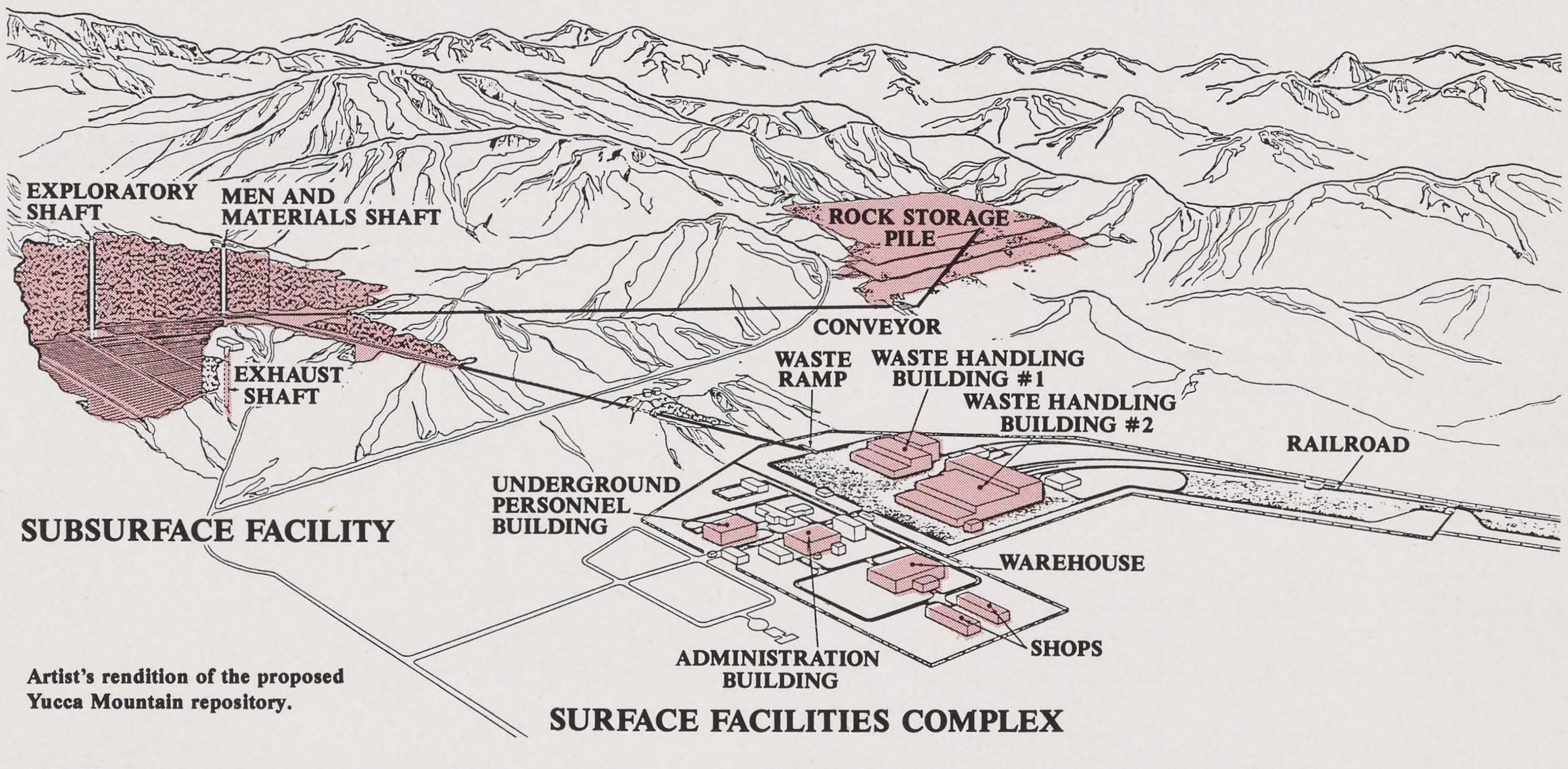
Nevada Nuclear Waste Project Office

Nevada Nuclear Waste Factsheet 1

A Yucca Mountain repository: What would it look like?



Artist's rendition of the proposed Yucca Mountain repository.

If detailed study shows that Yucca Mountain would be the most suitable site for a high-level nuclear waste repository, the Department of Energy (DOE) would be ready to begin construction in 1998. There would be a central surface facility covering 150 acres, and the underground repository spreading over more than 1,500 acres.

The surface facilities would be located on the east side of Yucca Mountain. They would be used for waste-handling and packaging operations in support of the underground activities, and to provide general repository support services. There would be fire and medical services as well as administrative offices, repair shops, a security office, warehouses, two separate waste-handling buildings, a machine shop and electrical shop.

Utilities, roads and a railroad would be extended to the site. New wells with storage provisions would supply the water required during construction and operation of the repository.

The subsurface facilities would be a mile west of the surface complex. The repository horizon would be between 650 and 1,300 feet above the water table. Access to the underground area would be via gently sloping ramps from the surface waste-handling area.

