Yucca Mountain: The Most Studied Real Estate on the Planet

Report to the Chairman

Senator James M. Inhofe
U.S. Senate Committee on Environment and Public Works
Majority Staff

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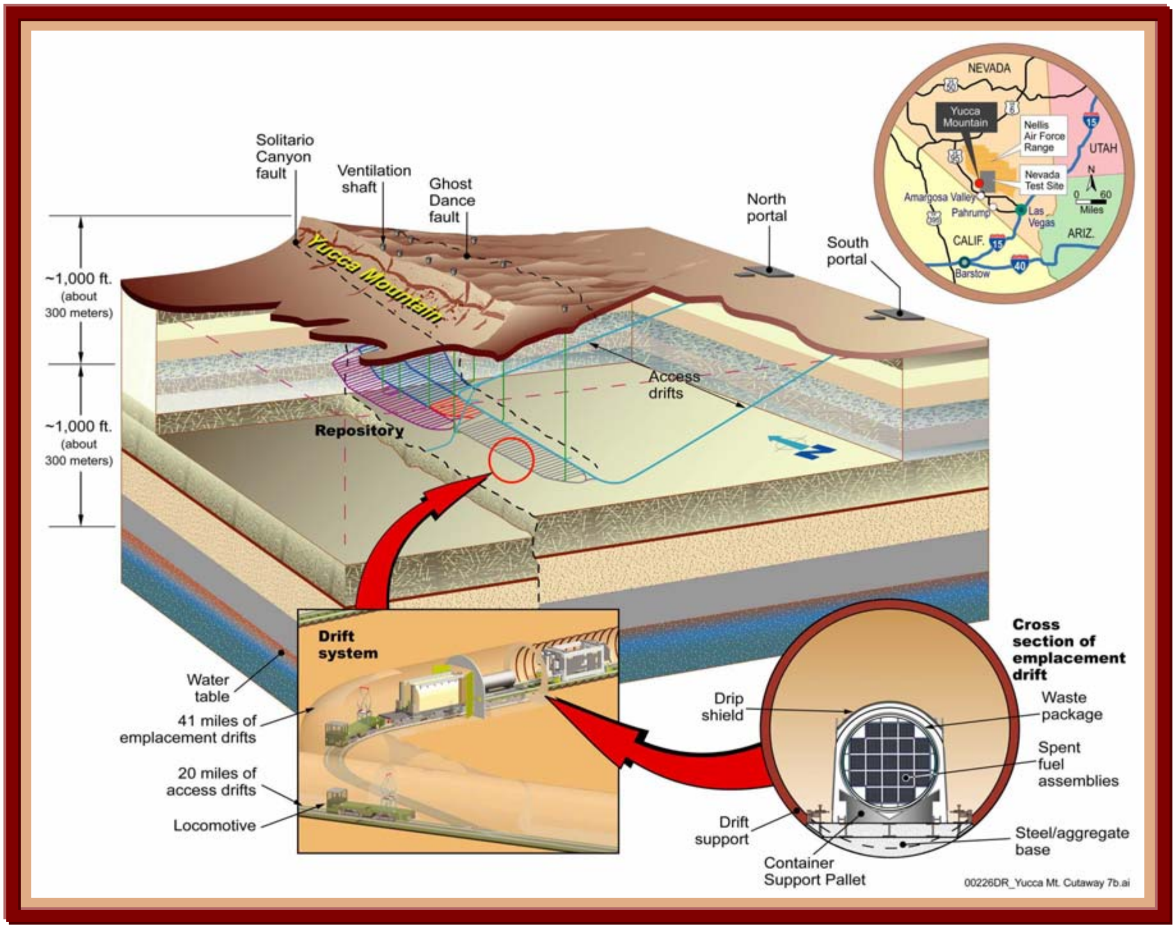

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INTRODUCTION

Yucca Mountain has been selected as the site for the Department of Energy's (DOE) geologic repository designed to store and dispose of spent nuclear fuel and high-level radioactive waste. When constructed, the site would be the nation's first geological repository for disposal of this type of radioactive waste.

The site is located on federally owned land on the western edge of the Nevada Test Site in southern Nye County, Nevada, about 90 miles northwest of Las Vegas.

The history of this site has been marred in political controversy since 1986 when it was selected. Ignored in the political controversy were the extensive scientific analyses along with both national and international peer reviews.

This paper addresses the analyses conducted at the site as well as explanations of the scientific issues surrounding it. In addition, the paper also considers the regulatory and legal challenges pertaining to the site.

Finally, based on the science, the paper supports opening Yucca Mountain without further delay as a critical component to nuclear renaissance and energy security in the United States.

HISTORY

50 years of international scientific study of nuclear waste disposal options

In September of 1955, a group of the nation's most distinguished scientists met at Princeton University under the auspices of the National Academy of Sciences (NAS) to consider the possibilities of disposing radioactive waste materials on land and to identify the research needed to support such activities. Two years later, these scientists released a report concluding "The Committee is convinced that radioactive waste can be disposed of safely in a variety of ways and at a large number of sites in the United States."[1] Hence the nation's search for a land based disposal site was launched.

On many occasions since 1955, scientists – not just in the United States but also around the world – have again and again convened to consider this topic. They have considered all possible forms of land based disposal as well as alternatives to land based disposal, such as rocketing the material into space or disposing of it beneath the ocean floor, but they have always come back to agreeing that disposal on land is the preferred option. The land based disposal concept has been refined over time into a method known as deep geologic disposal and consensus support for this method has withstood many difficult challenges. In 2001, another distinguished NAS panel concluded, "After four decades of study, geological disposal remains the only scientifically and technically credible long-term solution available."[2] Similarly, in 2003 the International Atomic Energy Agency (IAEA) concluded, "Disposal in a geological repository is the generally accepted solution for management of long lived wastes in practically all countries faced by the problem."

The nation's first effort to develop a deep geologic repository occurred in Lyons, Kansas in the 1960s. At this location, retrievable disposal in rock salt was demonstrated, but for numerous technological reasons, the effort to develop a repository there was abandoned. Funding for further work in this area lagged through the 1970s. Then, in 1979 an Interagency Review Group chaired by the Secretary of Energy and composed of

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[1] *The Disposal of Radioactive Waste on Land*, National Academy of Sciences Publication #519, September 1957, p. 3
[2] *Disposition of High-Level Waste and Spent Nuclear Fue*l, National Academy Press, 2001, p. 3

representatives of 14 government entities considered the problem and recommended that "detailed studies of specific, potential repository sites in different geologic environments should begin immediately."[3]

The US Department of Energy (DOE) began this study with a 1980 Environmental Impact Statement (EIS) to evaluate the proposed action "to select and pursue a programmatic strategy that would lead to disposal of existing and future commercially generated radioactive high-level and transuranic wastes in mined repositories in geologic formations."[4] In this EIS, the proposed geologic disposal action was compared to eight alternatives; Very Deep Hole Waste Disposal, Rock Melt Waste Disposal, Island-based Geologic Disposal, Sub-seabed Disposal, Ice Sheet Disposal, Well Injection Disposal, Transmutation, and Space Disposal. This EIS concluded that a mined geologic repository was the "most preferred"[5] concept. From this point forward, the problem of high-level radioactive waste disposal in the United States was no longer a question of how, but where.

The Nuclear Waste Policy Act of 1982 – Narrowing the options

Armed with DOE's 1980 EIS selecting geologic disposal as the preferred option, Congress moved to establish the process for selecting and developing a geologic disposal site with enactment of the 1982 Nuclear Waste Policy Act (NWPA). In this Act, Congress set forth a step-by-step process to evaluate potential candidate sites, select at least 3 sites for detailed characterization, approve a site for development and license it to assure that public health and safety would be protected. Among other provisions of the Act, Congress also established a Nuclear Waste Fund, composed of fees collected from the consumers of nuclear electricity, to pay for the disposal of commercial waste in the repository.

In February of 1983, DOE carried out the first requirement of the Act by formally identifying nine potentially acceptable sites in six states for the first repository, including Yucca Mountain in Nevada. DOE then began evaluating these sites against guidelines it established as called for by the Act. Draft Environmental Assessments (EAs) of each of these nine sites were issued for public comment in 1984. Considering the results of the assessments and comments received, DOE then nominated 5 of these sites, again including Yucca Mountain, for further consideration. Each of these EAs summarized an already extensive body of work. The Yucca Mountain EA contained over 1000 pages of scientific and technical information about that site[6] when it was finalized and published in May of 1986.

