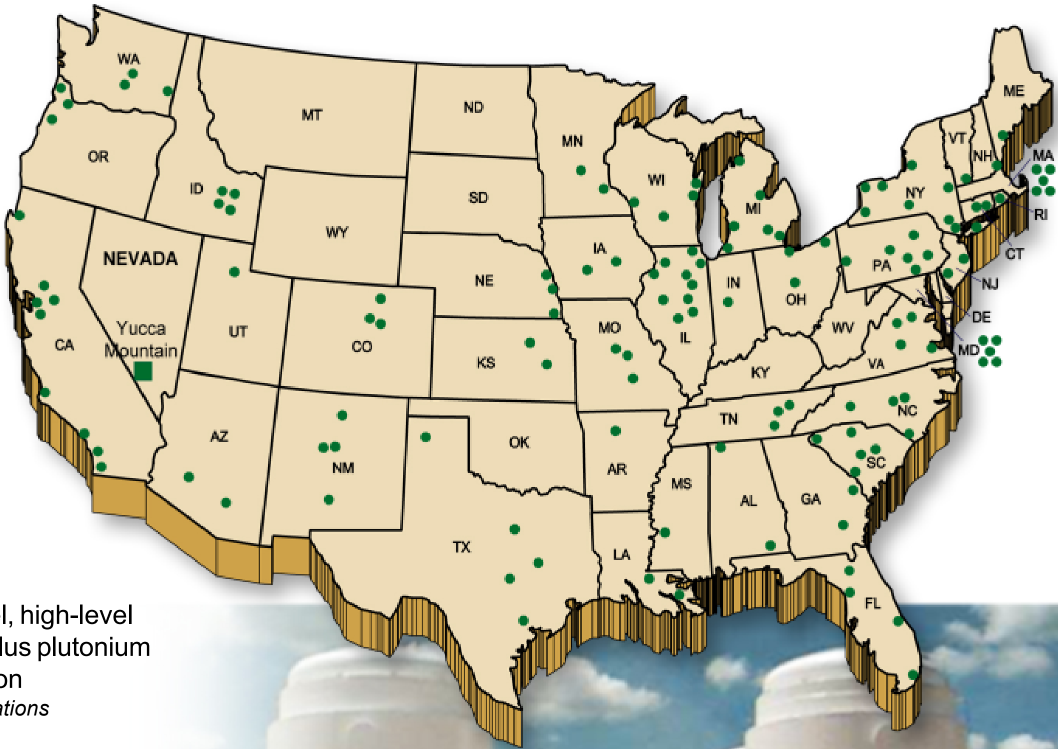
Why Yucca Mountain?

U.S. Department of Energy

Waste has been accumulating

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 our country's electricity, and many research and development activities produce high-level radioactive waste. These radioactive materials have accumulated since the mid-1940s and are currently stored in temporary facilities at some 131 sites in 39 states.



● Sites storing spent nuclear fuel, high-level radioactive waste, and/or surplus plutonium destined for geologic disposition

Symbols do not reflect precise locations

Leaving it where it is could have adverse impacts

Commercial spent nuclear fuel is currently stored in cooling pools or dry casks designed for relatively short lifespans. Most of these temporary storage sites are near large population centers, and because nuclear reactors require abundant water, they are also near rivers, lakes, and seacoasts. If not maintained and safeguarded, this material could seep into groundwater and travel in storm and snowmelt runoff into the nearby bodies of water. Should this occur, all U.S. coastlines could suffer negative consequences, affecting millions of Americans. Moreover, at least 20 major waterways currently supplying household water for more than 30 million Americans could be impacted. In all, more than 161 million Americans reside within 75 miles of where spent nuclear fuel and high-level radioactive waste are stored, closer than the residents of Las Vegas are to Yucca Mountain.

1956 — National Academy of Sciences evaluates land disposal of radioactive waste

1960–1970 — U.S. Atomic Energy Commission, Energy Research Development Administration, and DOE continue to evaluate options for nuclear waste management

1982 — Congress passes Nuclear Waste Policy Act that establishes a comprehensive policy for nuclear waste disposal

1987 — Congress amends the Nuclear Waste Policy Act and directs the Secretary to characterize only one site: Yucca Mountain

1992 — Congress passed the Energy Policy Act that directed the EPA to set Yucca Mountain specific standards

Congress created a legal obligation

In 1982 Congress acted to establish a comprehensive federal policy to resolve the national problem of what to do with wastes from nuclear reactors and defense facilities. The policy centers on deep geologic disposal of high-level radioactive waste.