The subsurface facilities would consist of main access drifts to the emplacement areas, the emplacement drifts, and service areas near the shafts and ramps.

There would be six access openings-four shafts and two ramps-connecting the subsurface with the surface areas. One shaft would be used to transport personnel and materials. It would be 20-24 feet in diameter and about 1,110 feet deep. The waste-handling ramp would be used to transport waste underground. It would be 20-25 feet in diameter and about 6,700 feet long. Another ramp would be used for the mined-material conveyor system and as an exhaust outlet for construction area ventilation. The ramp would be 20-25 feet in diameter and 4,650 feet long. The remaining three shafts would ventilate various underground areas.

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Nevada Nuclear Waste Factsheet 2

A Yucca Mountain repository: How would it operate?

If Yucca Mountain were selected as the nation's first high-level nuclear waste repository, the first waste would be received in 2003, under the current Department of Energy (DOE) plan. Drifts and boreholes would be mined, and a conveyor belt would transport the rock to the muckpile at the surface. A ramp connecting the surface and underground workings would allow vehicles to carry the heavy waste canisters. The Nuclear Waste Policy Act of 1982 limits to 70,000 metric tons the total amount of waste that could be emplaced, unless a second repository is in operation. About 700 boreholes could house the approximately 24,000 canisters in a projected horizontal emplacement configuration. Vertical emplacement-one canister per hole-would require much more excavation.

The final Environmental Assessment for Yucca Mountain proposes construction of a spur from the vicinity of Dike Siding, about 11 miles northeast of Las Vegas. A bridge spanning Fortymile Wash would accommodate both the road and railroad. A facility at Yucca Mountain would provide for railcar handling and temporary storage.

The outer perimeter of the repository would be surrounded by a buffer zone about 3 miles wide. As required by Environmental Protection standards, there would be no mining and no water pumping from the underlying aquifer.

The operations period of the repository would extend until 2053. The period would consist of a 28-year emplacement phase and a 22-year caretaker phase. A decision to retrieve the waste for reprocessing to recover valuable uranium and plutonium could add 30 years to the repository lifetime. If there were no retrieval, the repository would be decommissioned, sealed and marked. The decommissioning period would end either in 2056 or 2061, depending on the type of waste emplacement.

A multi-wheeled vehicle is proposed to transport waste from the above-ground handling facility to the underground repository

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Nevada Nuclear Waste Factsheet 3

The Nuclear Waste Policy Act of 1982: As amended, what does it do?

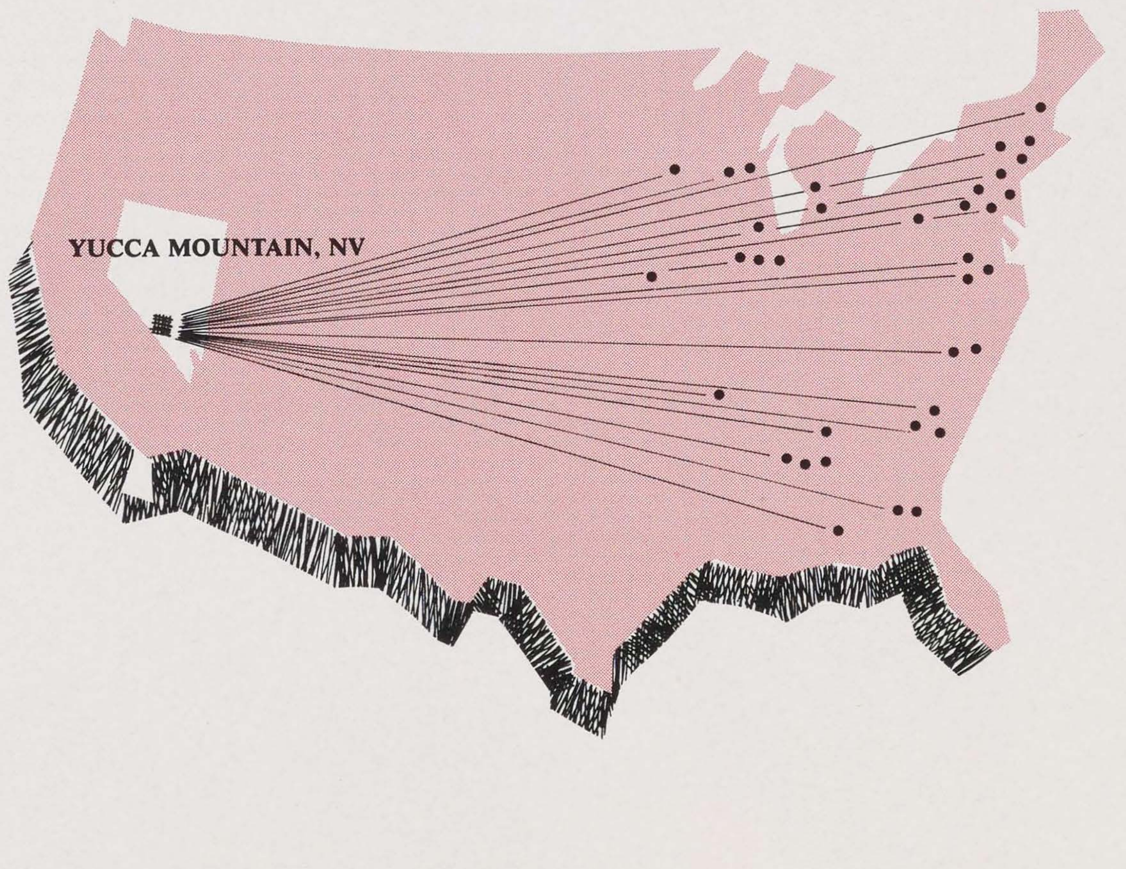
In 1982, Congress enacted a sweeping compromise designed to solve the pressing problem of how to dispose of high-level radioactive waste and spent fuel. Since the dawn of the Atomic Age, these dangerous waste products of nuclear energy had been stored where they were generated, at commercial reactors and defense facilities. Congress determined there should be permanent storage, and that the best way to isolate the waste from the biosphere would be to bury it in deep geologic repositories. No state wanted a dump, however, and the Nuclear Waste Policy Act was intended to work out a fair, scientific method of finding the best site.

