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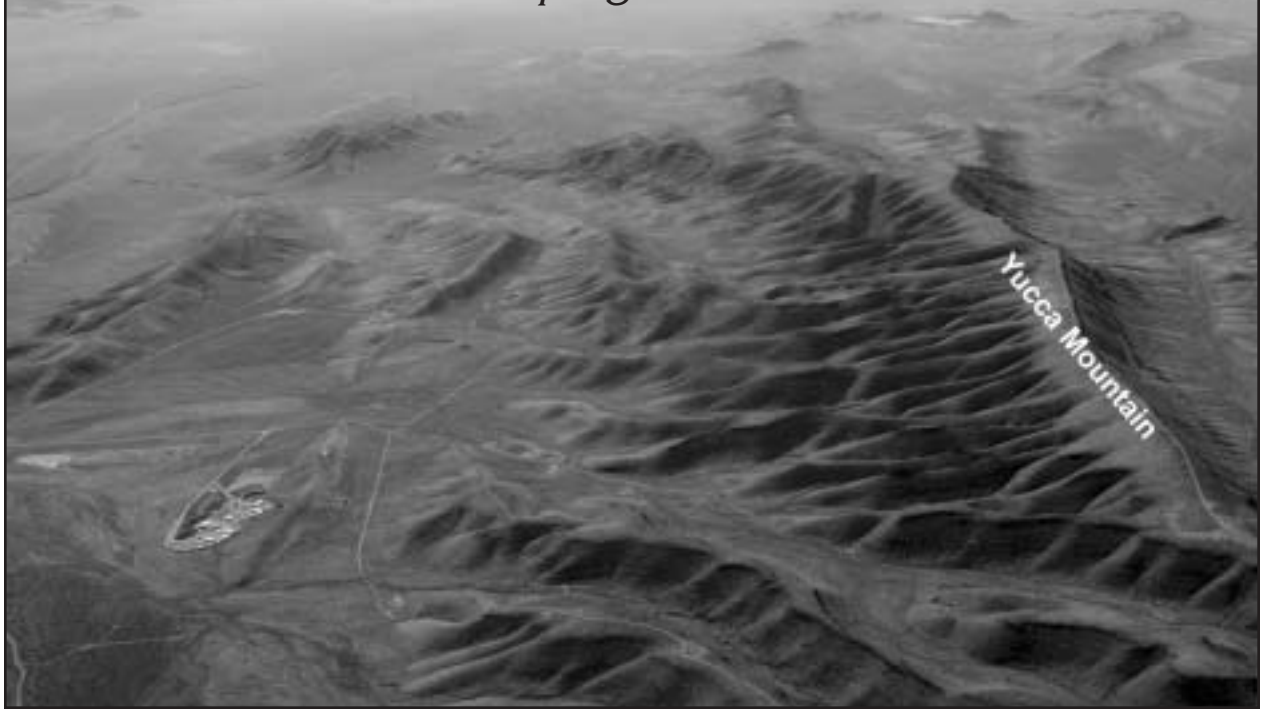


Aerial view of Yucca Mountain.

What's Next for Yucca Mountain?

By Richard G. Telfer

Congressional approval supporting the president's recommendation for Yucca Mountain to become the nation's first repository for spent nuclear fuel and high-level radioactive waste changed everything, and it changed nothing. For the U.S. Department of Energy's Office of Civilian Radioactive Waste Management (OCRWM), which oversees the Yucca Mountain project, the focus of studies and work now shifts to the license application. For the state of Nevada, however, which has strongly opposed this project for some 20 years, the effort to undermine the program is alive and well—and though changing tacks, perhaps getting stronger. Thus for both sides, the work continues, but the work is changing.

On the DOE Side

Over the past 20 years of characterization work, the DOE has completed the following projects:

- A 5-mile-long, 25-foot-diameter tunnel.
- Experimental exploratory shafts extending from the main tunnel.
- Tests to study the effect of heat on the rock over extended periods of time, the evidence of the existence of water—in the present or past—and core sampling of the various rock formations.
- Evaluation studies to determine the best equipment for boring tunnels that will house the waste.

