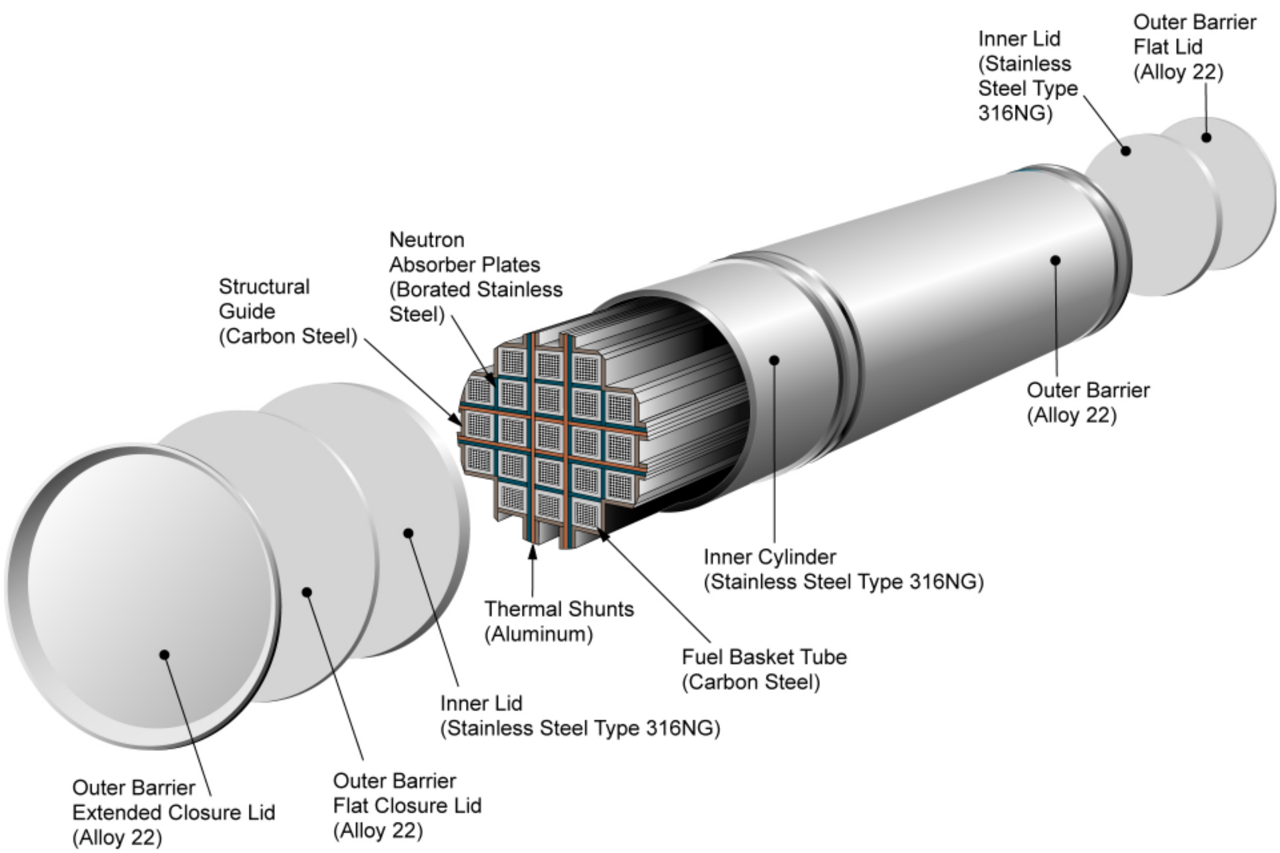
A: After more than 20 years of study, some of the nation's best scientists are confident in their understanding of the natural processes at Yucca Mountain and any changes to those processes that might result from waste disposal. The 10,000-year regulatory period is sufficiently long, however, that many people question how the DOE can be sure it understands the science well enough to be confident in using computer models to forecast what can happen that far into the future. Exactly that concern was a fundamental consideration as the regulations were being developed. For just this reason, the Environmental Protection Agency and the Nuclear Regulatory Commission require that the geologic repository rely on both the natural and engineered barriers. Having multiple barriers helps provide confidence that some uncertainty in an attribute of the performance of one barrier is acceptable, because other barriers are also acting to isolate the radionuclides.

Scientists base their projections of future performance on more than 20 years of tests and studies. Uncertainty is expected and treated in the regulations and multiple barriers are used to ensure safety.