Five years later, the compromise was shattered. The Department of Energy (DOE) site selection process was bogged down amid charges it was politically oriented, unscientific and violated the Act. Eventually, powerful congressional delegations, seeking to protect their states from any consideration as a dumpsite, stripped the Act of its main provisions and ordered that Yucca Mountain in Nevada be the only site to be studied for suitability.

The original Act provided for regional balance by siting two repositories, East and West. DOE was to screen potential sites, eventually choosing those that would undergo site characterization for final consideration. The host state would have a veto, although it could be overridden by Congress. A Monitored Retrievable Storage (MRS) facility would be built for packaging waste before it went to a repository. All work would be paid for by a levy on the bills of nuclear power users, and DOE would tap the fund to provide oversight grants to affected states and Indian tribes during site selection and construction. The Act also set up a timetable for various stages of the project.

What happened to that blueprint? From the beginning, the Act was recognized as a fragile compromise that would be successful only if its terms were followed both in letter and in spirit. There was a built-in adversary relationship between the DOE and the potential repository states, and within a few years there were more than 40 lawsuits against DOE claiming the department had violated the Act. Nevada in particular claimed DOE had followed a political rather than a scientific agenda. In 1986, the Department recommended characterization of potential first repository sites at Yucca Mountain, on the Hanford Reservation in Washington, and Deaf Smith County on the Texas Panhandle. At the same time, DOE announced it was halting the search for a second repository site in the eastern half of the country. Nevada filed more lawsuits alleging the decisions did not conform to the Act. It claimed they were based on election-year fears of candidates in eastern states whose residents strongly opposed a repository. Congressional investigators said DOE's own internal memos confirmed the allegation. Meanwhile, DOE's program fell behind the scheduled deadlines. Congress cut the department's budget and banned certain site work. There were hearings aimed at learning how to get the program back on track.

Then, late in 1987, the Senate passed a bill that would characterize the Nevada, Washington and Texas sites sequentially, beginning with Yucca Mountain. It provided for an MRS, and would pay $100 million a year to the eventual repositiory host state. In the House,



there was a rival plan calling for a moratorium during which the stalled repository program would be studied and corrected. When a House-Senate conference committee met in December to work out the differences between the two bills, it was decided to drop the Texas and Washington sites, order DOE to site characterize Yucca Mountian, scrap the MRS until a repository is licensed for construction, provide for benefits up to $20 million a year provided the state gave up its veto, and drop consideration of an eastern repository. If Yucca Mountain were determined unsuitable, DOE would report to Congress for new directions. The final version also provided for the appointment of a negotiator who would discuss possible incentives with governments that might volunteer to host a repository.

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Nevada Nuclear Waste Factsheet 4

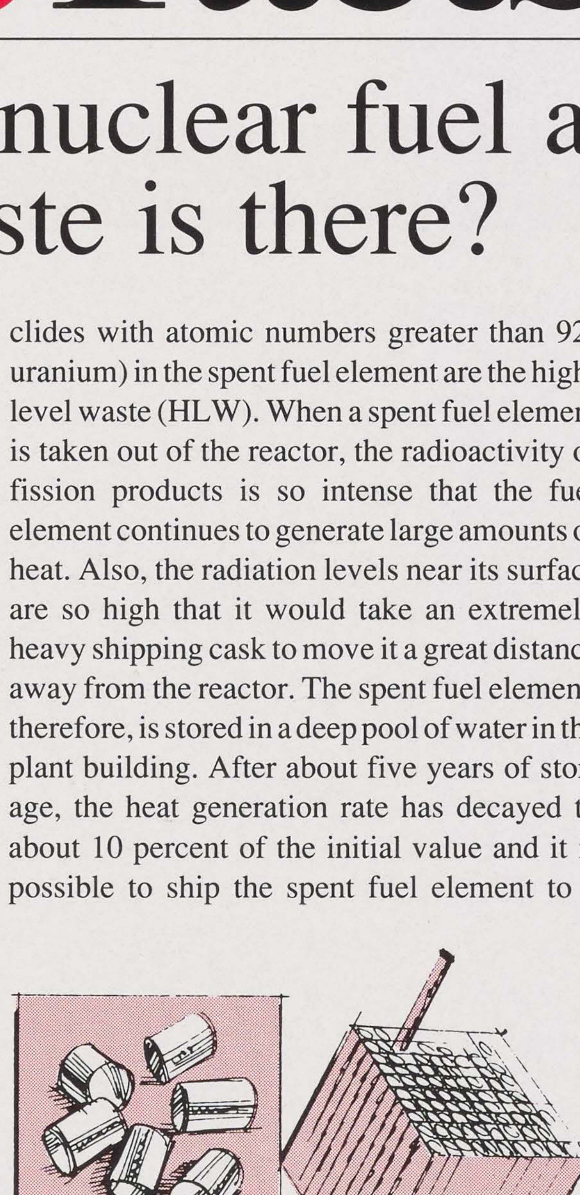
What is spent nuclear fuel and how much waste is there?