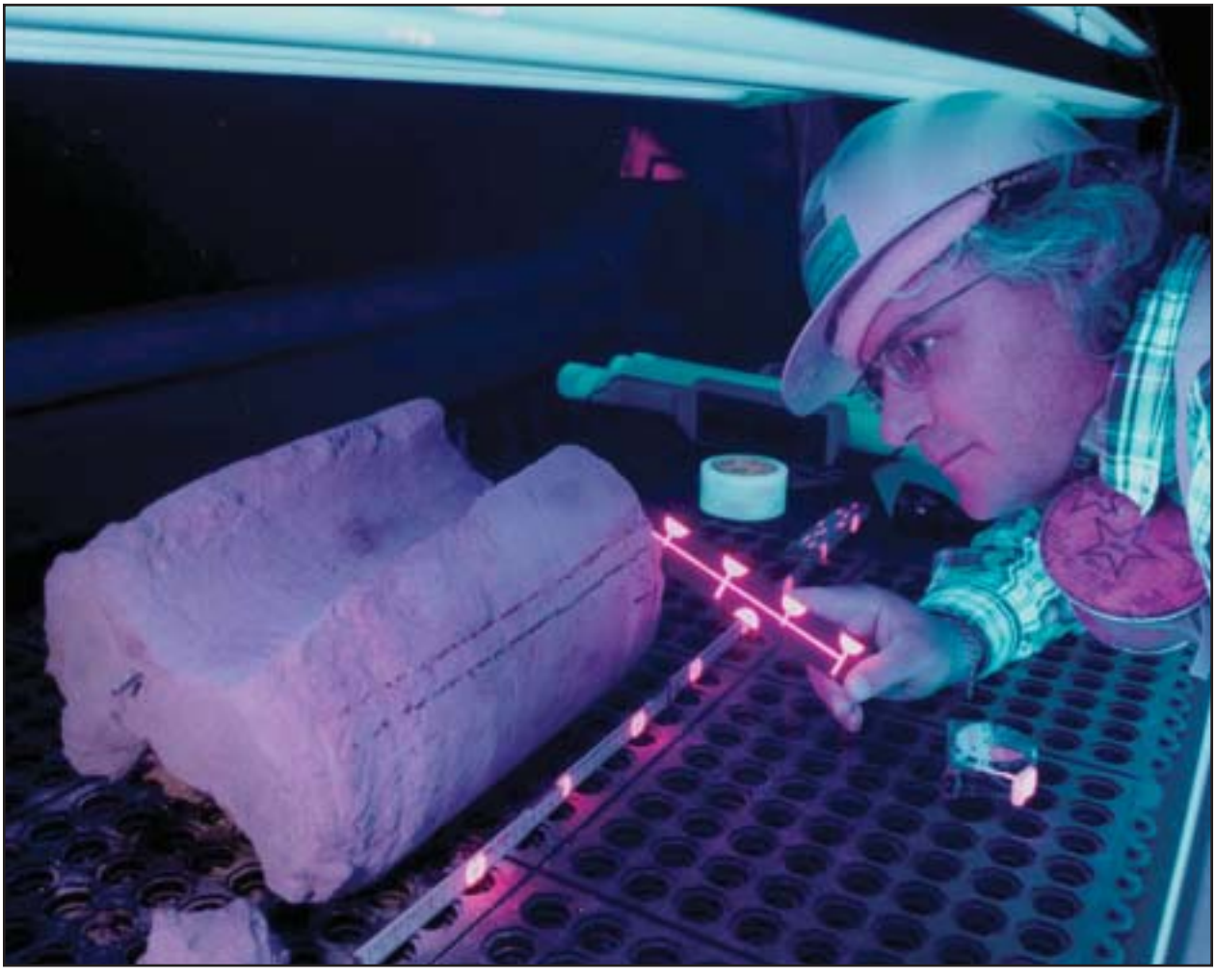
Scientists and engineers, employing computer models,

have been able to evaluate how waste packages, once in place, will be affected by the natural internal environment of the mountain. Countless other such studies have focused on every possible scenario that could take place deep within the repository area.