Although the research has produced an extensive scientific record, ranging from thousands to millions of years into the past, this record is subject to interpretation and includes uncertainties. The rocks themselves are millions of years old, and are not expected to change in 10,000 years. Some parameters, however, such as climate, for example, will change. The DOE's calculations assume such changes will occur in the future. While it is not known exactly when climate will change, there is very good data about climate and rainfall, covering more than the past 40,000 years, derived in part from the ancient, preserved nests of pack rats found at Yucca Mountain. For the 10,000-year period, the models use the current climate for the next 400 to 600 years, and then the models switch to what are called monsoon and glacial transition climates, during which the precipitation is increased by about 2 times and the infiltration is increased by about 4 times. Scientists also run what are called sensitivity studies on these and many other numbers used in the models to find out what happens if they were wrong. With the climate models, for example, the scientists examine ranges of rainfall and infiltration numbers to see how varying the inputs affects their forecasts of releases of radionuclides.

By doing this, the performance assessment results examine the capability of the repository barriers to perform under a range of conditions representing both likely and unlikely future conditions. The analysts deliberately use combinations of parameters causing less favorable performance, in order to provide confidence the repository will perform well.

The regulations established by the Nuclear Regulatory Commission and the Environmental Protection Agency require an engineered barrier system in addition to the natural barriers provided by the geologic setting. The engineered system would be built to complement the natural system. Project scientists have an understanding of how the natural and engineered systems change over time, and how they interact, based on scientific principles, tests, and evaluation of natural analogues. To be sure that its calculations for the Total System Performance Assessment were appropriate and sound as an approach to supporting a site recommendation decision, the DOE asked for and received a peer review that reflects an international perspective on the adequacy of its performance assessment approach to support a site recommendation decision. The review panel found the work done by the DOE for the Site Recommendation to be competent, consistent with sound international practices, and



Waste packages use multiple layers of highly corrosion-resistant Alloy 22 and stainless steel, along with multiple welded lids, to provide confidence that water will be kept away from the solid waste forms contained inside. By way of comparison, waste package walls are about 20 times thicker than a propane tank wall.

appropriate for a site recommendation decision. They also observed many conservative aspects of the calculations.

Over the past several years, the Nuclear Waste Technical Review Board has stated that it is appropriate for decision makers to consider the full range of outcomes in performance assessment calculations, and has recommended additional performance assessment analyses to better understand uncertainties. In response, the full range of outcomes in performance assessment calculations, as well as the results of the additional performance assessment analyses to better understand uncertainties, have been examined.

There is a strong basis for confidence in the outcome of safety evaluations to support the Site Recommendation. Project scientists believe the majority of the important data and model inputs used in the Total System Performance Assessment accurately reflect the current state of knowledge, which is considerable. In other cases, the scientists used deliberately and demonstrably cautious estimates to accommodate those things that are not presently well known. The Nuclear Waste Technical Review Board, the Nuclear Regulatory Commission, and the DOE recognize that additional information will be collected before the Nuclear Regulatory Commission could issue a license to construct. Also, information will be collected during the entire time the repository is operational if it is constructed. The plans to collect this new information will be guided by oversight groups and will reflect how best to continue to reduce uncertainty. The nation can have confidence that safety will be assured because the entire repository development process will bring in the formal licensing requirements of the Nuclear Regulatory Commission. The Nuclear Regulatory Commission will thoroughly review, question, and oversee every scientific and engineering aspect of the repository, including the collection of additional information, for many decades to come.

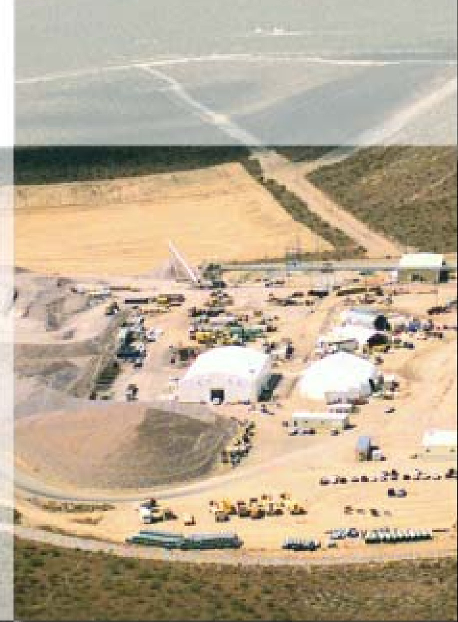
Q: *Will taxpayers subsidize large utilities for the disposal of high-level radioactive waste?*

No. Users of electricity generated by nuclear power pay a fee for disposal of the wastes from power generation.

A: The taxpayers are not subsidizing the utilities. The federal government's policy is that utilities' customers who receive the benefits of electricity generated by nuclear means should pay the costs of site characterization for the future disposal of commercial spent nuclear fuel, whether disposal occurs at Yucca Mountain or elsewhere. For wastes generated by the federal government, the federal budget pays the costs of site characterization and for the disposal of waste forms.