In passing the Nuclear Waste Policy Act, Congress assigned the primary responsibility for implementing this national policy to the Department of Energy. Congress also identified specific actions to be undertaken by the Secretary of Energy in characterizing a site and deciding whether to recommend approval of the site to the President. In 1987, Congress directed that only Yucca Mountain be characterized for potential use as a repository. The United States is following the open, orderly, and legally specified process of the Nuclear Waste Policy Act toward a decision on whether Yucca Mountain is a suitable site for a repository and, if so, whether to apply for authorization to construct.

Why Yucca Mountain?

There is a worldwide consensus that deep geologic disposal, the approach being followed by the United States, is the only scientifically credible, long-term solution for managing high-level radioactive waste. For more than 20 years, many of our nation's top scientists and engineers have studied Yucca Mountain in Nevada to determine if this arid site would be a suitable location for development of the nation's first repository for the geologic disposal of high-level radioactive waste. They have concluded that a repository at Yucca Mountain would protect public health and safety; preserve the quality of the environment; allow the environmental cleanup of Cold War weapons facilities; protect the nation from acts of terrorism; and support a sound energy policy.

Allowing the 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 Washington, South Carolina, 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, including solidified liquid waste.

Protecting the nation

Deep geologic disposal will safeguard radioactive waste from deliberate 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 robust metal containers some 1,000 feet underground. In addition, the Yucca Mountain site is remotely located on federal land, with restricted access, and adjacent to the Nevada Test Site. At the Nevada Test Site the United States has conducted over 800 nuclear weapon tests. The test site has a highly trained and effective rapid-response security force and is surrounded on three sides by the Nellis Air Force Range, all with restricted air space.

Many of our nation's large naval vessels are powered by nuclear reactors that generate a small but strategic amount of spent nuclear fuel. The waste from naval operations is currently being stored at the Idaho National Environmental and Engineering Laboratory while awaiting final disposal. This waste must be disposed of in order to maintain our naval vigilance, now and in the future.

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

The end of the Cold War has brought the welcome challenge of disposing of approximately 50 metric tons of surplus weapons-usable plutonium. Nuclear materials would be secure in a closed and sealed geologic repository where unauthorized removal would be virtually impossible. By permanently disposing of its own surplus nuclear materials, the United States would encourage other nations to do the same.

Providing support to a sound energy policy

Preserving the capabilities to generate electric power using nuclear energy is important to a balanced energy policy. Not only does nuclear power decrease our dependence on foreign oil, but it also keeps the price of other energy alternatives low. The preservation of energy options will not be possible without permanent disposal of the spent nuclear fuel.

As utilities have moved more and more spent fuel out of crowded cooling pools into outside, aboveground storage casks, the amounts of spent fuel stored onsite are rapidly approaching limits agreed upon between utilities and state governing bodies. When these limits are reached, new or additional storage will have to be renegotiated. In some cases, the reactors may have no option but to close down prematurely, and consumers will have to pay the increased costs of replacement power. Moreover, the costs for additional onsite dry storage have been rising rapidly.

How do we know it's safe?

The natural barriers work in concert with additional man-made barriers to isolate waste from the accessible environment for tens of thousands of years. Scientists have identified five key attributes that are important to long-term performance within the Yucca Mountain disposal system:

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 mean annual precipitation of about 12.5 inches. Little of this precipitation percolates 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 and nonwelded volcanic tuff: welded tuff at the surface, welded tuff at the level of the repository, and layers of nonwelded tuffs above and below the level of the repository. 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, water in small fractures has a tendency to remain in the fractures rather than flow into larger openings, such as tunnels.

Long-lived waste package and drip shield

The DOE has designed a titanium drip shield and a waste container to work in concert with the natural barriers in the mountain. The drip shield and Alloy 22 outer barrier of the waste package would be expected to have long lifetimes in the repository environment. Alloy 22, the outer barrier material of the waste package, is very corrosion-resistant, with general corrosion expected to penetrate only about 0.03 inches of this outer layer of material in 10,000 years. The Titanium Grade 7 is also corrosion-resistant, with general corrosion expected to penetrate only about 0.08 inches, of the 0.6 inches, in 10,000 years. Only about 1 percent of the waste packages are projected to lose 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. Even if water were to penetrate a waste package, several characteristics of the waste forms and the natural character of the repository rocks and water would limit radionuclide releases. In the early periods after closure, because of the warm temperatures, much of the water that penetrates the waste package will evaporate. The solid waste forms will not dissolve rapidly in the water expected in the repository environment. In addition, crushed tuff, which would be placed under the waste package and support pallet, would also delay the movement of radionuclides.

Delay and dilution of radionuclide concentrations by the natural barriers

Eventually, the engineered barrier systems could suffer some loss of integrity, and small amounts of water could contact waste, dissolve it, and carry some radionuclides out of the repository and into the rock below. The repository level is in the unsaturated zone, where the microscopic holes in the rock are only partially filled with water. The water table lies, on average, 1,000 feet below the repository level. At the proposed repository level, the host rock is fractured, and these fractures provide the main pathways for water and radionuclide transport through this zone. As water flows through fractures, dissolved radionuclides would diffuse into and out of the pores in the rock, increasing both the time it takes for radionuclides to move from the repository and the likelihood that they will be exposed to sorbing minerals (minerals that attract and hold them).