A facility onsite houses hundreds of core samples taken from the mountain. These continue to provide scientists with important information regarding specific areas for the safe storage of containers. These samples have provided data about many issues facing the geologists, including volcanic and seismic events in the region that span many years and that might have an effect on the safety of the site. The core samples are catalogued like books in a library for easy access to further investigation.

But site characterization testing has been winding down during the last several years and was completed in February. Now, according to OCRWM Director Margaret Chu, the DOE is undergoing a "cultural sea change" as it shifts its focus from two decades of scientific research to the licensing phase. The next task is the work that must be done to obtain a license from the U.S. Nuclear Regulatory Commission to operate the repository. Expected to take some three years to complete, the task involves examining every possible aspect of the mountain: physical properties, engineering design, safeguards, storage container design, and reliability, to name but a few. To provide guidance for this monumental task,

Location of Yucca Mountain, Nevada.



A scientist uses ultraviolet light to study how fluids move through rock.

The tunnel-boring machine reached daylight in April 1997.

the NRC released the *Yucca Mountain Review Plan* in March 2002. This 431-page plan spells out in detail what areas are to be studied, what tests must be conducted, what range of results are acceptable, and how tests are to be run and measured. A list of some of the scientific tests that will be conducted during the licensing phase can be found in the sidebar on pp. 44–45.

According to Chu, the DOE will be working "feverishly" to keep to the schedule of obtaining a license by 2007 and opening the repository by 2010. Chu, speaking before the National Academy of Sciences, said the DOE plans to use a modular approach to constructing the repository, so that high-level waste and spent fuel can start to be shipped to the site before construction is complete. Chu even gave some intriguing details, noting for the first time, for example, that the DOE plans to ship 400 metric tons of waste to Yucca Mountain in 2010, 600 metric tons in 2011, and 1200 metric tons in 2012.

Meanwhile . . . the State Protests

Even before the presidential recommendation and the subsequent congressional debate, Nevada Gov. Kenny Guinn had been pleading with the public to send at least a dollar to the State Nuclear Projects Agency to help cover the cost of the campaign against Yucca Mountain. Nevada has spent millions of dollars, both statewide and nationally, in its attempt to swing public opinion against the repository.

Now, in the wake of the congressional approval, Nevada is concentrating on the courts. The state has hired a le-

Proposed DOE Timetable for Licensing, Construction, and Operation

Certify Licensing Support Network	June 2004
U.S. Department of Energy to submit license application for construction authorization	December 2004
U.S. Nuclear Regulatory Commission to complete review, issue construction authorization	2008
Initial construction	2008–10
DOE to submit license application amendment to receive and possess	2008
NRC to complete review and issue license to receive and possess	2010
DOE to start repository operations	2010

Getting to Know the Mountain

- Located in Nye County, Nev., some 100 miles from Las Vegas and east of Death Valley, Calif.
- Protected from intrusion by state and federal lands (it lies adjacent to the underground weapons testing area at the Nevada Test Site).
- Composed of large concentrations of welded tuff.
- Situated in an arid high-desert climate.
- Near sites showing evidence of old volcanic activities present in the area.
- Jarred by earthquakes in the area now and then.
- Receives from 6 to 7 inches of rain annually, most of which evaporates almost immediately upon hitting the external surface areas of the mountain—a factor contributing to the site selection.
- The repository area is 1000 feet above the water table and about the same distance from the top of the mountain.

gal team headed by attorney Joseph Egan, of McLean, Va. Egan, who is also a nuclear engineer, spoke at a news briefing in Las Vegas on July 24. He was quoted in the *Las Vegas Review-Journal* as saying, "It's my opinion this project will collapse under its own ill-begotten design."

Lawsuits already on file against the Yucca Mountain project are aimed at, in addition to the DOE, the U.S. Environmental Protection Agency and the NRC. These include the following:

- A challenge to the EPA's radiation standards.
- Three challenges to the validity of the Yucca Mountain Site Guidelines (which by congressional mandate have already undergone revision).
- A challenge to the DOE's Environmental Impact Statement.

The state is also attempt-

On January 14, 2002, the Yucca Mountain project turned off the electrical heaters on the drift scale test. This completed the initial four-year phase of the test.