As required by the Nuclear Waste Policy Act, the consumers of electricity generated by commercial nuclear power plants pay a fee based on how much nuclear-generated power they use. This fee is 1.0 mil per kilowatt-hour of nuclear-generated electricity (i.e., one tenth of one cent per thousand watts supplied continuously for one hour). A kilowatt-hour is the amount of electricity required to run ten 100-watt light bulbs for one hour. The fees are then paid by the electric utilities into the Nuclear Waste Fund, held in account for the repository program by the U.S. Treasury. Each year Congress appropriates money from this fund for the repository program. If the program goes forward, the utilities' customers will continue to pay most of the costs of constructing, operating, and closing a repository. Costs associated with disposing of wastes generated by defense-related activities are covered by the federal budget.

The Nuclear Waste Policy Act required the DOE to have a repository or related facility sited, constructed, operational, and accepting commercial spent nuclear fuel by January 31, 1998. Because that deadline was not met, several electric utilities with nuclear power plants have sued the United States for breach of contract. The U.S. Court of Appeals for the District of Columbia Circuit has ruled that the DOE had an unconditional obligation, the reciprocal of the utilities' obligation to pay the prescribed fees, to begin spent fuel disposal by January 31, 1998.



Q: *Does the DOE plan to monitor the repository after its closure?*

A: The repository is designed such that it could be kept open for up to 100 years without precluding the capability of keeping it open for up to 300 years. Keeping the repository open means that the underground storage areas can be directly inspected and the waste packages readily retrieved, were that necessary. Thorough performance confirmation testing and monitoring will be performed during this operational period. In addition, the DOE must design and implement a postclosure monitoring program that complies with Nuclear Regulatory Commission regulations at 10 CFR Part 63. Before the DOE could close the repository, it would have to submit to the Nuclear Regulatory Commission an application to amend the license to permit the closure. The application would include, among other things, a description of the postclosure monitoring program.

The application also would describe the DOE's proposal for continued monitoring to prevent any activity that would pose an unreasonable risk of breaching the repository's engineered barriers, or that would increase the exposure to the public beyond the limits imposed by the Environmental Protection Agency and the Nuclear Regulatory Commission. In its application to close the repository, the DOE would define the details of this program. These requirements for a license amendment for closure, combined with the additional experience and knowledge gained during the intervening years, would allow the DOE to take full advantage of any new information, insights, or technologies that had developed since the start of repository operations.

Yes. Federal law requires the DOE to monitor the repository both before and after closure. Monitoring after closure of the repository will last for an indefinite period of time.

Q: *What alternative technologies might eliminate the need for a repository?*

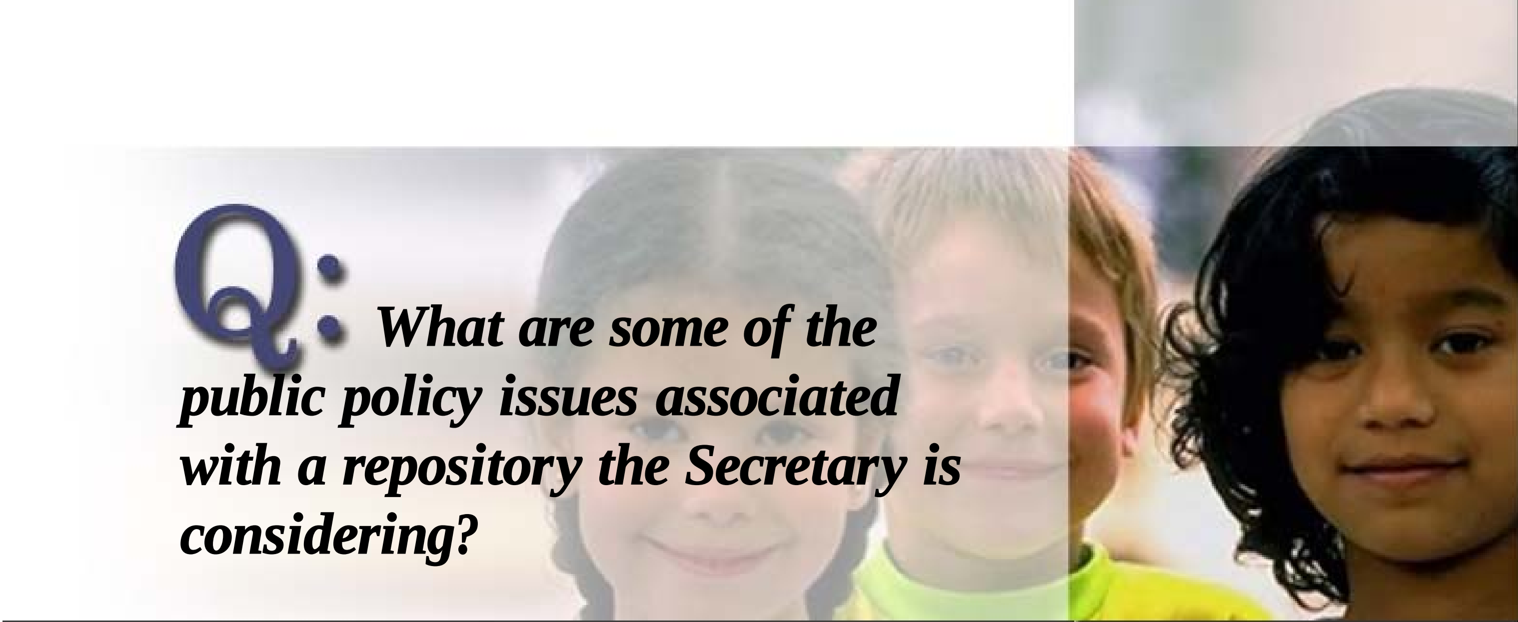
For the foreseeable future, there are no technologies that would eliminate the need for a repository. Options for the management of high-level wastes have been evaluated, but all produce high-level radioactive waste as byproducts that must themselves be disposed of in a repository to protect public health and safety.