In May of 1986, DOE completed two additional actions; the Department published a Multi-attribute Utility Analysis comparing the five nominated sites, ranking them in order of preference, and the Department formally recommended the three highest ranking sites – Yucca Mountain, Deaf Smith County Texas, and Hanford Washington – for detailed characterization as a potential repository[7]. Of these three sites, Yucca Mountain was rated number one overall based on a consideration of a number of factors including geohydrology, geochemistry, rock characteristics, tectonics, meteorology, costs and socioeconomic impacts.[8]

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[3] *Report to the President by the Interagency Review Group on Nuclear Waste Management*, March 1979, p.38
[4] *Management of Commercially Generated Radioactive Waste*, DOE/EIS-0046F, p. 1.7
[5] *Management of Commercially Generated Radioactive Waste*, DOE/EIS-0046F, p. 6.194
[6] Environmental Assessment, *Yucca Mountain Site, Nevada Research and Development Area, Nevada*, DOE/RW-0073, May 1986
[7] *Recommendation By The Secretary of Energy of Candidate Sites For Site Characterization For The First Radioactive-Waste Repository*, DOE/S-0048, May 1986, p. 9
[8] *A Multiattribute Utility Analysis of Sites Nominated For Characterization For The First Radioactive-Waste Repository – A decision Aiding Methodology*, DOE/RW-0074, May 1986, p. 5-16

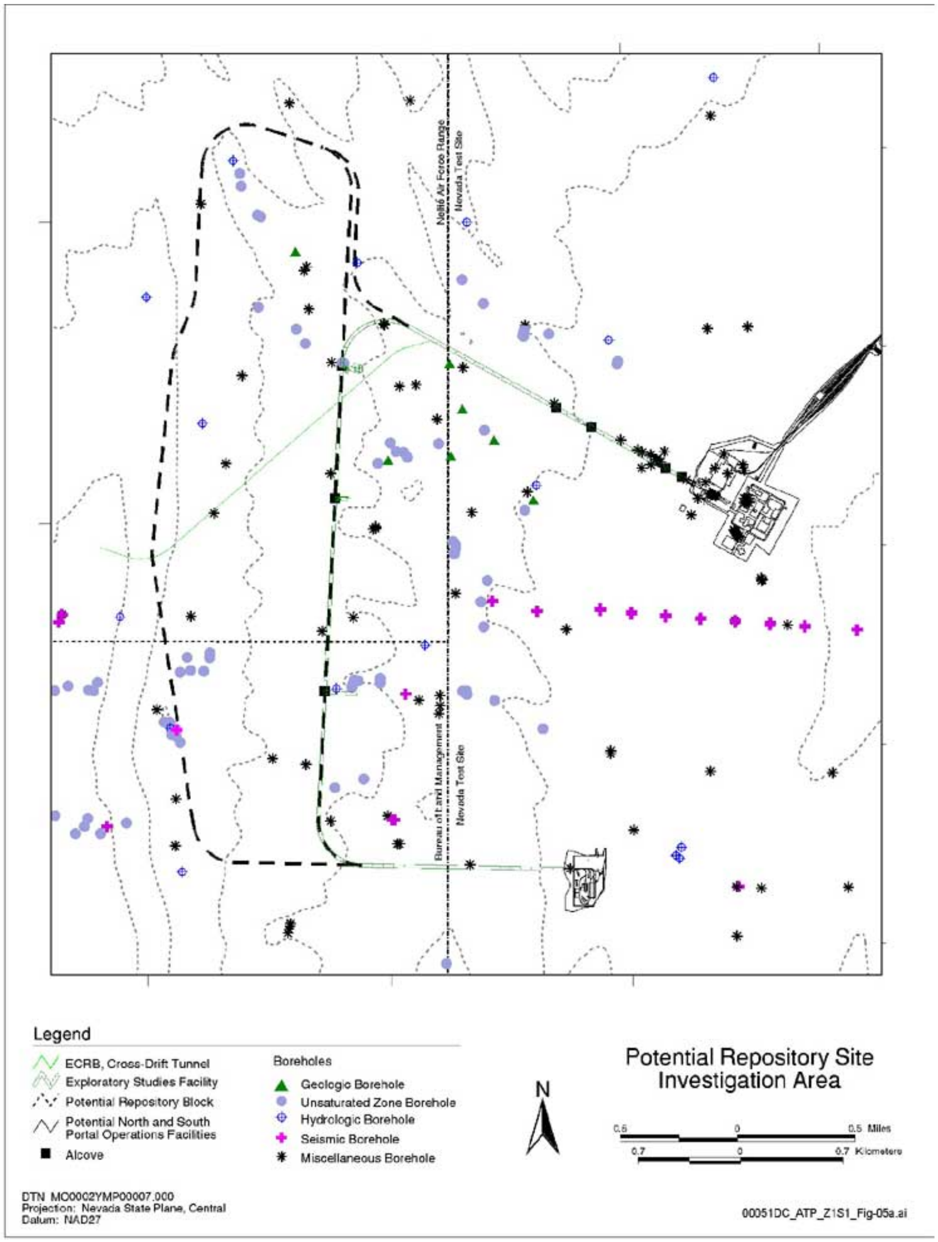
The Nuclear Waste Policy Act of 1987 – Focusing study on the best option

By the end of 1986, DOE had already conducted 5 years of extensive scientific study at potential repository sites and spent $1.1 billion.[9] This effort showed that Yucca Mountain was the best of nine sites originally considered. It was at this point, based on both confidence in Yucca Mountain and concern about escalating costs, that Congress decided to narrow the effort further. The 1987 Amendment to the NWPA redirected DOE to focus its site characterization studies solely on Yucca Mountain.

15 Years of Intensive Site Characterization Studies at Yucca Mountain

Between 1987 and 2002, DOE spent another $3.8 billion on scientific and technical studies of Yucca Mountain.[10] With this money, the Department completed in 1997 a 5-mile tunnel through Yucca Mountain to function as an Exploratory Study Facility.[11] In 1998, DOE completed a second 2-mile cross drift tunnel to facilitate additional experiments in the potential repository host rock.[12] These tunnels, and the numerous niches and alcoves carved off of them, created within Yucca Mountain the world's largest underground laboratory. From the surface, DOE drilled more than 180 boreholes deep into the geology of Yucca Mountain and its surrounding features.[13] Independent scientists working for Nye County Nevada drilled additional exploratory holes into the geology and collaborated with DOE scientists on their findings. These efforts were further supplemented by numerous laboratory experiments and excavation of similar geologic features both nearby and at natural analogue sites around the world. Through this work, the geology of Yucca Mountain and its ability to safely contain radioactive wastes became very well understood. The figure below illustrates the extent of the exploration.

[9] Office of Civilian Radioactive Waste Management, Program Financial and Budget Information, *FY 2004 Year-end Report*, p. 1-3
[10] Office of Civilian Radioactive Waste Management, Program Financial and Budget Information, *FY 2004 Year-end Report*, p. A-3
[11] *Yucca Mountain Science and Engineering Report*, DOE/RW-0539-1, February 2002, p. 1-11
[12] *Mountain Science and Engineering Report*, DOE/RW-0539-1, February 2002, p. 1-11
[13] *Mountain Science and Engineering Report*, DOE/RW-0539-1, February 2002, p. 1-12



[14]

During this time, more than 2500 scientists representing not only DOE and its direct contractors, but also five National Laboratories, the US Geologic Survey, and dozens of US Universities worked on the project. They took the data collected from Yucca Mountain and related studies and compiled it into a comprehensive assessment of the repository's predicted performance. As more data was collected, this performance assessment was continually refined. All this study and analysis was subjected to exhaustive critical peer review, most notably by the US Nuclear Waste Technical Review Board (NWTRB) – a group of 11 distinguished scientists appointed to review DOE's work and report its findings to Congress on a biannual basis as required by the NWPA. On many occasions, NWTRB's critical input resulted in substantial improvement to the project. For example, it was their idea to drill the second tunnel.

By 1998, with all of this extensive study, DOE began preparing to take the final steps toward making a decision. That year, the Department released its most comprehensive summary of

[14] *Yucca Mountain Science and Engineering Report*, DOE/RW-0539, February 2002

the effort to date – the *Viability Assessment of a Repository at Yucca Mountain*. In that document, DOE concluded:

> Over 15 years, extensive research has validated many of the expectations of the scientists who first suggested that remote, desert regions of the Southwest are well-suited for a geologic repository. Engineered barriers can be designed to contain waste for thousands of years, and the natural barriers can delay and dilute any radioactive material that migrates from waste packages.[15]

DOE was close to concluding its site characterization effort. The Viability Assessment laid out a detailed plan for completing the steps necessary to reach the long awaited decision. In accordance with that plan, DOE would spend the next three years checking and rechecking its data, validating and revalidating its models, and sharpening its analysis to reach a defensible conclusion on whether or not to move forward with the development of a repository at Yucca Mountain.

<u>The 2002 approval of Yucca Mountain – A decision based on sound science</u>

As DOE was finalizing its recommendation for the Yucca Mountain site, it sought one additional and very important independent expert review of the analysis (known as Total System Performance Assessment or TSPA) upon which that recommendation would be based. This outside reviewer, a joint peer review panel composed of top international experts assembled by the International Atomic Energy Agency and the Organization for Economic Cooperation and Development's Nuclear Energy Agency, reached its conclusion in November of 2001. The distinguished panel summarized its review with the following statement:

> While presenting room for improvement, the TSPA-Site Recommendation methodology is soundly based and has been implemented in a competent manner. Moreover, the modeling incorporates many conservatisms, including the extent to which water is able to contact the waste packages, the performance of engineered barriers, and retardation provided by the geosphere.
>
> Overall, the International Review Team considers that the implemented performance assessment approach provides an adequate basis for supporting a statement on likely compliance within the regulatory period of 10,000 years and, accordingly, for the site recommendation decision.[16]

Bolstered by the International Review Team's endorsement, the results of multiple reviews by NWTRB and the Nuclear Regulatory Commission (NRC), and DOE's own exhaustive internal reviews, the Secretary of Energy was in a position to recommend the Yucca Mountain site for development as a geologic repository. However, prior to making that recommendation, DOE subjected its work to intensive public scrutiny.