Continued Testing at Yucca Mountain

As the Yucca Mountain project enters the licensing phase, many scientific tests will continue as part of a performance confirmation program. These ongoing tests will help reduce uncertainties and provide additional assurance that a repository constructed at the Yucca Mountain site would be safe for workers, the public, and the environment. Following are examples of some of the ongoing test areas (*Source: U.S. Department of Energy*):

Chlorine-36 Validation: These are ongoing chemistry studies at two locations in the Exploratory Studies Facility to look for fast pathways in the flow system. The work is intended to provide a technical basis for the assessment that bomb-pulse chlorine-36 data below the Paintbrush tuff can be linked to a negligible amount of fast-flowing water.

Evaluation of Earthquakes: Earthquakes of potential significance are evaluated for potential impacts on proposed repository facilities.

U.S. Bureau of Reclamation (USBR) Lithophysal/ Fracture Studies: The U.S. Geological Survey and the gather detailed data about the abundance and character of lithophysae (air pockets) from the lower lithophysal zone of the Topopah Spring tuff.

Cross Drift Bulkhead, Periodic Entry to Observe and Test Conditions: The [Enhanced Characterization of the Repository Block] Cross Drift has been blocked off to gather data that will help evaluate flow and seepage processes in repository host rocks and Solitario Canyon fault zones.

Seepage Testing Update, Niche 5 and Systematic Hydrologic Characterization: Work at Niche 5 in the Cross Drift uses active testing and passive monitoring in the niche and surrounding rocks to quantify moisture movement around and seepage into drifts constructed in the lower lithophysal zone of the Tonopah Spring welded tuff.

Alcove 8-Niche 3 Seepage Studies: Infiltration and tracer tests are performed at the crossover location where Alcove 8 in the Cross Drift is located about 20 meters directly above Niche 3 in the Main Drift.

Active Fracture Model Block: A cubic meter block of the Topopah Spring lower lithophysal unit will be excavated to do laboratory flow testing aimed at validating the Active Fracture Model the project uses to describe subsurface fracture flow in the welded units. A second phase of the test will employ tracers to obtain transport data for the Unsaturated Zone Flow and Transport Model.

Drift-Scale Heater Test: This is a continuing test designed to approximate the heat from waste packages in a repository emplacement drift.

Busted Butte: This large unsaturated zone transport test was composed of several phases in which tracers were injected into the test bed through boreholes and the resulting tracer migration monitored and analyzed. These activities served to better define parameters used in Unsaturated Zone transport modeling and to validate laboratory data on radionuclide migration.

Atomic Energy of Canada Ltd. (AECL) Blocks: Two-cubic-meter blocks collected from Busted Butte are being testing by AECL for use in transport modeling.

Saturated Zone, Cooperative Work with Nye County: The Nye County Early Warning Drilling Program has drilled and tested a number of boreholes in the area south (downgradient) from Yucca Mountain. Data from these tests will help reduce uncertainties in this portion of the groundwater flow system, and the data is being added to the Saturated Zone Flow and Transport Model. Plans are to drill additional boreholes during the next several years.

Rock Properties Testing: Coring of large boreholes and slot tests in the Exploratory Studies Facility and Cross Drift are conducted to determine mechanical properties of the different stratigraphic layers of the rock where the proposed repository would be built.

Thermal Conductivity Testing: Several field thermal conductivity tests are conducted where the proposed repository would be built. By doing these tests in the field, the ambient moisture content, rock porosity, fractures, and lithophysal porosity (air pockets in the volcanic rock) are all accounted for.

Natural Convection Testing, Final Testing: Two natural convection tests, one at 25 percent and one at 44 percent full scale, are conducted at the DOE Losee Road facility in North Las Vegas. These tests are intended to help with validation of computer models of natural convection heat transfer that will occur after the repository is closed and forced ventilation has ended.

ing to prevent the federal government from using State of Nevada groundwater for construction and operational activities of the facility; a temporary restraining order has already prohibited the DOE from such use at the Yucca site.