Rock units in both the unsaturated zone and the saturated zone at Yucca Mountain contain minerals called zeolites that work like activated charcoal to adsorb and delay many radionuclides. The

degree of delay introduced by the saturated zone differs greatly for various radionuclides, depending on their capacity to sorb onto mineral surfaces and colloids (very small particles of clay or other material). Strongly sorbing radionuclide species have transport times that range from tens of thousands to millions of years, and do not significantly contribute to calculated doses during the 10,000-year period of regulatory compliance. In contrast, nonsorbing and weakly sorbing radionuclides have the potential to be carried to the accessible environment by groundwater thousands of years in the future—when the waste package and the waste forms have lost their integrity.

Flow paths from beneath the repository are generally southerly toward the Amargosa Desert. Radionuclide migration through the saturated zone results in dilution and reduced radionuclide concentrations in groundwater. Additionally, the water in the Amargosa Desert is in an isolated hydrologic basin that does not connect to any lakes or rivers that discharge into the ocean.

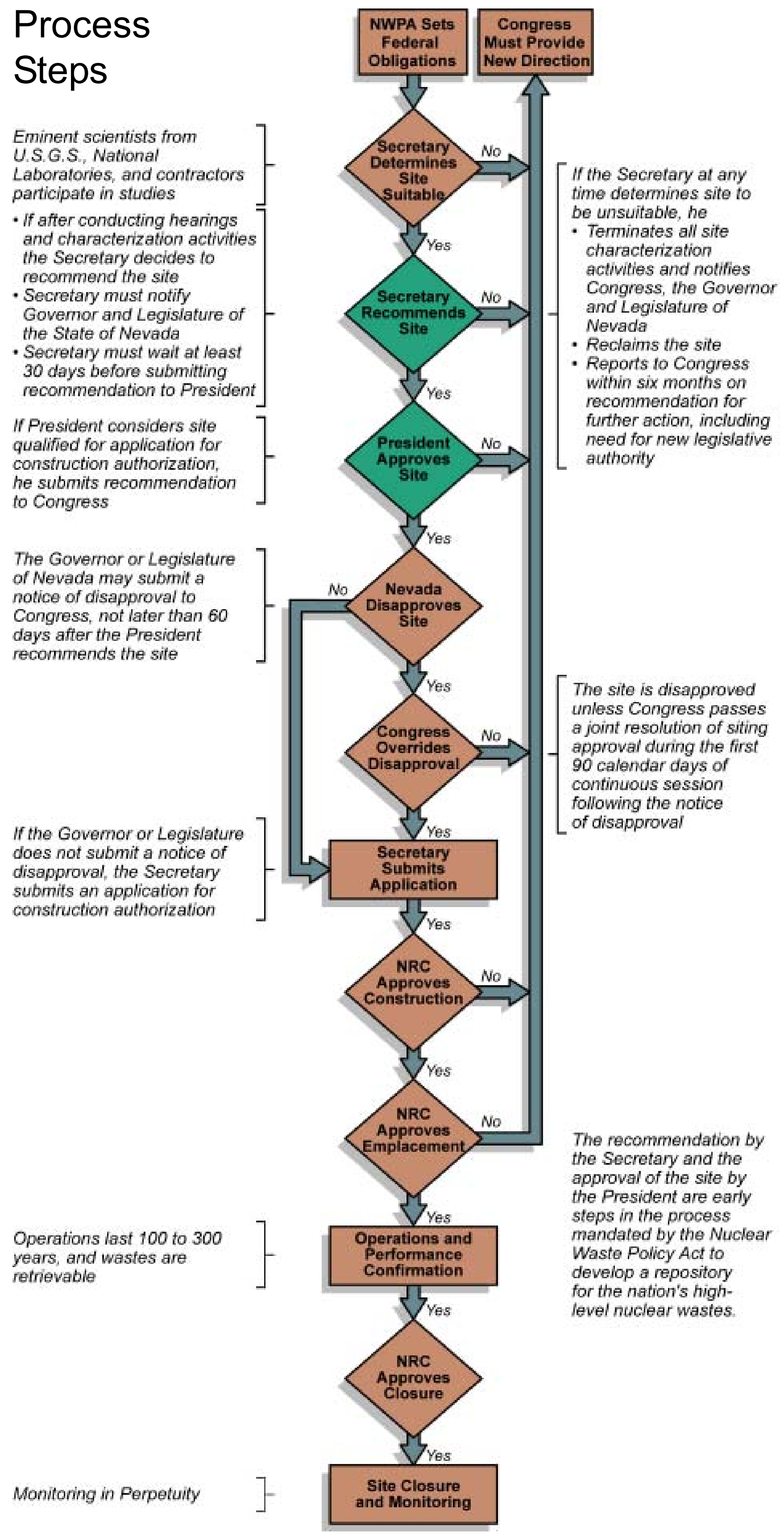
Low mean annual dose considering potentially disruptive events