Between May and August of 2001, DOE issued two science reports[17], each containing thousands of pages of information, summarizing the 15 year site characterization effort and solicited public comment on those reports over a period that extended to December. During this period DOE held 66 public hearings and sent 6,000 letters to individuals, corporations, and groups requesting comments.[18] By February of 2002 DOE had

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[15] *Viability Assessment of a Repository at Yucca Mountain*, DOE/RW-0508, December 1998, p. 36

[16] *OECD/NEA-IAEA Joint International Peer Review of the Yucca Mountain Site Characterization Project's Total System Performance Assessment Supporting the Site Recommendation Process, 2 November 2001*, p.4

[17] DOE, *Site Recommendation Comment Summary Document*, DOE/RW 548, February 2002. p. viii.

[18]*DOE's* Office of Civilian Radioactive Waste Management

considered and responded to all 17,000 comments received and, on February 14, the Secretary of Energy recommended the Yucca Mountain site to the President.[19]

As evidence of the scientific basis for going forward with the Yucca Mountain site, the Secretary's recommendation contained a comprehensive 850 page Science and Engineering Report[20] providing extensive detail on the work conducted at Yucca Mountain and an even more voluminous Environmental Impact Statement[21] showing that the recommended repository would have little to no adverse affect on future populations or the environment. The Secretary in the following statement summarized this work:

> After over 20 years of research and billions of dollars of carefully planned and reviewed scientific field work, the Department has found that a repository at Yucca Mountain brings together the location, natural barriers, and design elements most likely to protect the health and safety of the public, including those Americans living in the immediate vicinity, now and long into the future.[22]

The President approved the Secretary's recommendation. In April of 2002, the Governor of the State of Nevada, as provided for by the NWPA, vetoed this decision. In the NWPA's unprecedented procedure for assuring that any site decision received thorough and fair consideration, the Governor's veto could only be overridden by a majority vote in both houses of Congress. For three months Yucca Mountain was hotly debated in Congress, in committee hearings and on the floor of the House and Senate. In the end, Congress agreed with the President and voted to override the Nevada Governor's veto by an overwhelming bipartisan majority – 306-117 in the House and 60-39 in the Senate. In July 2002, the President signed this approval into law as the Yucca Mountain Development Act (YMDA).

By the time the YMDA was enacted, DOE had spent $7.1 billion on the evaluation of multiple sites, detailed study of Yucca Mountain, the preparation and defense of the site recommendation, and related waste acceptance and transportation planning activities. In the three years since, DOE has spent another $1.5 billion preparing a Yucca Mountain license application and continuing to work on its plans for the transportation to and acceptance of nuclear waste at Yucca Mountain. The Department will spend additional billions of dollars defending its application in the exhaustive NRC licensing process and completing its transportation and waste acceptance plans before construction of the repository can begin.

The Courts reject litigation challenging the 2002 Yucca Mountain approval

The Yucca Mountain project has not only been the subject of intense scientific and technical study, but judicial scrutiny as well. Most recently, in July 2004, the United States Court of Appeals for the District of Columbia Circuit handed down a decision in 13 separate cases – nine of which were initiated by the State of Nevada – consolidated together under the name *Nuclear Energy Institute v. Environmental Protection Agency*. In its decision, the Court addressed challenges to actions taken by the Environmental Protection Agency (EPA), NRC, DOE, the President, and Congress. The Court rejected all challenges to the Yucca Mountain project except for one.

Among the issues decided in favor of the project were DOE's use of a system of natural and engineered barriers to safely contain radioactive material; DOE's regulations and Final Environmental Impact Statement for Yucca Mountain; and the constitutionality of the

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[19] DOE's Office of Civilian Radioactive Waste Management

[20] *Yucca Mountain Science and Engineering Report*, DOE/RW-0539, February 2002

[21] *Final Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada*, DOE/EIS-0250, February 2002

[22] *Recommendation by the Secretary of Energy Regarding the Suitability of the Yucca Mountain Site for a Repository under the Nuclear Waste Policy Act of 1982*, DOE, February 2002, p. 6

Yucca Mountain Development Act, which statutorily approved the Yucca Mountain site for development as a repository. All of these issues have now been finally decided and all parties to the litigation have elected not to appeal. They cannot be raised again, having been conclusively determined by the Court.

The only challenge to the project upheld by the Court was restricted to the limited issue of EPA's adoption of a 10,000-year period for evaluating repository performance. In particular, the Court determined that EPA's radiation standard was not "based on and consistent with" a National Academy of Science's recommendation that compliance be determined based on when peak dose is estimated to occur, as long as that scientifically-determined estimate does not extend beyond one million years. The Court concluded that there were two options: Either EPA could revise its regulations to extend the compliance period out to the time of peak dose; or Congress could enact legislation to specify what the compliance period should be.

After evaluating its options for complying with the Court decision, EPA proposed in August 2005 to modify its regulations to add a separate standard to limit radiation exposures over the period extending from 10,000 years to 1 million years in the future. While the court's ruling may delay the project, DOE remains obligated to comply with the NWPA and YMDA and to continue with the project. The nation's top scientists, their international peers, Congress, the President, and the Courts are in firm agreement – the Yucca Mountain project must go forward.

MARGIN OF SAFETY

<u>The most stringent radiation protection standards ever imposed</u>

In addition to specifying the procedure for selecting a repository site, and providing a mechanism for funding it, the NWPA also specifies a process for establishing the regulations against which the safety of any repository will be judged. This process requires EPA to establish a radiation protection standard and for NRC to regulate the repository using regulations based on that standard. The 1992 Energy Policy Act amended the NWPA to provide specific instructions to EPA and NRC to base this standard and regulation on the specific recommendations of the National Academy of Sciences. In 1995, the Academy provided the recommendations called for in the Act[23], and in 2001, the agencies completed rulemakings promulgating these requirements[24]. These requirements represent the most advanced waste disposal regulations in the world.

The scientists and regulators at the Academy and the implementing agencies sought to achieve extraordinarily high assurances that the health and safety of both present and future generations would be protected. They responded to the unprecedented challenges of the repository by requiring levels of protection and measures that exceed any known precedent.

For example, EPA set the limit for radiation exposures to individuals in future populations over the next 10,000 years to 15 millirems per year. EPA's August 2005 proposal adds a separate requirement that radiation exposures be shown to be less than 350 millirems per year over the next 1 million years. Although scientists conservatively assume that even small amounts of radiation carry some risk of health effects, both limits are quite small in comparison to levels at which health effects are know to occur. Such effects have not been observed below 1000 millirems and exposures do not become fatal until levels approach

[23] *Technical Basis for Yucca Mountain Standards*, National Academy Press, 1995
[24] EPA Standard 40 CFR Part 197 and NRC Regulation 10 CFR Part 63

200,000 millirems[25] (for acute, or all-at-once, exposures as opposed to exposures spread out over a year).

While regulators typically set such limits far below levels known to cause health effects, in the case of the Yucca Mountain standard, EPA has gone farther than most other countries. In the United States, public radiation limits for low-level radioactive waste disposal facilities and uranium fuel cycle facilities are set at 25 millirems per year.[26] Internationally, Germany sets a repository limit at 30 millirems per year and France at 25 millirems per year while Spain, Switzerland, and the Nordic countries set the lowest limits at 10 millirems per year.[27]

In reality though, the EPA standard is even tougher than the low end of the international spectrum because of a groundwater standard that the EPA included in addition to the 15 millirem per year individual protection standard. This will require DOE to show radiation exposures to future individuals are far below the 15 millirem per year limit. NRC will then incorporate these limits in its rigorous licensing regulations for Yucca Mountain.

The specific radiation limits set are only one element of the regulations that exemplify their stringency. The Academy's recommendations have defined requirements for a "Reasonably Maximally Exposed Individual" to test compliance with the radiation protection limits[28].

In DOE's Yucca Mountain TSPA, the Department must assume that this individual:

- lives at a point near Yucca Mountain directly above the highest concentration of radionuclides flowing from beneath Yucca Mountain;
- lives a lifestyle consistent with that currently observed in this region (which is highly dependent on groundwater for drinking, crop irrigation, bathing, etc.), and drinks two liters of the contaminated groundwater every day;
- has no knowledge of the nearby repository or ability to treat his water supply to remove radioactive contaminants; and
- has no access to any advance in technology or knowledge that could render him less susceptible or even impervious to the risks of Yucca Mountain.