Also on the legal team is an authority on states' rights and constitutional matters from Washington, D.C., and a former solicitor of the NRC. The legal team is gearing up to challenge three federal agency decisions over "states' rights and flawed science issues." The group will also defend Nevada in a suit over water rights for the construction and operation of the repository. Another suit may be filed, according to Egan, "when" (note, not "if") the DOE misses the deadline for filing a licensing application with the NRC. The Nevada attorney general, who has been opposed to the project from the very beginning, said she believes the state will win its battles in court and that Yucca Mountain will never serve as a waste repository.

On January 7, 2002, Secretary of Energy Spencer Abraham visited the facilities at Yucca Mountain.

Las Vegas and Clark County

Although neither the city of Las Vegas nor Clark County is located anywhere near the site, both have joined in the legal action against the establishment of the repository. Clark County has already contributed $2.5 million to the legal battle. Earlier the county developed an impact assessment report, which discussed how the repository would affect the gaming industry and property values. Since Nevada has no state income tax—one of the reasons for the massive influx of new residents each year—monies for operating the state are derived

Breached Waste Package/Drip Shield Testing: Data from these tests will be used to validate models used to predict the probability that water (that seeps into a drift) will penetrate one or more breaches in the drip shield or waste package.

Waste Form Testing: Testing consists of lab work to improve the understanding of spent fuel and radionuclide mobilization performance and a lab testing program to obtain the mechanistic and kinetic response of the various waste forms (commercial and DOE) to dissolution when exposed to a variety of water chemistries and to dry and moist air oxidation.

Waste Package Corrosion Studies: Testing in this area will provide information on the performance of the construction materials of the waste package and the drip shield.

Unsaturated Zone Process Modeling: Several areas of the Unsaturated Zone F&T Model are refined to incorporate the latest hydrologic and transport data from the underground testing program.

Saturated Zone Process Modeling: The Saturated Zone Model is refined and expanded in the following areas: geochemical constraints on groundwater flow directions, mixing of Saturated Zone waters, boundary conditions, water levels, and system recharge.

Coupled Processes Process Modeling: This is an evaluation of coupled processes and modeling predictions regarding the behavior of the rock under thermal perturbation.

Engineered Barrier System Process Modeling: This continuing modeling effort is for the evaluation of the in-drift environment.

Abstraction of Process Models into the Total System Performance Assessment (TSPA): The various process models that contribute to the assessment of the combined natural and engineered systems are too complex to be simultaneously put into the performance assessment model. Consequently, only those aspects of the individual process models that contribute significantly to the potential dose are considered in the TSPA.

TSPA:The TSPA is an overarching model that takes input from the various components of the natural and engineered systems and produces multiple realizations of the predicted performance of the site under a range of conditions.

from the property tax, sales tax, and the gaming tax. The impact assessment projected potential revenue losses in all three tax receipt areas should the repository become a reality. Many in the community, having read or heard of the contents of the 83-page document, are already talking about putting their homes on the market before the value plummets.

And in Congress

Nevada Sen. Harry Reid, Senate majority whip and chair of the Senate Appropriations Committee's Subcommittee on Energy and Water Development, has managed to limit funds for Yucca Mountain work. The Nuclear Waste Fund, established in the Nuclear Waste Policy Act of 1982, is collected from ratepayers whose electricity is generated by nuclear energy at the rate of 1 mill per kilowatt-hour. Annually the fund has grown at the rate of $600 million to $700 million. Approximately $11 billion has been collected thus far, but just a little more than half has reached its intended purpose: funding the Yucca Mountain study.

According to some analysts, short funding by Congress has these effects:

- Resulted in countless setbacks.
- Caused the DOE to miss by at least four years a date for accepting waste.
- Allowed antinuclear forces to gain more support.

The DOE Approaches the Community

Recognizing a need to respond to public concerns, the DOE has held countless stakeholder meetings to address questions, supply the public with information, and gain input from citizens, especially of Nevada. Conducted tours of Yucca Mountain have been an ongoing activity aimed at helping the public understand the complexity of the problems being faced and the vast amount of research work being performed to ensure that the mountain will protect the environment and human population from harmful radiation.