Yucca Mountain provides an environment in which hydrogeologic conditions important to waste isolation (e.g., a thick unsaturated zone with low rates of water movement) have changed little, if at all, for millions of years. The DOE considered three specific disruptive processes and events (i.e., volcanism, ground motion from seismic events, and nuclear criticality) that could impact the performance of a repository at Yucca Mountain.

Of the three, volcanism resulted in a low but calculable dose during the regulatory period. The likelihood of the repository being disrupted by a volcano is extremely small (about 1 chance in 70 million per year) and the estimated probability weighted dose would be less than one percent of the NRC and EPA radiation protection standards. The NRC requires all nuclear facilities to withstand expected natural phenomena like earthquakes. Criticality was found to have such a low likelihood that it is not necessary to consider further according to regulations.

What is next?

NWPA Process Steps



"The demanding plans for Yucca Mountain are motivated by a sense of responsibility to future generations. . . . The fundamental goal should be to pass on a world in which each succeeding generation has the opportunity for a quality of life that is as good or better than that enjoyed by the preceding generation. . . . Important enabling factors include an environment that is stable or improving, ample material and cultural resources, and continued technical and scientific abilities."

– David Bodansky,
Professor Emeritus of Physics
University of Washington

"We believe that the scientific studies conducted to date show that Yucca Mountain is a suitable site for the isolation of radioactive waste, with significant performance contributions expected from multiple redundant barriers in both natural and engineered systems. . . .

It is my considered opinion and that of my staff that the Yucca Mountain site is suitable for recommendation as the nation's first geologic repository."

– Charles V. Shank, Director
Lawrence Berkeley National Laboratory
September 2001

"After four decades of study, geological disposal remains the only scientifically and technically credible long-term solution available to meet the need for safety without reliance on active management. It also offers security benefits because it would place fissile materials out of reach of all but the most sophisticated weapons builders."

– National Academy of Sciences, 2000

"The conclusion drawn from these studies is that geologic disposal remains the only long-term approach for dealing with long-lived radioactive waste. Further, the USGS believes that the scientific work performed to date supports a decision to recommend Yucca Mountain for development as a nuclear waste repository."

– Charles G. Groat, Director
U.S. Geological Survey
October 2001

"I have been in the hardware and construction supply business for over 30 years and have had to live by this common business principle: when you make an obligation, you honor it or you face consequences. Since the Nuclear Waste Policy Act set the policy that the disposal of the Nation's high-level radioactive waste must be the Government's responsibility, the utilities can hardly switch to another removal agent."

– Honorable Lauren "Bubba" McDonald, Jr.,
Commissioner Georgia Public Service
Commission on behalf of NARUC

Doing nothing is not an option

The United States currently has about 47,500 metric tons of spent nuclear fuel (45,000 from commercial power reactors and 2,500 from defense reactors). In addition, DOE is currently processing over 100 million gallons of liquid high-level radioactive waste from defense activities and stabilizing it into borosilicate glass. By 2040 this nation could generate almost 108,000 metric tons of spent nuclear fuel and more than 22,000 canisters of high-level radioactive waste glass. This waste must be properly managed to prevent adverse impacts to the health and safety of millions of Americans and to the environment.

In the aftermath of the tragic events of September 11, the DOE, along with other federal agencies, is continuing to assess measures that could be taken to minimize the risk or consequences of radiological sabotage or terrorist attacks against our nation's nuclear facilities and spent nuclear fuel shipments. Deep geologic disposal of spent nuclear fuel and high-level radioactive waste provides optimal security by emplacing the material so far underground that it would provide protection from both inadvertent and intentional human intrusion, including potential terrorist activities.

Our obligation to future generations

The Nuclear Waste Policy Act requires that the generators and owners of the high-level radioactive waste be responsible for disposing of such waste. This requirement derives from the conviction that the generations receiving the benefits of nuclear power are also responsible for the disposal of the waste. It is widely believed that future generations should not bear these burdens when the means for safe disposal are available to this generation.

We as a nation must also preserve the flexibility for future generations to make the final decisions on whether to close the repository or retrieve the waste to reclaim its energy value or take advantage of future technology.

U.S. Department of Energy
Office of Public Affairs

1000 Independence Ave. SW
Washington, DC 20585
http://www.energy.gov