Pellets of uranium oxide are the fuel for most commercial nuclear power plants generating electrical power. These solid pellets are sealed in metal tubes approximately twice the diameter of a pencil and about 12 to 13 feet long. The tubes are bundled together into assemblies, each containing between 50 and 270 tubes, depending on the design of the reactor in which they are to be used. Between the tubes is space for coolant to flow and remove the heat generated by the controlled chain reaction. The reactor core consists of many fuel assemblies.

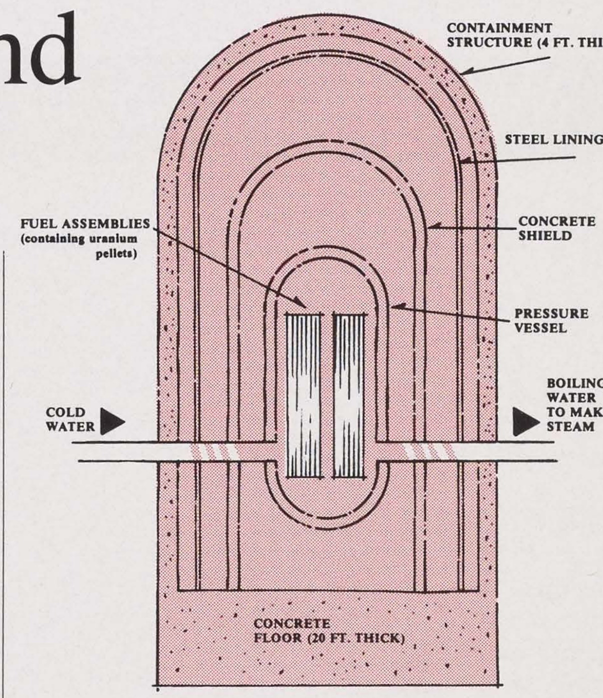
When an unspent fuel assembly is placed in a reactor, the uranium is 3.3% enriched in the uranium isotope, uranium 235. Every 1,000 kilograms of uranium consists of 33 kilograms of uranium 235 and 967 kilograms of uranium 238. The uranium 235 is fissile and helps maintain the controlled chain reaction but the uranium 238 is not. The assembly is kept in the reactor for about 1,100 days. During this time span, so much fissile material is irradiated that the fuel element can no longer support the chain reaction and it becomes a spent fuel element.

Spent fuel is measured in metric tons of heavy metals (MTHM) or metric tons of uranium (MTU). Over a span of 1,100 days, a typical modern commercial nuclear power plant produces about 100 MTU of spent fuel elements. There are about 100 modern nuclear power plants in the United States and these produce not quite 3,000 MTU of spent fuel elements per year. As of 1986, more than 12,000 MTU spent fuel elements had been produced by the commercial nuclear power industry. This inventory is expected to increase to 40,000 MTU by the year 2,000.

The radioactive fission products and the transuranics, (isotopes of plutonium, and nuclides with atomic numbers greater than 92-uranium) in the spent fuel element are the high-level waste (HLW). When a spent fuel element is taken out of the reactor, the radioactivity of fission products is so intense that the fuel element continues to generate large amounts of heat. Also, the radiation levels near its surface are so high that it would take an extremely heavy shipping cask to move it a great distance away from the reactor. The spent fuel element, therefore, is stored in a deep pool of water in the plant building. After about five years of storage, the heat generation rate has decayed to about 10 percent of the initial value and it is possible to ship the spent fuel element to a distant place. However, the spent fuel element still contains a very large amount of dangerous radioactive nuclei. In 1,000 kilograms of uranium, there are about 0.6 kilograms of strontium 90 and 1.2 kilograms of cesium 137, two very hazardous radionuclides that decay with half lives of about 30 years. (Half-life is the time required for a radio-active substance to lose 50 percent of its activity by decay.) The decay of these radionuclides to insignificant levels requires about 1,000 years. Five of the nine kilograms of transuranics are plutonium 239 which decays with a half life of 24,000 years. It takes several hundred thousand years for this amount of plutonium to decay to insignificant levels.