A: Alternative technologies and options have been, and will continue to be, evaluated for the responsible management of high-level radioactive waste.

Many nations reprocess their spent nuclear fuel, which slightly reduces the volume of high-level radioactive waste. Liquid high-level radioactive waste, however, is a by-product of reprocessing. Prior to transport or disposal, this new amount of liquid waste must be vitrified, a process by which the waste is combined with sand and other materials and melted together to form a stable glass. This waste also must be disposed of in a repository to ensure the protection of public health and safety.

The DOE supports, and continues to fund, further research and development of accelerator transmutation of nuclear wastes, a process that could reduce the amount of long-half-life actinides (a type of radionuclide) in the commercial spent fuel. The high-level radioactive waste that is a by-product of this process also requires disposal in a repository to ensure the protection of public health and safety.

A repository at Yucca Mountain would centralize the disposal of high-level radioactive waste, while maintaining the option to retrieve it. With the waste retrievable, we preserve future generations' options to take advantage of alternative technologies, while protecting the health and safety of the public for thousands of years in the future.



Q: *What are some of the public policy issues associated with a repository the Secretary is considering?*

A: The relevant public policy issues all converge on safety and security. If Yucca Mountain is chosen as the repository site, it will enhance the safety and security of the high-level radioactive waste and spent nuclear fuel through disposal.

Protecting Public Health and Safety and Preserving the Quality of the Environment

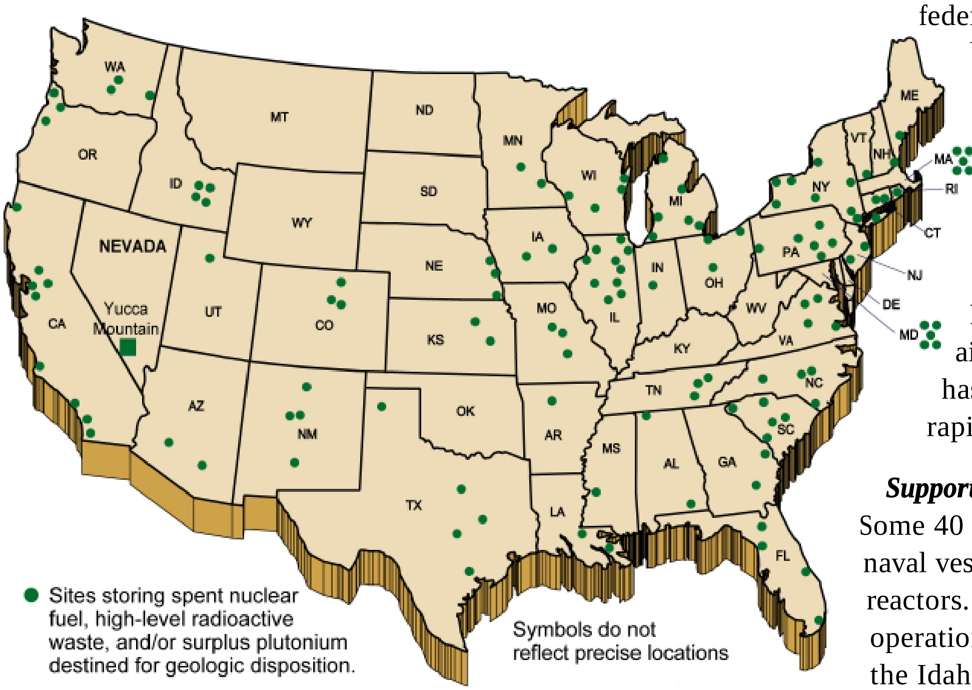
At present, spent nuclear fuel and high-level radioactive waste are temporarily stored in surface facilities at 131 locations in 39 states. It is clearly preferable to store wastes 1,000 feet underground, if it can be done safely. Most of the existing storage sites are near population centers, and because nuclear reactors require abundant water, most of these sites are also located near rivers, lakes, and seacoasts. Analyses indicate that these stored materials, if left where they are indefinitely, could become a serious hazard to nearby populations and the environment. If not perpetually maintained and safeguarded, this material could travel through groundwater and surface water runoff to rivers and streams that people use for domestic and agricultural purposes. Should this occur, 20 major waterways and all seacoasts could be adversely impacted. Currently, more than 30 million people are served by municipal water systems with intakes along the potentially affected portions of these waterways. Over the 10,000-year regulatory compliance period, without a geologic repository, trillions of dollars could be required to maintain facilities and thousands of lives would be impacted.