In carrying out its role, as prescribed by EPA, NRC adds additional layers of protection by specifying detailed requirements for every aspect of DOE's TSPA and by requiring that DOE demonstrate that it meets the radiation protection limits with multiple barriers. In addition to its repository regulation, NRC has specified detailed expectations for DOE's technical analysis in a 400 page Yucca Mountain Review Plan.[29]

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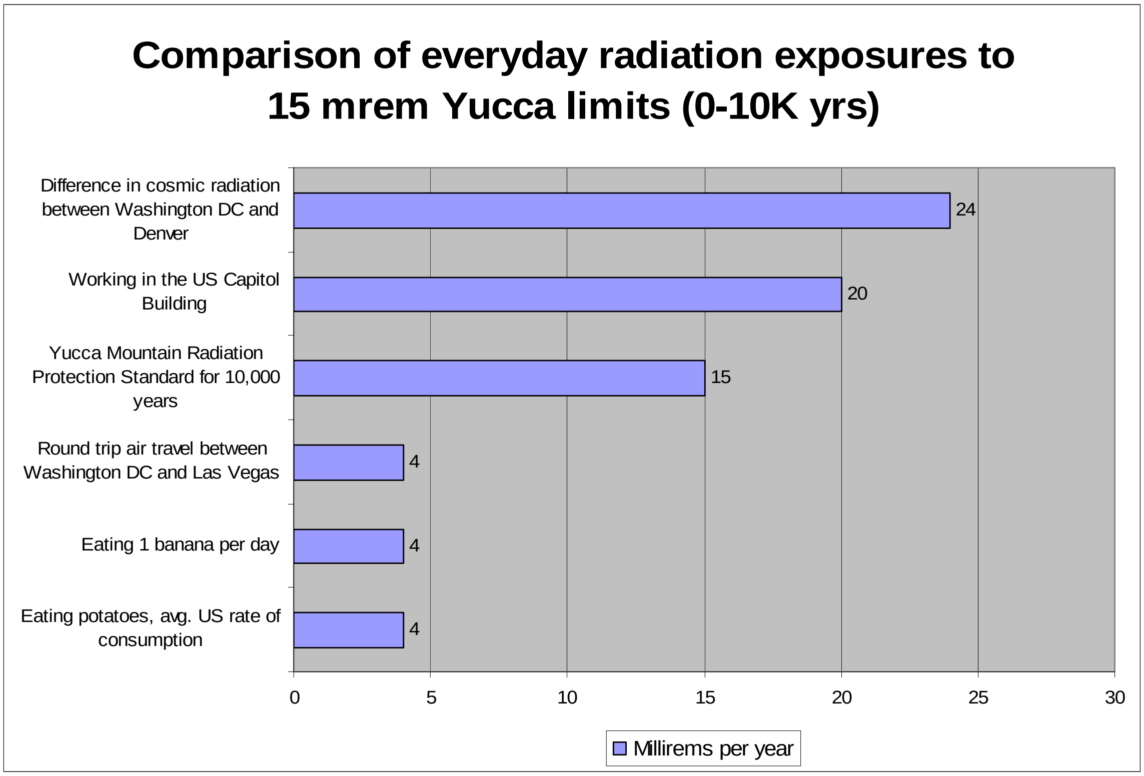
25 *Introduction to Nuclear Engineering*, John R. Lamarsh, 2nd Edition, 1983, p. 415
26 *Technical Basis for Yucca Mountain Standards*, National Academy Press, 1995, p. 50
27 *Technical Basis for Yucca Mountain Standards*, National Academy Press, 1995, pp 43-45.
28 40 CFR 197.21
29 NUREG-1804, *Yucca Mountain Review Plan*, USNRC, July 2003

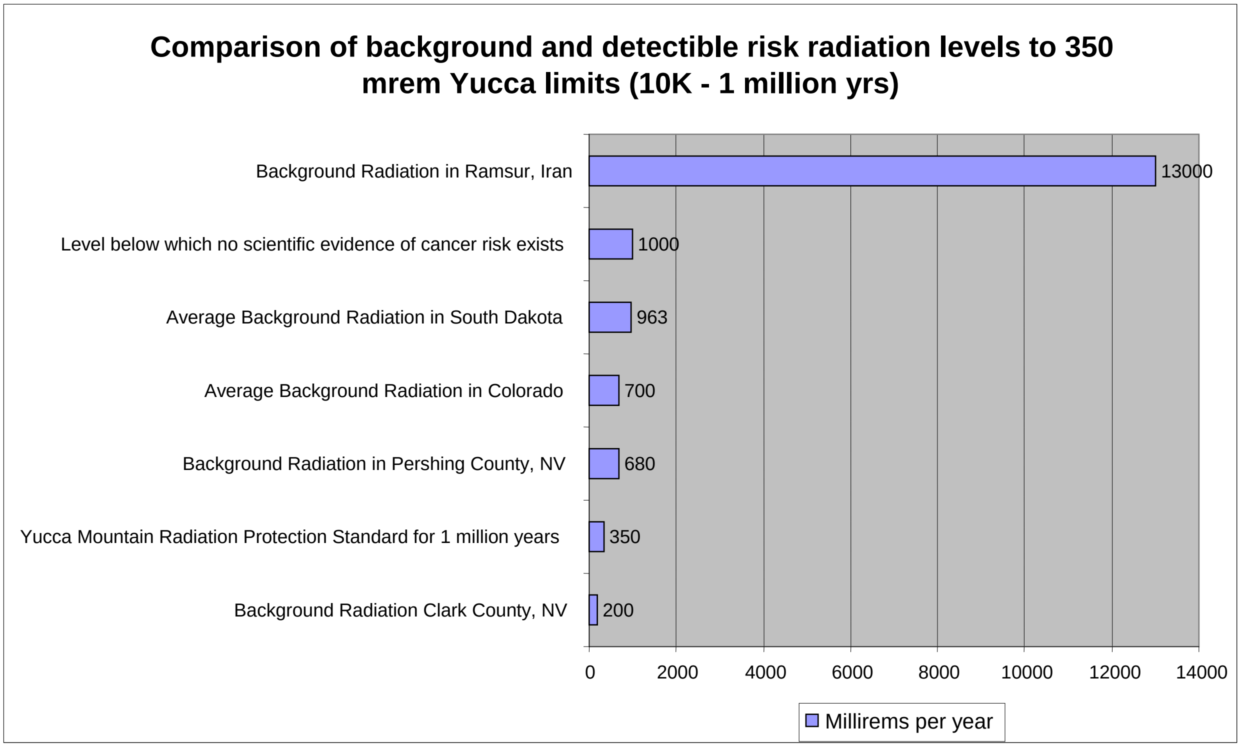
Risks in perspective[30, 31, 32, 33]

The 15 millirem per year (in addition to background) limit imposed on Yucca Mountain for the first 10,000 years is not only low by nuclear regulatory standards, but is small in comparison to many everyday encounters with radiation. The chart below provides some examples:



Similarly, the 350 millirem limit proposed for the time period between 10,000 and one million years can be seen to be small in comparison to normal exposures. In addition, this dose is small when compared to doses received by members of the public from natural background radiation from radon gas, cosmic, and terrestrial sources and even smaller in comparison to the level at which scientists can begin to detect any risk of cancer. The following chart illustrates this:

[30] Ralph Anderson, Certified Health Physicist
[31] Proposed 40 CFR 197, Public Health and Environmental Radiation Protection Standards, Yucca Mountain, Nevada; USEPA, 70 Fed. Reg., 49037
[32] *A Review of Radiation Dose Response and Recommendations for the Final Step in Risk Assessment*, Hechanova and Morris, Harry Reid Center for Environmental Studies, September 16, 1999, Table 1
[33] *The Health Effects of Low-Level Radiation*, American Council on Science and Health, September 2005



In summary, 15 millirems is not considered a significant amount of radiation, and one would have to live a very limited lifestyle in a carefully selected location to keep exposure below 350 millirems per year.

Nevertheless, opponents of Yucca Mountain claim that radiation levels set by this standard are unsafe, touting calculations that purport to show that 15 millirems/yr equates to a 1 in 835 chance of cancer and 350 millirems/yr equates to a 1 in 36 chance of cancer. There is absolutely no data behind these numbers. They come from an extrapolation of the linear nonthreshold dose/health effects model published in the recent NAS report[34]. This "statistic" is derived by extrapolating effects from what is known about much higher levels of radiation to the lower levels of radiation that will be encountered at Yucca Mountain. Hence they are mixing apples and oranges. What is even more misleading is that the radiation doses used from the NAS extrapolation models by the opponents are for doses received by individuals all at once whereas the radiation doses at Yucca Mountain are for doses received over the lifetime of an individual. One cannot simply take the sum of radiation doses received over a lifetime and treat all of these doses as one instantaneous dose to the body. It is also important to note that the doses used in the model by the NAS are for an entire population whereas the dose estimates at Yucca Mountain represents the most exposed individuals in the population. The Health Physics Society pointed out the best use of the NAS' model:

> In accordance with current knowledge of radiation health risks, the Health Physics Society recommends against quantitative estimation of health risks below an individual dose of 5 rem in one year or a lifetime dose of 10 rem (10,000 mrem) above that received from natural sources. Doses from natural background radiation in the United States average about 0.3 rem per year. A dose of 5 rem will be accumulated in the first 17 years of life and about 25 rem in a lifetime of 80 years.

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[34] *Health Risks from Exposure to Low Levels of Ionizing Radiation: BEIR VII – Phase 2*, National Academy of Sciences, ISBN:0-309-09156-X, 2005

> Estimation of health risk associated with radiation doses that are of similar magnitude as those received from natural sources should be strictly qualitative and encompass a range of hypothetical health outcomes, including the possibility of no adverse health effects at such low levels. [35]

The statement above clarifies that "estimation of health risk" should be qualitative (not quantitative) at levels involving radiation doses that are of similar magnitude as those received from natural sources.