Nuclear power plants are fueled by pellets of uranium oxide, each about the size of a pencil eraser. The pellets are sealed into long metal tubes called rods. The rods are then bundled together into fuel assemblies.



A series of barriers separates the outside world from the heat and raditation of the nuclear plant's uranium.

Under the Nuclear Waste Act of 1982, The Department of Energy (DOE) is allowed to dispose of 70,000 MTU of spent fuel elements in the first repository, before a second repository is operational. This amount of spent fuel will contain about 630 tons of transuranics, mostly plutonium. Because of the hazard associated with such a large amount of plutonium, the DOE must look for a site that can isolate the waste from the biosphere for 10,000 years.

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Nevada Nuclear Waste Factsheet 5

Why Yucca Mountain?

The Nuclear Waste Policy Act of 1982 specified procedures the Department of Energy (DOE) must follow in siting the country's first high-level nuclear waste repository. DOE selected Yucca Mountain in southern Nevada as one of three sites to be studied in detail to determine if they could safely isolate the waste for 10,000 years, as the standard requires. In 1987, Congress ordered that only Yucca Mountain be studied.

The Yucca Mountain rock is "welded tuff", a dense form of compacted volcanic material laid down more than four million years ago. DOE says that tuff formation provides the large, stable block of rock required for a repository.

A major concern of the study is that water could drain into the repository, pick up radionuclides, and eventually contaminate the underground water supply of the region's farms and communities. Yucca Mountain is in an arid location, and DOE says most of the six-inch-per-year rainfall runs off or evaporates without penetrating the mountain's surface. The DOE says that less than 5 percent of the rainfall percolates down to the water table which would be at least 650 feet below the repository.

DOE hydrologists say that if radionuclides were to dissolve in the water passing through the repository, it is highly unlikely that they could ever reach and contaminate the groundwater. They say this is because the tuff contains zeolites, a group of minerals with the capability to remove radioactive material from water. DOE says if radionuclides were released into the water, they would be trapped by the chemical and physical reaction produced by the zeolites.

DOE also says the possiblity of an earthquake damaging a repository is unlikely, although it is a subject for "site characterization" study. It says tunnels mined in tuff at the adjacent Nevada Test Site during the last 25 years are still intact despite repeated shocks from nearby weapons detonations.

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Nevada Nuclear Waste Factsheet 6

A Yucca Mountain repository: What are Nevada's concerns?

Nevada's major concerns about constructing a high-level nuclear waste repository at Yucca Mountain were summarized in response to the Department of Energy's (DOE) draft Environmental Assessment in December 1984. The state feels the final EA of May 1986 did not address those concerns adequately.

The summary prepared by the state Nuclear Waste Project Office (NWPO) included these comments:

•A reasonable interpretation of the available information suggests that a large earthquake with accompanying surface faulting could probably occur during the lifetime of the facility, with the possibility of loss of repository integrity. The site is located within an active tectonic zone called the Walker Lane Structural Zone, a source of numerous large earthquakes in recorded history. The site area contains a number of faults which may be also capable of generating large earthquakes;

•Studies indicate a major earthquake could have a drastic effect on the water table, causing it to rise dramatically. (Nevada's concerns about tectonic and hydrologic faults are supported by a report by a DOE scientist, who suggested DOE should consider abandoning the Yucca Mountain site.)

•The EPA standards for disposal of high-level radioactive materials indicate that a site should be disqualified if the ground water travel time from the repository to the accessible environment is less than 1,000 years. NWPO calculations, using conservative approximations to bound numerical uncertainty, find that ground water travel time could range from 900 to 34,000 years. The minimum number for ground water travel time does not meet the EPA ground water travel time requirement;

•A repository at Yucca Mountain may conflict with future weapons testing and the established mission of the adjacent Nevada Test Site. Testing currently is not in areas near Yucca Mountain, but there must be a Defense Department declaration that future atomic testing will not conflict with a waste repository at Yucca Mountain;