Local residents' safety and health and the environment are also protected. The Environmental Protection Agency and Nuclear Regulatory Commission regulations address the performance of a repository by setting radiation protection standards that protect the

The most compelling issue is the protection of the health and safety of millions of Americans in almost every state. In addition, a repository would also protect national security and support a balanced energy supply.

public, workers, and the environment. The DOE has evaluated the ability of the natural and engineered barrier systems to isolate radioactive materials from the environment. These studies and analyses indicate that the health and safety of all those individuals living in the vicinity of the repository would be protected.

Environmental cleanup of Cold War weapons facilities: The production of nuclear weapons during World War II and the Cold War resulted in a legacy of high-level radioactive waste and spent nuclear fuel that is currently stored in



Spent nuclear fuel and high-level radioactive wastes are currently stored in temporary facilities in 39 states

Washington, South Carolina, Colorado, and Idaho. Large volumes of high-level radioactive waste were created in the past when spent nuclear fuel was reprocessed to extract plutonium for weapons use. The high-level waste left over from that process exists in liquid and solid forms. Federal sites where this liquid waste has been stored, and in some instances has leaked from holding tanks, require varying degrees of remediation. The cleanup and decommissioning of the former weapons-production sites will require permanent disposal of all these materials.

Protecting the Nation

Protecting the nation from acts of terrorism: Fundamentally, deep geologic disposal of radioactive waste is safe from acts of sabotage or terrorism. No reasonably conceivable attack at the surface of a repository could have a significant impact on the high-level waste contained in very long-lasting metal containers some 1,000 feet underground in solid rock. In addition, the Yucca Mountain site is remotely located on federal land, with restricted access because of its proximity to the Nevada Test Site, where the United States has conducted over 800 nuclear weapons tests. Yucca Mountain is also surrounded on three sides by the Nellis Air Force Range, which has restricted airspace, and the site already has a highly trained and effective rapid-response security force.

Supporting the U.S. Navy nuclear fleet: Some 40 percent of the nation's large naval vessels are powered by nuclear reactors. Spent nuclear fuel from naval operations is currently being stored at the Idaho National Environmental and Engineering Laboratory, in temporary storage facilities, and is awaiting final disposal. This waste must be disposed of in order to maintain our naval capability, now and in the future.

Dismantling nuclear weapons: The end of the Cold War has brought the welcome challenge to our country of disposing of surplus weapons-grade plutonium. This could be used as mixed oxide fuel, which would then generate spent fuel, or immobilized material. The spent fuel or immobilized material would be secure in the geologic repository, where unauthorized removal would be very hard even if institutional controls were lost.

By permanently disposing of surplus nuclear weapons materials, the United States would encourage other nations to do the same.

Fuel from research reactors: The DOE has provided fuel for use in research reactors in both U.S. and foreign universities and laboratories. To support nuclear nonproliferation objectives, these research facilities are required to return the DOE-owned spent nuclear fuel. These spent fuels are being stored at the Savannah River Site, in South Carolina, and at the Idaho National Engineering and Environmental Laboratory, while awaiting disposal in a repository.

Providing support for America's balanced energy security

Roughly 20% of our country's electricity is generated from nuclear power. This means that, on average, each home, farm, factory, and business in America runs on nuclear fuel nearly five hours a day. If we continue to avoid resolving the nuclear waste question, sooner or later we will have to decide which five hours of electricity we are willing to do without.