Unfortunately, congressional action prohibiting the DOE from using tax dollars to advertise these popular events has denied many citizens the opportunity to know about the tour schedules and learn firsthand about the mountain. Rather, the ratepayer dollars in the Nuclear Waste Fund are used for announcing the tours.

Also, the DOE has established a science center in Las Vegas that serves as the starting place for tour groups. Many exhibits line the walls with hands-on displays. Much excitement is generated with youngsters when they visit the mock Climax Mine, which replicates the original one located at the Nevada Test Site. The mine allows visitors to get an idea of what one design for the repository looked like. Many locals and tourists visit the center each week and express their appreciation for such a facility and how much they learned from their experience.

To reach further into the community, specialists from

What Nevadans Are Now Saying

Although for the past 20 years most Nevada citizens have been mildly or strongly opposed to the Yucca Mountain project, the tone is starting to change. Near the repository site lie the communities of Indian Springs, Amargosa Valley, Beaty, Tonopah, Rachel, and Caliente. Comments by citizens there and elsewhere in the state show signs of emerging acceptance of the project, for various reasons.

An article in the July 14, 2002, *Las Vegas Review-Journal* quoted several residents on their views of the project:

• Mike Walrath, Indian Springs: "It's going to put money in this place. It's going to put money in the entire state."

• Rick Fox, Indian Springs: "It'll put more permanent people here; it'll make the town more stable. People don't buy here because it is all trailers."

• Doris Jackson, Amargosa Valley, estimates that 90 percent of rural Nevada welcomes Yucca Mountain because it might bring some economic prosperity to the region. But for Ed Goedhart, manager of the region's Ponderosa Dairy Farm, the thought of storing high-level waste just 18 miles from his cows makes him "queasy."

• Alpheus Bruton, Beatty: "I don't have any concerns about the high-level nuclear waste, and I don't even know anyone who does, unless they're a politician."

• Joni Eastley, the only woman on the Nye County Commission, sees a bright future for Tonopah, a future that includes Yucca Mountain. "Nye County wants people to recognize that Yucca Mountain is not located in Las Vegas. This is not located in Clark County. This is located in our home. The people in this community are very patriotic, and they're proud of the fact that they had something to do with developing the storage facility for this waste."

• Kevin Phillips, mayor of Caliente, hopes the town, site of the last westbound Union Pacific stop before Yucca Mountain, will become a depot where waste will be loaded onto trucks and hauled to the repository, and he hopes that this depot will generate some construction and off-loading jobs to pour money and resources into the town.

In general, the prevailing feeling is that people don't necessarily want the repository, but if it has to be here, then "Let's get some benefits." Hotel executives withheld comment for the most part, except one suggesting that what worried the hotel industry was transportation of the spent fuel and not the plans for the mountain itself.

the center frequently conduct workshops for families in retail malls within the city. At these events, parents and children learn together about radiation and how to design and test packages to withstand being dropped without damaging the contents, as well as learning about water flow in a desert and seeing examples of some of the wildlife common to the Yucca Mountain area. Frequently, children are heard saying, "Dad can we build something like this for me to take to school for my science class?" Interest remains high, and the demand for additional programs has been on the rise, but budgetary cutbacks have greatly curtailed these programs.

The estimate of the number of shipments has been reduced to some 3500 rail shipments and 1100 truck shipments over the lifetime of the repository, with an average of 175 shipments a year.

Nevada Plays the Terror Card

The Transportation Issue

We knew it was coming, but it was still a shock at how successful the effort was. Last year, Nevada hired a public relations firm to "inform the public about the dangers of nuclear waste transportation." Using television and news articles in areas of the nation where Nevada officials believed nuclear shipments might pass, the message was loud and clear—trucks and trains carrying spent-fuel assemblies will be a threat to your community's health and safety. To date, no routes have been finalized, but the messages built fear in the minds of many, and today these scare tactics continue. Concerns about nuclear waste transport were heightened by the events of 9/11. Many people who already opposed the concept of one central storage facility jumped on the bandwagon of "Leave it where it is."

The DOE Response

The safety record of transporting spent fuel over the past 30 years has been has been impressive. Moving more than 2700 shipments for more than 1½ million miles without any release of radioactive materials that would harm humans or the environment is a testament to those involved with the planning, scheduling, and actual movement of spent fuel and HLW.