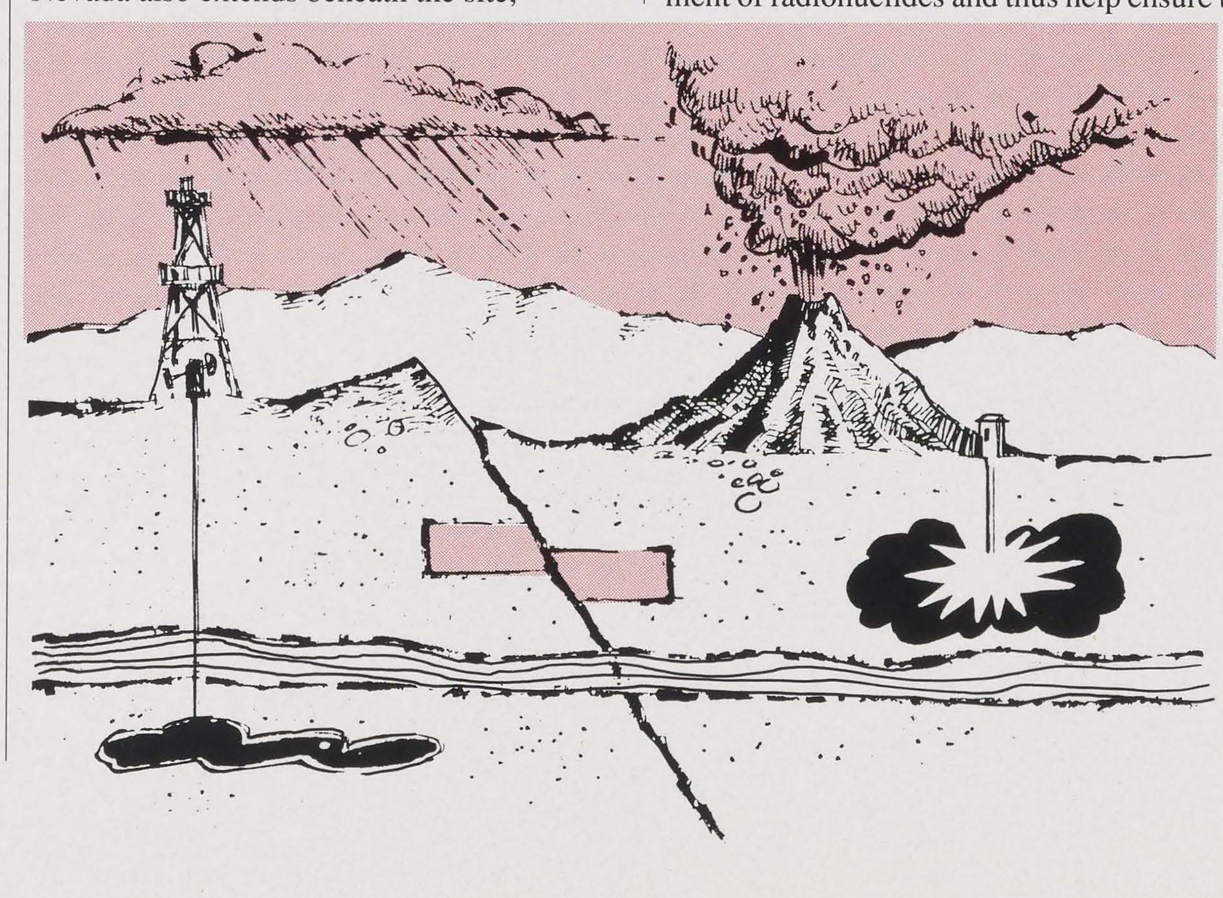
•The potential of natural resources at the site is supported by the presence of gold and silver in drill cores, and the location of Yucca Mountain along the rim of a buried caldera. New studies indicate an overthrust belt marking oil deposits may extend to the site. A regional carbonate aquifer currently being evaluated as a future water supply for southern Nevada also extends beneath the site;

•EA support documents suggest that a risk of volcanic eruption exists at Yucca Mountain. The site is located adjacent to a major volcanic field;

•A national laboratory identified Crater Flat, immediately adjacent to Yucca Mountain, as a potential "hot rock geothermal area." This would suggest the presence of magma, reinforcing Nevada's concern about volcanism;

•A review of climatic changes in southern Nevada over the last 10,000 years suggests that under future "wet" cycles (possibly glacial periods), water infiltration may increase and cause a rise in the ground water table. This could potentially impact the site's ability to contain and isolate the waste;

•The EA claims that zeolites, an accessory mineral in volcanic tuff, would retard movement of radionuclides and thus help ensure the



isolation capability of the site. However, zeolites may be unstable at expected repository temperatures and thus may not effectively retard radionuclide movement toward the water table. In fact, they could promote instability of underground repository openings;

•Given the decision to put defense waste as well as commercial waste in a repository, it is questionable whether there is sufficient host rock available at Yucca Mountain for emplacing the initial 70,000 tons allowed by the Nuclear Waste Policy Act.

In addition to these and other technical concerns, Nevada officials fear the state's vital tourist industry could suffer because of a repository at Yucca Mountain. Visitors would have to travel the same highways as trucks carrying nuclear waste. (The EA says the repository receipt facilities could accept 1,000 truck and 500 rail shipments per year, but other figures in the EA indicate there could be up to three times that number of trucks if there is no interim handling facility in the east.) Although casks containing the waste would be designed for maximum safety and security, there almost certainly would be accidents. Tourists could be scared away by the perception of a nuclear disaster.

The state contends the EA presents a "best-case" scenario that minimizes potential impacts to the social and fiscal systems of southern Nevada. Although there would be economic benefits during construction, estimates of direct and indirect employment figures are highly inflated compared to numbers used for other potential repository sites. Communities would thrive during the construction period, but would be left with empty schools, houses and stores when the boom ends. Moreover, the presence of a nuclear waste repository could be a factor in diverting new business away from Nevada.