Some existing facilities are limited in the amount of spent nuclear fuel they can store onsite. When the limits are reached, either new or additional storage space will have to be negotiated, or in some cases, these reactors may have no choice but to close down prematurely. Moreover, the costs for additional onsite dry spent fuel storage and security have been rising rapidly.

The U.S. Navy's aircraft carriers and submarines are powered by nuclear reactors, which produce waste that must be disposed of in a repository.

Nuclear arms reductions result in excess plutonium, which must be disposed of in a repository. Geologic disposal of defense waste protects the health and safety of the public, while keeping such material out of the reach of terrorists and rogue nations.

Q: *Why have the DOE's siting guidelines changed?*

The DOE changed its siting guidelines because these guidelines must be consistent with the EPA radiological protection standards and the Nuclear Regulatory Commission licensing requirements and approach.

A: In 1987 and 1992, Congress changed the law governing evaluation and selection of a repository site. This change required the Environmental Protection Agency and Nuclear Regulatory Commission to issue new regulations solely for Yucca Mountain, and those regulations became final in 2001. In concert with these changes, the DOE proposed new, Yucca Mountain-specific suitability guidelines in 1999. The DOE guidelines were finalized shortly after those of the Environmental Protection Agency and the Nuclear Regulatory Commission, in order to ensure their consistency.

Congress, and the Environmental Protection Agency and the Nuclear Regulatory Commission acting pursuant to congressional direction, have changed the regulatory framework in such a way that the prior suitability guidelines at 10 CFR part 960 no longer fit comfortably within that framework. In addition, the 1987 amendments to the Nuclear Waste Policy Act have eliminated any obligation on the DOE's part to make comparative judgments about sites in the course of making the suitability determination.

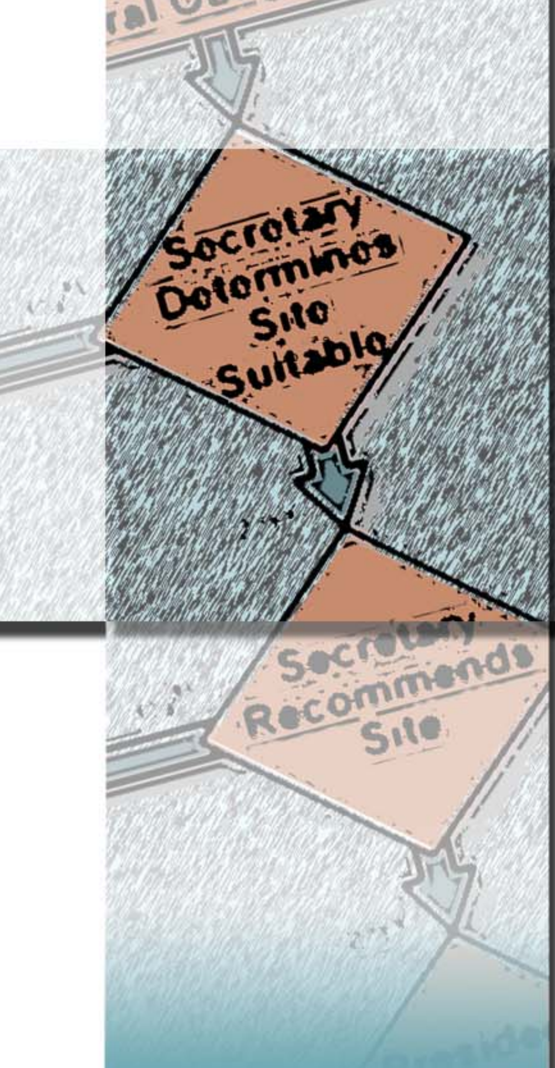
Accordingly, the DOE changed its siting guidelines to be consistent with this new framework. Indeed, it would have been impermissible and unreasonable not to have changed the prior guidelines that were based on out-of-date standards and licensing regulations. The revised guidelines, at 10 CFR 963, reflect the 1987 amendments' directive to DOE to focus on Yucca Mountain alone, the basic analysis for assessing repository performance recommended by the National Academy of Sciences, which differs from that embedded in the 1984 Guidelines, the adoption by the Environmental Protection Agency of Yucca Mountain specific radiological protection standards, as mandated by the Energy Policy Act of 1992, and the adoption by the Nuclear Regulatory Commission of new regulations for licensing repositories which, under the NWPA's structure, must define the areas and methodology of the DOE's inquiries into Yucca Mountain's suitability.