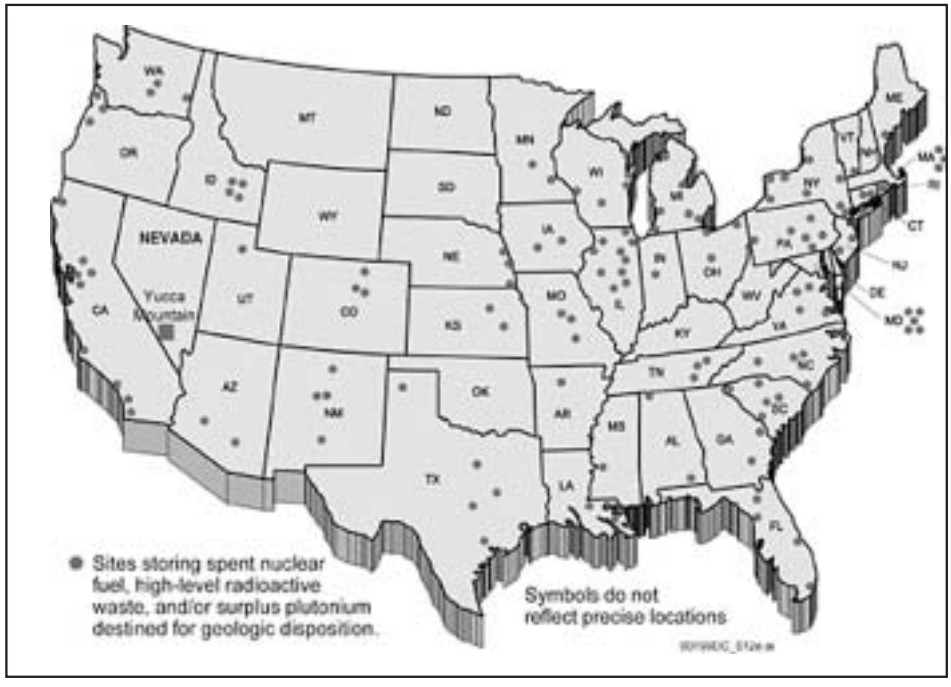
Such transport is regulated by the U.S. Department of Transportation, in cooperation with the NRC and the DOE, and strict guidelines must be met before any nuclear material is transported by either rail or truck

According to Chu, Energy Secretary Spencer Abraham will unveil a "National Transportation Plan" sometime next year. The DOE must identify exact routes to be used, prepare state and local emergency response teams, and construct a $900 million rail line to Yucca Mountain.