Although hundreds of studies have looked for health effects at low levels of radiation – even at levels 3 times higher than EPA's proposed 350 millirem limit, no such effects have been found. There is no discernable difference in cancer rates between people who live in high background radiation regions and those in low background regions – even though the differences are often times far more than 350 mrem per year.

Pessimistic assumptions

The setting of stringent standards is one of several elements of a defense-in-depth approach to protecting public health and safety that applied to Yucca Mountain. Even greater levels of protection are provided by the cautiously pessimistic approach (known in scientific circles as conservatism) that DOE will use to demonstrate compliance with these requirements. As mentioned above, DOE is required by regulation to make many conservative assumptions about how much groundwater potentially exposed individuals drink and how little benefit they will receive from future advances in technology. However, in addition to what is required by regulation, even deeper layers of conservatism are added by assumptions DOE's scientists and engineers make to account for uncertainties about the future by erring on the side of safety.

The TSPA that will support DOE's license application to NRC will not merely show that radiation exposures to the hypothetical RMEI will be below 15 millirems per year over the next 10,000 years but will show exposures levels far beneath this level due to the added conservative assumptions. Similar levels of conservatism will be built into DOE's million-year analysis once the EPA's rulemaking is completed.

Three specific examples of DOE selecting worse case inputs to their analysis are the manner with which the Department treats the mobility of a key radioisotope – Neptunium – in the Yucca Mountain geology, their approach to addressing the extremely remote possibility that volcanoes may affect the repository in the distant future, and their inclusion of "fast-pathways" through the mountain in the TSPA even though the evidence of the existence of these pathways is not conclusive.

Neptunium 237 is one of the longest-lived radioisotopes present in nuclear waste, with a half-life of over 2 million years. Therefore, it is an extremely important contributor to radiation exposure risk in the distant future, accounting for as much as 69 percent of potential exposures after 100,000 years.[36] Of course, whether or not anyone actually receives such an exposure depends on the ability of neptunium to escape from used nuclear fuel, move through the rocks of Yucca Mountain, and contaminate groundwater. This scenario depends on the solubility of Neptunium at the surface of dissolving nuclear fuel in the Yucca Mountain environment. This parameter is not a known value, it is one DOE must determine based on experimental data.

DOE has invested considerable scientific effort examining this data and has arrived at what the agency believes is a conservative determination of neptunium solubility. Independent

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[35] *Radiation Risk Perspective*, Health Physics Society, August 2004

[36] *Yucca Mountain Science and Engineering Report*, DOE/RW-0539, February 2002, p. 4-442

scientists who have looked at the same data find DOE's choice of a value for neptunium solubility to be conservative. In fact, scientists at the Electric Power Research Institute have called DOE's base case assumptions in this area "unrealistically conservative"[37] and expressed concern that DOE's conceptual model of neptunium solubility "imposes an unwarranted perception of potentially higher dose levels resulting from a repository at Yucca Mountain than is reasonably supported by data from the DOE and independent international scientific peer groups."[38]

The annual probability that a volcano could erupt in Yucca Mountain in the distant future is estimated to be just above the 1 in 100 million regulatory threshold that requires an event to be considered in the Yucca Mountain TSPA.[39] Consideration of such highly unlikely events is in itself conservative and DOE did consider such an event. In DOE's conservative analysis, a volcano is the "primary disruptive event" contributing to long-term radiation exposures.[40] DOE postulates a violent scenario in which an unusually energetic eruption completely vaporizes numerous waste packages and throws small radioactive particles to the surface where they could be easily inhaled. Scientists from the Electric Power Research Institute developed their own scenario and concluded "a series of compounding conservatisms used by DOE and NRC lead to about 9 orders of magnitude of conservatism associated with any potential radiation dose."[41] Nine orders of magnitude mean that the DOE scenario overestimates volcano risks by a factor of 1 billion – but still shows compliance.

For many years, scientists have debated the topic of whether or not the possible presence of the radioisotope Chlorine-36 in Yucca Mountain is an indication of "fast pathways" for the travel of water through the mountain. This debate continues even though it remains a subject of disagreement between scientists as to whether the isotope exists at the site.[42] The only way for such "recent" Chlorine-36 to have reached the depths of Yucca Mountain would be through "fast pathways" along a somehow interconnected grid of fractures in the rock. While the debate is technically unsettled, DOE has for now rendered it moot by taking the conservative approach of assuming that these elusive fast pathways do exist. They have incorporated fracture flow parameters into the TSPA based on the worst-case interpretation of the Chlorine-36.[43] In all likelihood, DOE is again overestimating radiation exposures for the sake of erring on the side of safety.

Even with all of these conservatisms, DOE's analyses of Yucca Mountain have consistently shown that public health and safety will be protected. But what would the future of Yucca Mountain look like if all of the excessive conservatisms were removed? The answer to that question most likely lays in the distant past, at a place called Oklo in Gabon, Africa. At that location over a billion years ago, a natural nuclear reactor formed in uranium deposits producing the same radioactive waste isotopes that we are trying to dispose of from modern commercial nuclear reactors.[44] Those radioisotopes remained right where they started, contaminating nothing, harming no one – in a climate not nearly as dry and favorable to long term waste isolation as Yucca Mountain. The remaining long-lived isotopes are in fact so

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[37] *Review of Alternative Models and Supporting Evidence for Maximum Neptunium Concentrations at the Proposed Yucca Mountain Repository*, EPRI Report 1012104, July 2005, p. v

[38] *Ibid*, p. vi

[39] *Potential Igneous Processes Relevant to the Yucca Mountain Repository*: Extrusive-Release Scenario, EPRI Report 1008169, June 2004, p. 1-2

[40] *Yucca Mountain Science and Engineering Report*, DOE/RW-0539, February 2002, p. 4-450

[41] *Potential Igneous Processes Relevant to the Yucca Mountain Repository*: Extrusive-Release Scenario, EPRI Report 1008169, June 2004, p. 11-3

[42] Letter B. John Garrick, Chairman US Nuclear Waste Technical Review Board, to Dennis Hastert, Speaker of the House, Ted Stevens, President Pro Tempore of the Senate, and Spencer Abraham, Secretary of Energy, December 30, 2004

[43] *Yucca Mountain Science and Engineering Report*, DOE/RW-0539, February 2002, p. 4-43

[44] American Nuclear Society, *Oklo's Natural Fission Reactors*, www.ans.org/pi/np/oklo/

well preserved in their original location that they provide scientists with "pristine timing records" for the operation of the natural reactor 2 billion years ago.[45]

YUCCA MOUNTAIN PEFORMANCE ASSESSMENT – CURRENT STATE OF KNOWLEDGE

Water infiltration into Yucca Mountain is low and well understood

In deep geologic disposal, the one overriding concern is the potential for radioactive contaminants to reach the accessible environment. Every known process for degrading and transporting such contaminants involves water. Yucca Mountain is one of the driest locations in the United States, receiving an average annual rainfall of only seven inches.[46] 95 percent of the water falling on Yucca Mountain either evaporates or runs off, further limiting the amount available to seep into the repository.[47] It also provides a minimum of 1200 vertical feet of dry solid rock above the water table.[48] DOE has chosen to locate the repository in that dry rock mid-way between the surface and the water table.

Of course, science is not simply content with finding the driest spot for disposal. With regulatory requirements that limit releases to fractions of natural background radiation, scientists have been concerned with how even the smallest traces of water might move through mountain and affect the repository. Most of the billions of dollars spent have been focused on studying how small quantities of water move through the mountain, how that moisture might affect the engineered barriers that will protect the waste, and how water might transport radionuclides from the repository to and through the water table.

Through this massive scientific effort, DOE has learned how small amounts of water can seep into the surface of the mountain, how these droplets are distributed and redistributed by fractures, faults and multiple layers of different types of rock, what barriers to flow the water might encounter, how flow characteristics will be affected by heat given off by the emplaced waste, and what causes water to drip into the tunnels or to be diverted along the tunnel walls.

This information is collected and analyzed by multiple scientific teams, checked and rechecked, and examined by outside experts in each of the highly specialized fields that look into the geo-hydrology of Yucca Mountain. The results of this work are then compiled into conservative models that estimate the rate at which these tiny amounts of moisture might reach the engineered barriers that will protect waste in the repository tunnels.

Other teams of scientists evaluate in similar detail how the water might degrade the engineered barriers over long periods of time. These scientists also construct conservative models of radiation release which, in turn, serve as input to yet more analyses by scientists who specialize in how radioactive material might travel along flow paths in the rock to the water table below. More conservative assumptions are added and then the flow of groundwater itself is evaluated as the last leg of the journey to the well of the awaiting individual (RMEI) who must, by regulation, drink the water at a rate of two liters per day.