Finally, the state contends the Department of Energy has failed to follow the spirit and letter of the Nuclear Waste Policy Act's provisions for carrying out the siting program. Nevada believes decisions on screening and selection of sites have placed primary emphasis on political desires rather than technical merits. For example, although Congress intended a second repository be located east of the Mississippi in order to provide regional balance to the problem, DOE halted the site search during the 1986 election campaign. Western states claimed the halt was intended to help candidates in politically powerful eastern states that opposed the siting program.

In December 1987, Congress amended the original Act and ordered that Yucca Mountain be the only site to be studied for suitability as the country's first high-level nuclear waste dump. Sites in Texas and Washington, which with Yucca Mountain had been selected by DOE in May 1986 for site characterization, were eliminated from further consideration. If Yucca Mountain failed to meet the suitability test, at least $1 billion and several years of study would have been wasted, and there would be no ready fallback site. Nevada believes that such pressure to license Yucca Mountain could cause DOE to recommend the site, even though site characterization may have revealed technical faults that would compromise its ability to isolate radiation from the biosphere.

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Nevada Nuclear Waste Factsheet 7

Yucca Mountain: Transportation to a repository

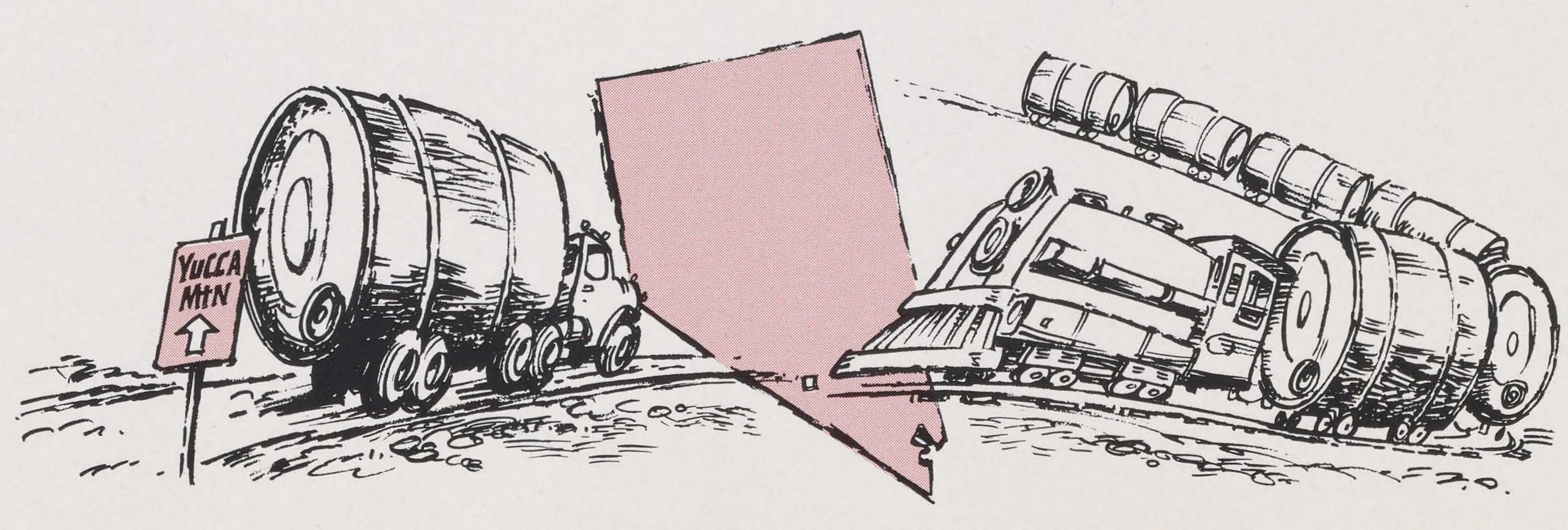
Transportation would be a major factor in the operation of a possible high-level nuclear waste repository at Yucca Mountain. The first waste would arrive in 2003, under a revised schedule for opening the facility. Most of the shipments would originate in the East, since that is where most of the commercial reactors are located. Recent publications and statements by the U.S. Department of Energy (DOE) indicate there would be approximately 28,000 highway and 10,000 rail shipments to Yucca Mountain during the scheduled 28-year emplacement phase. Should a monitored retrievable storage (MRS) facility be authorized by the Congress, the number of shipments to the repository would be reduced. Waste from reactors would be sent to the MRS for consolidation and repackaging, thereby reducing the volume of shipments. The MRS would be designed to assure that all shipments to the repository would be by rail, thereby eliminating highway shipments except for waste from western reactors and the defense programs.

In addition to the repository's emplacement phase, there would be a 22-year caretaker phase during which the waste could be retrieved for reprocessing, should that become a viable option for supplying fresh fuel to reactors. A decision to reprocess would lengthen the life of the repository up to 30 years to provide for retrieval. This, again, would result in a large number of truck or rail shipments-this time from the repository.