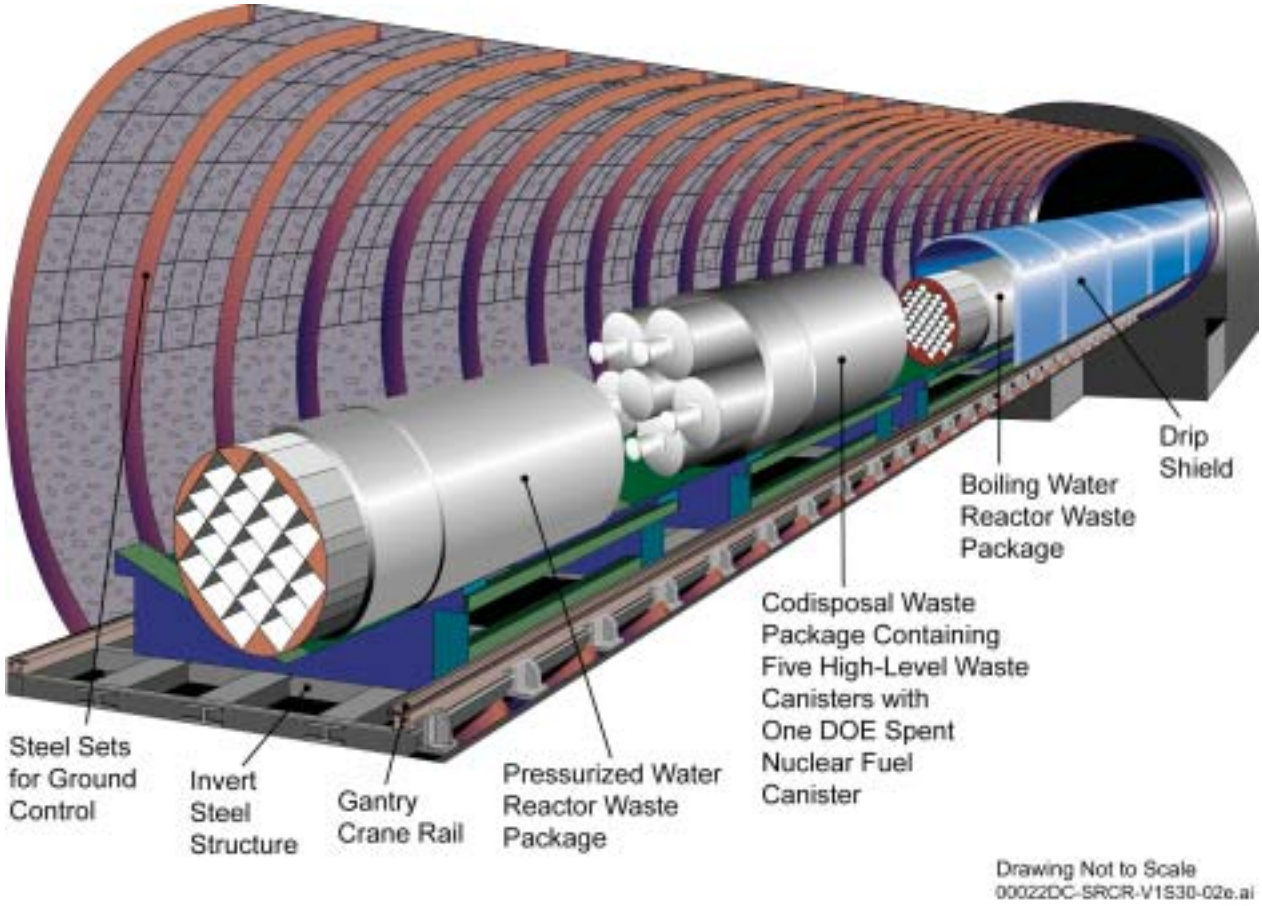
Important to the understanding of the safe movement of the spent-fuel assemblies is the extensiveness of the tests that have been performed on cask designs over the years. Following are some examples:

- Crash tests involving a locomotive traveling at 80 miles per hour striking a cask.
- Puncture tests, whereby a cask falls 30 inches onto a 6-in.-diameter steel shaft.
- Thermal tests, with the cask fully engulfed in fire for 30 minutes at 1470°F.
- Drop tests, with the cask falling 30 feet onto a hard surface and landing at its weakest point.
- Immersion tests, with the cask submerged in 3 ft of water after having been in the flame test.

Certification of the cask design and reliability of the tested cask is based on its ability to prevent release of harmful radiation. Through the years, designs have been modified to better meet rigorous standards set for safe containment of the spent-fuel assemblies.



A national map of current waste locations.



Cutaway of a drift with three types of waste packages.

Visitors to a public open house tour on the crest of Yucca Mountain, November 2001.

For the past several months, a wide variety of figures have been bandied about by the media and the antinuclear forces regarding the number of shipments yearly that would arrive at the repository. Even one of the DOE's own studies stated that truck transport would involve as many as 100 000 shipments. However, since the DOE is committed to rail transport, the estimate of the number of shipments has been reduced to some 3500 rail shipments and 1100 truck shipments over the lifetime of the repository, with an average of 175 shipments a year. This figure is small compared to the more than 300 million hazardous material and nuclear shipments annually in the United States. Nuclear materials are being moved daily from former nuclear weapons facilities, research labs, and medical centers without incident. ■

Richard Telfer, a retired career educator, lives in Las Vegas and thus has personal exposure to both sides of the Yucca Mountain debate. He has served on the Citizens Advisory Board for the Nevada Test Site, consults on nuclear issues, and has been a frequent contributor to Radwaste Solutions.