The 7 miles of tunnels and 180+ boreholes drilled into Yucca Mountain have allowed DOE to observe all of these phenomena. They have injected water into the mountain and measured it in the tunnels. They have heated the rock and measured its response. They have routed tracers through the fractures and faults. They combine what they learn from

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45 *Record of Cycling Operation of the natural Nuclear Reactor in the Oklo/Okelobondo Area in Gabon*, AP Meshik et. al., American Physical Society, May 13, 2004, p. 4

46 *Yucca Mountain Science and Engineering Report*, DOE/RW-0539, February 2002, p.5-8

47 *Yucca Mountain Science and Engineering Report*, DOE/RW-0539, February 2002, p.4-22

48 *Yucca Mountain Science and Engineering Report*, DOE/RW-0539, February 2002, p. 5-8

inside the mountain with still more data taken from conventional laboratory experiments and computer modeling. They seek the opinions of the world's leading independent experts and comparative data from natural analogue sites. They compile all of this into a comprehensive assessment of Yucca Mountain's expected performance. At every step, they add conservatisms, making sure that they have not *underestimated* the risk from water.

When all of the science of water flow through all of the different parts of the geologic system is brought together, it provides a compelling story of just why Yucca Mountain is a safe disposal site. Not only is water scarce, it's going to have a long road to make any difference at all. DOE's conservative analysis, which includes fast pathways for water travel, shows that it will take at least 500 years for a single molecule of water to travel from initial contact with the surface, through the repository, to the RMEI's drinking water. 99 percent of all water molecules on this journey will take over a thousand years and 50 percent will take over 10,000 years to complete the trip.[49]

Multiple Barriers will provide defense-in-depth protection

The dry remote location of Yucca Mountain is only the first of many protective features that characterize the repository under development at this site. The current repository design includes nine separate and distinct protective barriers in the mountain itself.[50] Some of these are natural, and some of them are man made. They are listed as follows

1. Surface soils and topography - which limit the amount of water seeping into Yucca Mountain.
2. Depth - at least 600 feet of dry rock above the repository tunnels (a geologic region known as the unsaturated zone) through which water can only move very slowly.
3. Titanium drip shields - placed in the tunnel to prevent water from dripping directly onto, and falling rocks from damaging, the packages in which the waste is contained.
4. Waste Packages - made of the most corrosion resistant metal known to man (Alloy-22). This metal is the result of over 100 years of evolutionary experience with progressively more durable nickel-chromium alloys.
5. The Zirconium or stainless steel cladding - incases each and every used nuclear fuel element.
6. Waste form - used nuclear fuel is a solid ceramic material that is difficult to break down.
7. The structural materials placed on the tunnel floors – limits release of waste to saturated zone beneath the waste packages.
8. Depth beneath repository - 600 feet (minimum) of dry rock between the repository tunnels and the groundwater (again, the unsaturated zone)
9. The geology of the region in which the groundwater flows (known as the saturated zone) - many radioactive molecules will adhere to these wet features and be blocked from reaching the drinking supply.

The advantage of having so many protections is that if any of them perform less effectively than expected, the others will still protect public health and safety.

[49] *Expected Travel Time of a Water Molecule*, Presentation of J. Russell Dyer USDOE, Presentation to the Nuclear Waste Technical Review Board, March 9, 2004, p. 4

[50] *Barrier Capability Analysis*, Presentation of Peter Swift, Sandia National Laboratories to the Nuclear Waste Technical Review Board, January 28, 2003

Key Technical Issues have been resolved

DOE's understanding of the movement of water through Yucca Mountain and its confidence in the multiple barriers that provide protection against radiation release have been thoroughly scrutinized and challenged by NRC's technical staff during an exhaustive pre-licensing review of DOE's technical work. This review was specifically called for by the NWPA to prepare both agencies for the licensing process. Over the last 5 years, DOE and NRC technical staff's have met on dozens of occasions to discuss the details of this work. In these meetings, NRC staff raised questions and requested additional information on 293 specific technical topics. These inquiries became known as Key Technical Issue Agreements (KTIAs).

Over the years, correspondence and additional interactions between the agencies on the KTIAs have been intense, continuous, and occasionally contentious. All of this played out in a public forum in which outsiders, including Yucca Mountain's staunchest opponents, weighed-in. Throughout this process DOE was consistently able to produce the requested additional information (often conducting additional research) and answer the tough questions. Today, NRC considers 255 of these 293 KTIA's to be closed.[51] The rest are either in the final stages of negotiation or are the subject of DOE commitments to answer in the forthcoming license application.

NRC is not the only outside reviewer that has questioned DOE's work. The distinguished scientists of the NWTRB have been testing DOE's scientific knowledge for 15 years.[52] Public NWTRB meetings, conducted approximately three times each year are highly adversarial in nature. The NWTRB panel grills DOE's experts for hours in an inquisition style forum. NWTRB carefully considers how DOE responds and documents its views in letters and reports to Congress. In January 2002, the Board noted several program strengths and weaknesses and told Congress that "no individual scientific or technical factor has been identified that would automatically eliminate Yucca Mountain"[53]. Since this time, the Board has continued to hone in on what it perceived to be the project's weaknesses. In July 2004, the Board reversed its position on the most significant of these, the possibility that corrosion would attack waste packages at a greater rate than DOE had estimated, concluding that the corrosion mechanism of concern was now considered to be "unlikely".[54] By the end of 2004, the Board's view of the project was taking on an increasingly supportive tone with a year-end summary to Congress stating "the Board believes that progress has been made in several of the areas on which the Board commented in its letters to DOE."[55]

The fact that DOE's work has been subject to the critical review of NRC and NWTRB, over a period of several years, has given policy-makers confidence that the Department's well documented understanding of Yucca Mountain is valid. These reviews will continue and (in the case of NRC during the licensing process) intensify over the coming years as the project moves forward.

If challenges brought by independent experts were not enough, the Yucca Mountain program is specifically designed to engender critical input from the project's staunchest

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51 DOE/NRC Quarterly Management meeting, June 6, 2005, Pahrump, Nevada.

52 First NWTRB Report to Congress, March, 1990

53 Letter US Nuclear Waste Technical Review Board, to Dennis Hastert, Speaker of the House, Robert Byrd, President Pro Tempore of the Senate, and Spencer Abraham, Secretary of Energy, January 24, 2002

54 Letter US Nuclear Waste Technical Review Board, to Dr. Margaret Chu, Director, USDOE Office of Civilian Radioactive Waste Management, July 28, 2004

55 Letter US Nuclear Waste Technical Review Board, to Dennis Hastert, Speaker of the House, Ted Stevens, President Pro Tempore of the Senate, and Spencer Abraham, Secretary of Energy, December 30, 2004

opponent. The State of Nevada, which is ardently opposed to the project, receives up to $2 million each year from the nuclear waste fund to conduct oversight.[56]

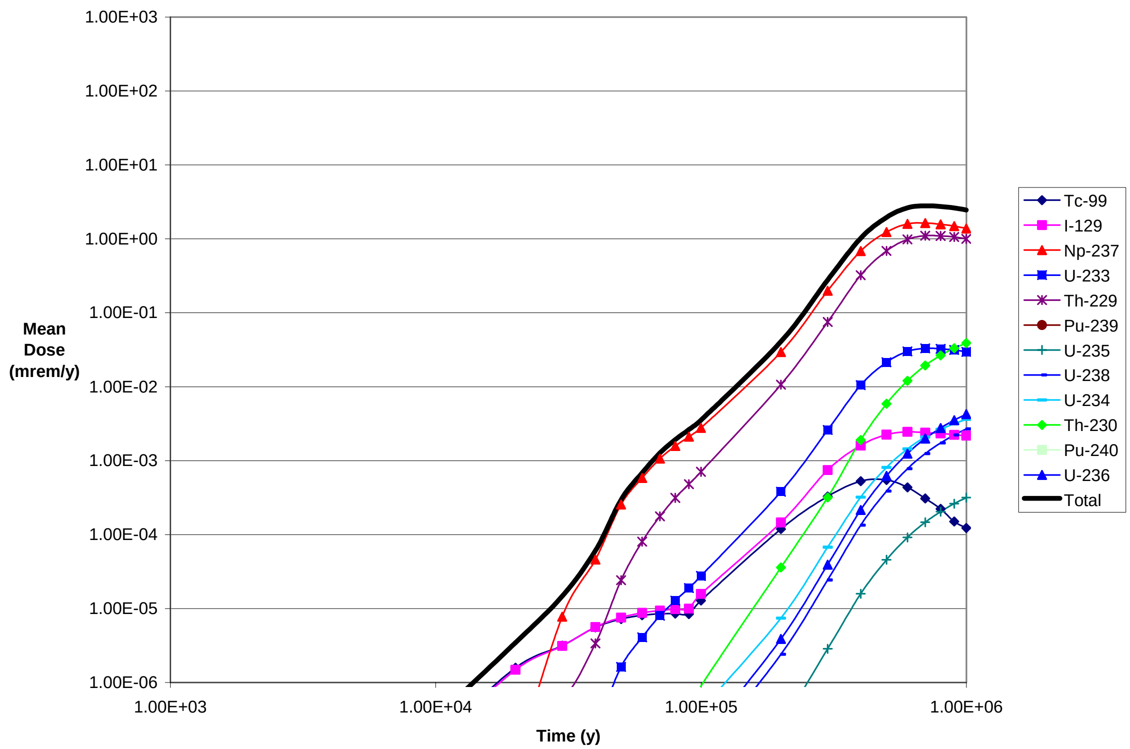
What we know tells us that radiation risk to future populations will be low

Working with a well understood mountain, the multiple natural and manufactured barriers it provides, and proven methods for addressing technical issues that have been thoroughly vetted with NRC, NWTRB, independent peer review groups and others, DOE has refined its TSPA of Yucca Mountain.