Shipping casks would be designed to contain the waste in the event of serious accident. Crash tests of older, heavier shipping containers or casks (not filled with spent fuel) demonstrated that, if properly built and maintained, they could withstand tremendous impacts. However, the casks that would be used for repository shipments would be built of lighter materials and their response to accidents is yet untested. Knowledge of potential cask response is most important since the unprecedented volume of nuclear waste shipments on Nevada's present transportation system would likely result in accidents. That would increase risk to the population along the routes and raise the spectre of disaster among the public.

The prospect that thousands of nuclear waste shipments would ride the rails and highways before closure of the repository is a subject of deep concern not only to Nevada, but also the numerous "corridor" states through which the shipments would pass. The corridor states have acted jointly to initiate programs that would address public fears about transportation. Such states expressed concern over DOE's delay in identifying specific routes to a repository because, in the absence of specified routes, adequate state and local planning is difficult.

States and local governments want to be assured that there would be emergency response capabilities along potential routes; that there would be adequate shipping notification, inspection and enforcement programs; that there would be tracking systems for locating shipments along the route; that crews with the shipments would be properly trained; that the shipping casks would be tested fully to insure they could withstand the most severe impact in the event of an accident; and that the shipments would be protected against possible terrorism.



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Nevada Nuclear Waste Factsheet 8

Yucca Mountain: Contamination From Weapons Testing or Spent Fuel...What's the Difference?

The answer to this question is in two parts: (1) The amount of contamination that has resulted from weapons testing at the Nevada Test Site is minute compared to the amount of potential contamination associated with a spent fuel repository at Yucca Mountain; (2) Although certain areas of the Nevada Test Site are contaminated, Yucca Mountain is not. It lies mostly outside the Test Site. The Department of Energy has jurisdiction over the Nevada Test Site but not the repository area of Yucca Mountain, although the surface facility a mile from the storage area would be on the Test Site.

Calculations using the Trinity Test, the first nuclear weapon exploded in New Mexico in July 1945, show that it would take about 2.3 million Trinity blasts to produce the same fission product inventory that would be in a spent fuel repository. It would take thousands of years of weapons testing at the current rate to approach the amount of contamination associated with a repository.

It would take more than 27,000 undetonated Trinity weapons to match the plutonium-239 inventory of the spent fuel repository. So far, the DOE has detonated about 700 nuclear weapons since the start of testing in the 1950s, and the current testing rate is about 20 per year. Therefore, it would take weapons testing at least 10,000 to 100,000 years to produce the fission product inventory of a maximum 70,000 tons in the spent fuel repository. It would take over 1,000 years of undetonated testing to put in the soil the plutonium-239 inventory of the spent fuel repository.

In arriving at conclusion (1), there are two important assumptions:

1. The repository contains 70,000 metric tons of heavy metals (MTHM) of spent fuel, the current limit for the first repository stipulated in the Nuclear Policy Act of 1982, with an average burnup of 33,000 megawatt-days (MW-d). For fuel with a burnup of 33,000 MW-d, for each MTHM charged to the reactor, 44 kilograms (kg) (97 pounds) of uranium are converted to 35 kg (77 pounds) of fission product plus 9 kg of transuranics, i.e. 35 kg of material are fissioned. About 65 percent of the transuranics is plutonium-239.

2. Complete fissioning of 56 kg (123 pounds) of material will produce an explosive yield of 1 megaton (MT) of TNT (mega is a prefix denoting 1 million).

The Trinity weapon had an explosive yield of 18.6 kiloton (kt) of TNT (kilo is a prefix denoting 1 thousand). The critical mass for plutonium-239 is about 15 kg (33 pounds).

The following calculations result from these two assumptions:

1. Total amount of

uranium that is fissioned in the production of 70,000 MTHM of spent fuel: 70,000 x 35 = 2,450,000 kg (5,400,000 pounds).

Amount of fissioned uranium expressed in units of weapon yield: 2,450,000 ÷ 56 = 43,750 MT = 43,750,000 kt.

Amount of fissioned uranium expressed in units of Trinity weapon: 43,759,000 ÷ 18.6 = 2,350,000 Trinity weapons.

2. The 70,000 MTHM of spent fuel will contain the following quantity of transuranics: 70,000 x 9 = 630,000 kg (1,400,000 pounds).

Approximately 65% of this is plutonium-239. 630,000 x .65 = 409,500 kg of Pu-239.

Amount of plutonium-239 expressed in number of critical masses: 409,500 ÷ 15 = 27,300 critical masses of plutonium-239.

Conclusion (2) requires a re-emphasis of the Nevada Test Site-Yucca Mountain relationship. Weapons testing has, indeed, contaminated a portion of the Nevada Test Site. However, Yucca Mountain is adjacent to - not on - the Nevada Test Site. The surface facilities of the proposed repository would be located on the Nevada Test Site, but the underground or waste emplacement area would be located outside the Nevada Test Site. While the Nevada Test Site is under Department of Energy jurisdiction, Yucca Mountain is divided under three different jurisdictions - DOE, Nellis Air Force Base Gunnery Range, and the Bureau of Land Management.

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