Q: *Where are the wastes that would be placed in a repository?*

A: The U.S. Navy's nuclear-powered vessels, the nation's past production and ongoing dismantlement of nuclear weapons, the commercial generation of 20 percent of the country's electricity, and many research and development activities produce high-level radioactive waste. These materials have accumulated since the mid-1940s and are currently located at 131 sites in 39 states in temporary surface storage facilities while awaiting final disposal. Most of these storage sites are near population centers, and because nuclear reactors require abundant water, most of the sites are also located near rivers, lakes, and seacoasts. In all, more than 161 million Americans reside within 75 miles of where radioactive wastes are stored, closer than the residents of Las Vegas are to Yucca Mountain.

As early as 1957, a National Academy of Sciences report to the Atomic Energy Commission suggested burying radioactive waste in geologic formations. In 2001, the National Research Council of the National Academy of Sciences noted that after four decades of study, ***geologic disposal remains the only scientifically and technically credible long-term solution available to meet safety needs*** without reliance on active management. It also offers security benefits because it would place fissile material out of reach of all but the most sophisticated weapons builders.

High-level radioactive waste and spent nuclear fuel from the use of nuclear materials to power naval vessels, make nuclear weapons, and produce electricity have accumulated since the mid-1940s. These materials are currently located at 131 sites in 39 states in temporary storage facilities awaiting final disposal.



Q: *What steps of the repository development process would follow a recommendation by the Secretary?*

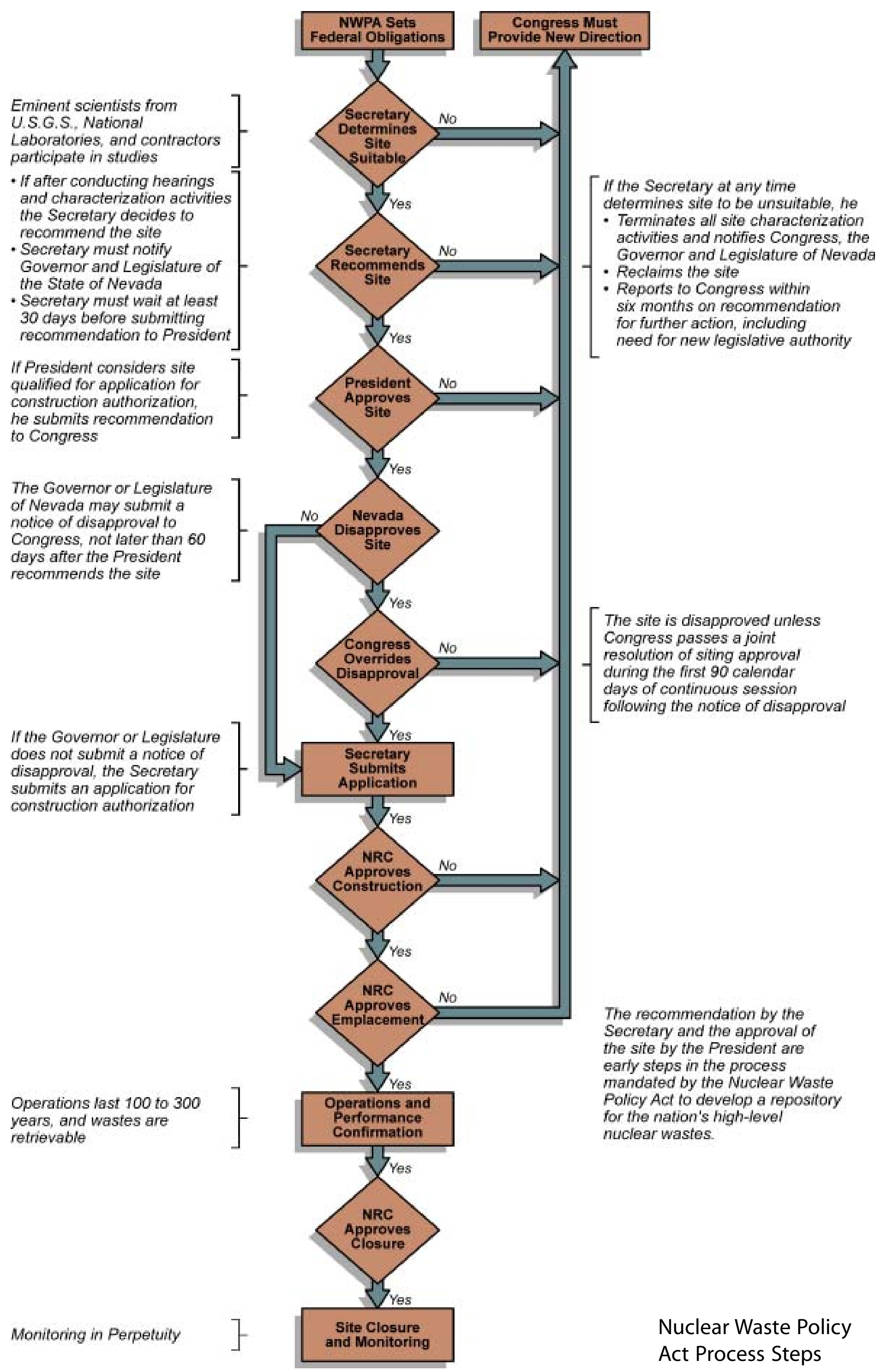
A: Following a recommendation by the Secretary, the President may recommend the Yucca Mountain site to Congress if he considers it qualified for application to the Nuclear Regulatory Commission for authorization to construct a repository. If the President submits a recommendation to Congress, he must also submit to Congress a copy of the statement of the basis for the Secretary's recommendation. Nevada has the right to disapprove any Presidential recommendation submitted to Congress, and if Nevada chooses to exercise its right, both houses of Congress must act affirmatively to accept the recommendation.