DOE's most recent TSPA projects that annual radiation exposure to future populations will be less than 0.00002 millirems for the first 10,000 years after the repository is closed.[57] This is a tiny fraction of the regulatory limit of 15 millirem, which is already conservatively low.

Although DOE projections for periods beyond 10,000 years are highly conservative and regulatory limits for such projections have yet to be established, the same analysis shows that annual exposures for a million years after repository closure would always be less than 150 millirems – well below what people already receive.[58]

Removing the excess conservatisms, as independent scientists at the Electric Power Research Institute have done in their analyses, shows that doses will be less than 10 percent of what DOE projects. The following figures show the results of EPRI's more realistic analysis carried out over a 1 million year time period.[59] Note that the dose at 10,000 years is expected to be 0 mrems per year and the dose at 1 million years is expected to be about 3 mrems per year.



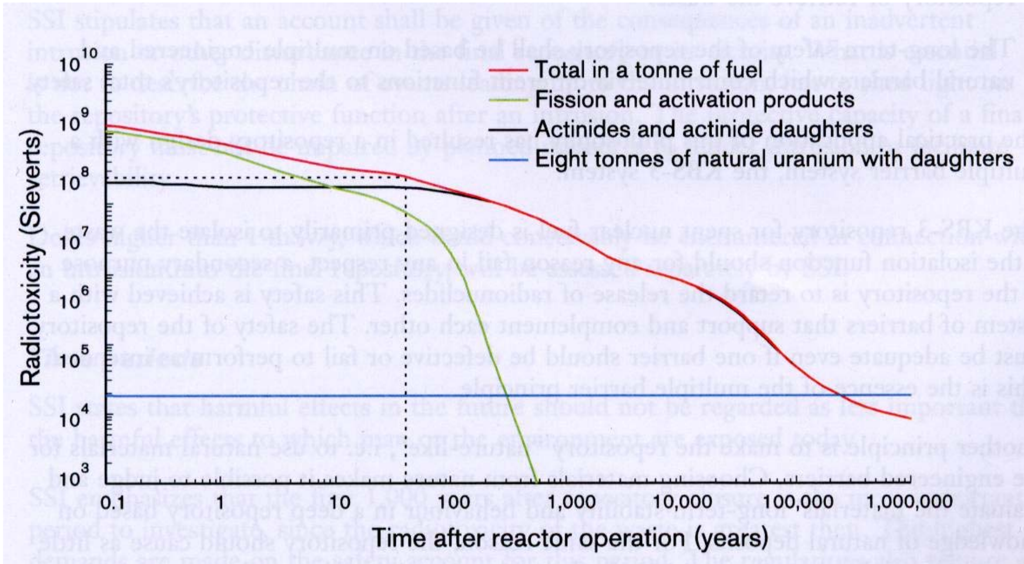
[56] *FY2005 Consolidated Appropriations Act,* Conference Report

[57] *Final Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada*, DOE/EIS-0250, February 2002, p. 5-24

[58] *Final Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada*, DOE/EIS-0250, February 2002, p 5-25

[59] *Scientific and Technical Priorities at Yucca Mountain*, EPRI Final Report 1003335, December 2003, p 4-18

An alternate way to look at the risk to future populations over an extremely long time frame, and to put both DOE's conservative analysis and EPRI's more realistic assessment in perspective, is to compare how the radio-toxicity of used nuclear fuel compares to that of the natural uranium ore from which it was produced. The figure below shows that well before 1 million years, the material we will be putting into Yucca Mountain will be less hazardous than the material we originally mined from the earth.



From this perspective, it becomes apparent that the effects of the repository to future generations are likely to be far less than what even today's most realistic predictions suggest.

FUTURE REVIEWS OF PROJECT AND OVERSIGHT

Rigorous NRC licensing process lies ahead

As much as the scientific and technical basis for moving forward with the geologic disposal of nuclear waste has been tested over the last 15 years – the most significant test still lies ahead. The NWPA calls for NRC to conduct a 3-year review (with the option for the Commission to extend for one additional year) of DOE's application to build and operate a repository at Yucca Mountain before construction of the repository can be authorized. The review does not end there. NRC will conduct additional reviews as the repository is being constructed before operations can be authorized.

These reviews will be intensive and each consists of two major phases. During the first phase, NRC technical staff and independent experts operating under contract to the NRC will review the Department's application. They will ask questions, request additional information, and reach a determination on whether or not the scientific and technical basis for developing the repository is sound. During the second phase, opponents of the project will be given an opportunity to contest any of the findings reached in the first phase. Each contention will be heard by an independent adjudicatory panel of three judges who will hold hearings, gather facts, and rule on the merits of these contentions. Essentially, every element of the Yucca Mountain license application will be put on trial twice. NRC will only be able to issue a construction authorization if the first determinations have been completed favorably (e.g. a ruling favorable to the project). NRC will not be able to license the operation of the repository until the second trial is similarly completed.

As mentioned above, NRC has spent a considerable effort over several years preparing for this review. In addition to the dozens of scientists and engineers on its own technical staff, NRC maintains a $19 million dollar per year independent scientific program at the Center for Nuclear Waste Regulatory Analysis to provide expert input.[60] Opponents of the project have also spent a significant amount of effort preparing to challenge both DOE's work and NRC's review of it in the second phase of the project. The State of Nevada, who opposes the project, has retained a legal team of experienced nuclear litigators for this purpose.

While the completed work and exhaustive reviews provide an extraordinarily high level of confidence that waste disposal at Yucca Mountain will be safe, the coming reviews which will occur during the licensing process are designed to remove any doubt.

Monitoring and retrievability will provide for future enhancements

No matter how safe we believe waste disposal at Yucca Mountain is today, there will always be opportunities that arise to make it safer in the future. Current NRC regulations require performance confirmation programs to verify that the repository is "functioning as intended"[61] and provide for the establishment of license conditions tied to research and development programs to address safety questions.[62] Whatever is learned from these programs can be applied to develop future enhancements, and even support retrieval of the waste if necessary. The same regulations require that DOE maintain retrievability of the waste for at least 50 years.[63]

DOE should take maximum advantage of this opportunity for repository performance to be monitored for an extended period of time. Extending such programs to the upper end of the currently planned range of 50-300 years, in order to examine and challenge our analysis of what might happen over such long time frames would provide the greatest benefit. If this monitoring program identifies new information that does not confirm existing models of repository performance, the project should be fully prepared to make whatever modifications in repository design and operations that may be required.

Ongoing research and development on improved waste forms

While current reprocessing technology offers limited short-term benefits to used nuclear fuel disposal, future technologies have the potential to provide benefits that will make disposal more efficient and cost effective. In addition to reducing the radio-toxicity of many forms of nuclear waste, reprocessed waste can better utilize the capacity of the repository or reducing the need for some longer-term protections. Reprocessing and related technologies (such as transmutation of waste) could further nonproliferation goals or play an important role in the future of nuclear energy by providing needed nuclear fuel supplies.

However, reprocessing and related technologies must be part of an economic nuclear fuel cycle. The additional costs associated with federal government reprocessing to achieve these goals should not be borne by the electricity consumer. The timely implementation of nuclear waste disposal at Yucca Mountain gives the federal government ample opportunity to put in place parallel programs to develop reprocessing technologies and pursue the research, development and demonstration of new, improved, proliferation-resistant reprocessing technologies. These programs would work best if deployed in conjunction with the development of the repository, perhaps to the point where research and disposal facilities become co-located in the vicinity of Yucca Mountain.

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[60] Presentation of Buhdi Sager, Director Center for Nuclear Waste Regulatory Analysis to the NRC Advisory Committee on Nuclear Waste, February 24, 2005

[61] 10 CFR Part 63, Subpart F

[62] 10 CFR Part 63.32

[63] 10 CFR Part 63.111

TRANSPORTATION OF HIGH LEVEL RADIOACTIVE WASTE IS SAFE AND RELIABLE

Since 1964, the U.S. commercial nuclear energy industry has safely transported more than 10,000 used nuclear fuel assemblies in over 2,400 shipments.[64] When combined with Navy and DOE transportation, there have been over 3,000 shipments safely covering 1.7 million miles.[65] During this time, there have been no injuries, fatalities, or environmental damage resulting from the radioactive nature of the cargo. The containers in which the material is transported are robust and thoroughly tested. Used fuel from commercial nuclear power plants is transported in massive, vault-like containers. These specially designed containers weigh between 25 and 40 tons for truck transport and between 75 and 125 tons for rail shipments.[66]

High level radioactive waste shipping containers are designed to protect the public against even the most unlikely accidents – including high speed crashes, long lasting fires, and submersion in water – all without breaking open. The NRC must approve the container designs. Before the agency certifies a design, the manufacturer must demonstrate compliance with rigorous engineering and safety criteria. NRC routinely inspects container manufacturers to assure that design and quality assurance requirements are being met. In addition, container designs must be able to pass a sequence of hypothetical accident tests involving forces greater than the containers would experience in actual conditions. These test conditions include[67]:

- A 30-foot free fall onto an unyielding surface, which would be equivalent to a head-on crash at 120 mph into a concrete bridge abutment.
- A puncture test allowing the container to fall 40 inches onto a steel rod six inches in diameter.
- A 30-minute exposure to fire at 1,475 degrees Fahrenheit that engulfs the entire container.
- Submerging the same container under three feet of water for eight hours.