Steps in the repository siting and development process as required by the Nuclear Waste Policy Act are shown in the figure on the opposite page.

Any recommendation by the President would be an intermediate step in the process of developing a repository at Yucca Mountain. The political process determines ultimate acceptance of the Presidential recommendation. Construction or waste emplacement could begin, if and only if, the DOE submits a license application, goes through a multi-year review and public adjudicatory hearing process, and receives a construction authorization from the Nuclear Regulatory Commission. The Nuclear Regulatory Commission has the statutory responsibility to ensure that any repository constructed at Yucca Mountain would meet stringent safety standards. The hearings conducted by the Nuclear Regulatory Commission would be an extensive construction licensing proceeding, focusing on public health and safety. The Nuclear Regulatory Commission review process, including the hearings, is expected to take a minimum of three years after the DOE submits a license application. Opposing viewpoints will be heard in the proceeding, which will be conducted by an administrative court, not the DOE or the Nuclear Regulatory Commission. Following construction authorization, the DOE would have to complete initial construction, and apply for and receive a license from the Nuclear Regulatory Commission before any wastes could be received or emplaced.

confirmation program during the preclosure period. Operation of the repository would also be subject to congressional oversight and annual authorization through the budget process.

The DOE would be subject to Nuclear Regulatory Commission oversight throughout the construction and operation phases of the repository. The Nuclear Regulatory Commission would impose on the DOE certain conditions for operation, and requirements to collect data to ensure that the repository was functioning as described in the licensing documents. The DOE will continue to study important issues to ensure confidence in any decision to close the repository. For example, the Nuclear Regulatory Commission requires that the DOE implement a performance



Nuclear Waste Policy Act Process Steps

Q: *How can the DOE move forward with a site recommendation if there are a number of technical items yet to complete for the NRC?*

A: The Nuclear Regulatory Commission provided a sufficiency letter to the DOE on November 13, 2001, that concluded that existing and planned work, upon completion, would be sufficient to apply for a construction authorization. The agreed-upon course of action by the DOE and the Nuclear Regulatory Commission is intended to assist in the license application phase of the project, not site recommendation. In consultation with the Nuclear Regulatory Commission staff concerning ***licensing***, the DOE agreed it would obtain certain additional information relating to nine "key technical issues" to support a license application. To address these nine technical issues, the DOE agreed to undertake 293 activities that would resolve the issues to the Nuclear Regulatory Commission's satisfaction.

The Nuclear Regulatory Commission has never stated that this was work that the DOE needed to complete before ***site recommendation.*** To the contrary, in its letter to the DOE, which the Nuclear Waste Policy Act specifies the DOE must have in order to proceed with site recommendation, it listed ***all*** of these issues as "***closed pending.***" Closed pending means the Nuclear Regulatory Commission staff had confidence that the DOE's proposed approach, together with the agreement to provide additional information, acceptably addressed the Nuclear Regulatory Commission's issue such that no additional information beyond that provided or agreed to would likely be required for a license application.

Over one third of the necessary actions to fulfill the 293 agreements have been completed by the DOE and submitted to the Nuclear Regulatory Commission for review (of which, 23 agreements have been formally documented as "closed" by the Nuclear Regulatory Commission). The nature of the remaining work consists of documentation (improve technical positions and provide additional plans and procedures) and confirmation (enhance understanding with additional testing or analysis or additional corroboration of data or models). The DOE believes, based on its existing suite of site recommendation documentation and analyses, that the potential impacts of the additional work will not affect the conclusion on whether the site is likely to meet the radiation protection standards.

The Nuclear Regulatory Commission provided a "sufficiency letter" to the DOE on November 13, 2001, describing the sufficiency of information for inclusion in a license application, as required by the Nuclear Waste Policy Act.

U.S. Department of Energy
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