In addition to the tests required for NRC certification, engineers and scientists at Sandia National Laboratories in New Mexico conducted a wide range of tests on used nuclear fuel transportation containers in the 1970s and 1980s. These tests included[68]:

- Running a flatbed tractor-trailer carrying a container into a concrete wall at 84 mph.
- Placing a container on a rail car that was driven into a concrete wall at 81 mph.
- Placing a container on a tractor-trailer that was broadsided by a train locomotive traveling at 80 mph.

In all cases, post-crash assessments showed that the containers – although slightly dented and charred – would not have released their contents.

Since those tests, regulators and scientists have continued to closely evaluate and improve their understanding of the safety of high-level radioactive waste shipment.[69] In 1987, NRC conducted a study using data form real-world severe accidents of all kinds and concluded

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[64] Energy Resources International Data, 2000
[65] NEI Fact Sheet, *Experience, Testing Confirm Transportation of Used Nuclear Fuel is Safe, Reliable*, September 2005
[66] NEI Fact Sheet, *Experience, Testing Confirm Transportation of Used Nuclear Fuel is Safe, Reliable*, September 2005
[67] 10 CFR Part 71.73
[68] NEI Fact Sheet, *Experience, Testing Confirm Transportation of Used Nuclear Fuel is Safe, Reliable*, September 2005
[69] NEI Fact Sheet, *Experience, Testing Confirm Transportation of Used Nuclear Fuel is Safe, Reliable*, September 2005

that transport containers designed to NRC requirements would withstand such accidents. Other Sandia Laboratory tests have evaluated a terrorist attack, subjecting a container to a device 30 times more powerful than a typical anti-tank weapon. The impact caused only a quarter inch diameter hole through the primary containment wall. NRC estimated that such a hole could have resulted in the release of less than 10 grams – one-third of an ounce – of used fuel.

What has been learned about the safety of high-level radioactive transportation through experience and testing has been further validated using the latest computer programs and modeling techniques. The scientists at Sandia applied these methods to a study that validated existing methods of assuring safety and concluded that transportation risks were "orders of magnitude smaller" than what was previously believed.[70]

This vast experience indicates that concerns about the transportation of radioactive materials to Yucca Mountain, often cited by the project's opponents, are significantly over-stated. The technical basis for safe transportation is just as sound as that for the mountain itself. These materials can and should be transported to Yucca Mountain for final disposal.

CONCLUSION: A TIME TO MOVE FORWARD – FURTHER DELAY IS NOT AN OPTION

Extensive Studies consistently show Yucca Mountain to be a sound site for nuclear waste disposal

From the science of 1986, which indicated that Yucca Mountain was the best of nine potential U.S. sites for geologic disposal of nuclear waste, to the science of 1998, which validated the expectation that "remote, desert regions of the Southwest are well-suited for a geologic repository", to the science of 2002, demonstrating that a geologic repository at Yucca Mountain can protect public health and safety in accordance with stringent regulations – confidence in this particular site as the solution to meeting U.S. nuclear waste disposal needs has been continually on the increase. More is known about Yucca Mountain than any other parcel of real estate on the planet. This knowledge extends well below the surface through miles of tunnels and dozens of drillings. It has been confirmed in the laboratory, reviewed by independent experts, and validated against information from analogous sites around the world.

Through all that has been gained by 20 years and $8.6 billion dollars of world leading scientific research, one thing has remained constant – the more we examine Yucca Mountain, the better it looks. There is certainly no reason in science not to move forward directly with this project.

Yet, the Federal agencies charged with moving forward now balk and hesitate over barriers both real and imagined. The time has come for the Federal Government to take a long hard look at the Yucca Mountain project and to figure out how past delays can be made up and future delays avoided. Now is the time for this important project to move forward as directly as possible.

The cost of not moving forward is extremely high

Delays in the case of Yucca Mountain are not only unnecessary but are also costly. The federal government has already spent over $8 billion on the program and will spend another $49 billion based on current cost estimates.[71] Meanwhile, electric ratepayers (in the case of

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[70] *Reexamination of Spent Fuel Shipment Risk Estimates*, NUREG/CR-6672, US Nuclear Regulatory Commission, March 2000
[71] *US DOE Total System Life Cycle Cost Report*, DOE/RW-0533, May 2001, p. 1-1

commercial used nuclear fuel) and taxpayers (in the case of government sites) continue to pay billions of dollars, in *addition* to what is being paid to develop Yucca Mountain, to store waste at interim sites that were never meant for long-term storage.

Since the Federal Government defaulted on its statutory and contractual obligation to begin removing used nuclear fuel from reactor sites in 1999, 38 operating commercial nuclear reactors have exceeded their originally available storage space (in spent fuel pools) and had to develop costly dry storage facilities.[72] By the end of 2010, 78 reactors will have run out of space.[73] Additionally, used nuclear fuel is stranded at 10 shutdown reactor sites, where the entire expense of maintaining and securing the site stems from the need to take care of the stranded waste. These mounting costs are the subject of litigation between the reactor owners and DOE. One reactor owner, Exelon, has already settled its damages claim with DOE. This settlement calls for DOE to make initial payments to Exelon for costs already incurred then continuing payments for each year that additional costs result from the government's failure to move the waste. At 7 shutdown reactor sites in 6 states, between $2 million and $4 million per site each year is being spent simply to store the used fuel that has yet to be removed.[74] It is estimated that the total industry wide liability for DOE's default could be as much as $56 billion.[75]

Nuclear waste disposal capability is an environmental imperative

Leaving nuclear waste where it is indefinitely is simply not acceptable public policy. Currently this material is temporarily stored at over 100 locations in 39 states. Certainly, safety at these temporary locations can be assured for at least the next 100 years. It is more prudent from a security standpoint to store the waste from multiple sites at one centralized location. However, continued inaction imposes a potentially significant burden on future generations and has potentially serious environmental consequences should future generations either be unable or unwilling to take on this burden – at a cost of over $1billion per year.

Nuclear waste disposal capability supports national energy and security policy

When Secretary of Energy Spencer Abraham recommended the Yucca Mountain site for approval, he made the following statement about the importance of the project:

> Our national security interests are likewise at stake. Forty percent of our warships, including many of the most strategic vessels in the Navy, are powered by nuclear fuel, which eventually becomes spent fuel. At the same time, the end of the Cold War has brought the welcome challenge to our Nation of disposing of surplus weapons-grade plutonium as part of the process of decommissioning our nuclear weapons. Regardless of whether this material is turned into reactor fuel or otherwise treated, an underground repository is an indispensable component in any plan for its complete disposition.[76]

This statement is even more true today. As our world has continued to evolve following the tragic events of September 11, 2001, national security and energy security have become ever

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[72] CST Associates data, 12/31/2004
[73] CST Associates data, 12/31/2004
[74] Remarks of Charles Pray, Maine Department of Nuclear Safety, at US Transportation Coalition Yucca Mountain Summit III, October 5, 2005
[75] Nuclear Energy Institute Fact Sheet, *Used Nuclear Fuel Management*, October 2004
[76] *Final Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada*, DOE/EIS-0250, February 2002, p. 2

more inexorably linked. Dependence on energy supplies from unstable parts of the world weakens America. Assuring that terrorism never becomes nuclear terrorism demands that the United States always remain at the forefront when it comes to responsible management of nuclear technologies – both to assure adequate supplies of energy and protect against dangerous proliferation of the technology.

Safe and effective disposal of nuclear waste is a fundamental cornerstone of any responsible strategy for leadership in nuclear technology. As Secretary Abraham went on to say in explaining the national security reasons behind his site recommendation, "By moving forward with Yucca Mountain, we will show leadership, set out a roadmap, and encourage other nations to follow."[77]

Demand for new nuclear plants also demands disposal capability

Recent public opinion surveys indicate that 70 percent of all Americans now favor nuclear energy while only 24 percent oppose it.[78] These same polls indicate that the thinking behind these sentiments is strong, as 79 percent agreed that nuclear energy's role in meeting clean air regulations should be recognized, 77 percent supported preparations to build new nuclear plants, and 70 percent said that a new reactor would be welcome at the existing nuclear site in their community. The President recently echoed these sentiments when, in a June 2005 speech on energy and economic policy stated the following, "It is time for this country to start building nuclear power plants again." Just one month later, a strong bipartisan majority in Congress agreed, passing a comprehensive energy bill that included significant incentives for new nuclear plant construction.

The rise in demand for new nuclear plants reflects a high level of foresight among the American people and in their elected leaders. People are becoming increasingly aware of not only the importance of energy supply to our economy but also affect that energy choices have on our environment. This well educated population knows that expansion of nuclear energy is necessary. They also know that such an expansion demands an effective solution to the disposal of nuclear waste. That is why 71 percent of those surveyed also believe that the federal government should continue to develop the Yucca Mountain repository.[79]

[77] *Final Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada*, DOE/EIS-0250, February 2002, p. 2
[78] Bisconti Research Inc./NOP World, Surveys conducted October 2004 and May 2005
[79] Bisconti Research Inc./NOP World, Surveys conducted October 2004 and May 2005