

ILLUMINATING THE DECISION PATH: THE YUCCA MOUNTAIN SITE RECOMMENDATION

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ABSTRACT

On February 14, 2002, U.S. Secretary of Energy Spencer Abraham provided to the President the “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.” This Recommendation, along with supporting materials, complied with statutory requirements for communicating a site recommendation to the President, and it did more: in 49 pages, the Recommendation also spoke directly to the Nation, illuminating the methodology and considerations that led toward the decision to recommend the site. Addressing technical suitability, national interests, and public concerns, the Recommendation helped the public understand the potential risks and benefits of repository development and placed those risks and benefits in a meaningful national context.

BACKGROUND

On February 14, 2002, Secretary of Energy Spencer Abraham gave to President Bush his recommendation of “the deep underground site at Yucca Mountain, Nevada, for development as our Nation’s first permanent facility for disposing of high-level nuclear waste.” That recommendation fulfilled the direction in the Nuclear Waste Policy Act of 1982, as amended (the NWPA), that the Secretary determine whether to recommend the site for development as a repository. That determination set in motion an NWPA-defined process that involved actions by the President, the State of Nevada, and Congress, and culminated in President Bush’s signature, on July 23, 2002, on a Joint Resolution of Congress approving Yucca Mountain.

The Secretary communicated his recommendation in a 50-page document, *the 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* (hereinafter the Recommendation Document), prepared for the President and for the Nation.

The recommendation built on the foundation of over two decades of science and was informed by extensive public comment in the year prior to its issuance. The recommendation was accompanied by an extensive suite of supporting documentation that was directly responsive to the statutory requirement “a comprehensive statement of the basis for such a recommendation.” In developing the Recommendation Document, the Secretary did not attempt to duplicate the data and analysis of the voluminous technical documents that supported it, such as the Final

Environmental Impact Statement, Science and Engineering Report, and Yucca Mountain Site Suitability Evaluation. Rather, the Secretary fulfilled three important objectives:

- To communicate the recommendation, explaining the decision criteria and what the recommendation means
- To state the scientific case accessibly and in context
- To address topics that were appropriate for the Secretary's special consideration, specifically, the national interest and principal arguments against the repository.

Central to these objectives was a realistic and relevant communication of the risks of constructing and operating a repository, in context with other risks faced by individuals and by the Nation.

THE DECISION PATH

Through the NWPA, Congress directed that the Secretary undertake site characterization activities "to provide the data required for evaluation of the suitability" of the Yucca Mountain site in support of a license application submittal to the Nuclear Regulatory Commission. The Act charged the Secretary with setting the criteria for determining suitability, which are contained in the Department's "Yucca Mountain Site Suitability Guidelines" rule. The recommendation itself, according to the Act, was to be based on consideration of materials required to be submitted to the President along with the recommendation, including the record of hearings conducted in the vicinity of Yucca Mountain. "Such other information [not specified in the Act] as the Secretary considers appropriate" was also to be included.

The information evaluated by the Secretary in making his recommendation was extensive and complex, but the decision path itself was straightforward. The Recommendation Document describes the process:

- First, the Secretary determined whether the site was scientifically and technically suitable.
- Only after concluding that the site was suitable, the Secretary addressed whether building a repository at Yucca Mountain was in the national interest.
- Finally, the Secretary evaluated arguments that had been made against moving ahead to determine whether those arguments introduced "countervailing considerations weighty enough to overcome the arguments for proceeding with development."

These three steps constituted the framework of the Recommendation Document. This structure enabled the President and the Nation to trace the logical process the Secretary conducted and to review each of his findings in sequence.

Defining this clear path for the public was critical. While the Department conducted the site characterization program and consideration process in an open and transparent manner, with many thousands of pages of documentation posted on the web and many opportunities for the public to learn about and comment on the work, it is likely that few members of the general public read and analyzed all of the available information. Approval of the Yucca Mountain site ultimately was a national decision on which every Senator and Congressional representative was

asked to vote, and one which – whether or not a repository at Yucca Mountain is licensed and built – will affect the lives of all Americans. Stepping through the process that resulted in the recommendation supports public understanding of the scope and impact of the recommendation, gives pointers to the supplementary material constituting the technical basis, and provides an assurance that the recommendation was made with due regard for all relevant issues.

COMMUNICATING THE SUITABILITY CASE

There are inherent challenges in attempting to summarize the scientific and technical information underlying the finding of suitability. Development of a repository for spent fuel and high-level waste is a first-of-its-kind endeavor in the United States. This project, like virtually all nuclear projects, evokes a strong emotional reaction in some quarters. The scientific and technical underpinnings of the project are not easily understood, and uncertainty is inevitable. As the Nuclear Waste Technical Review Board observed, “Eliminating all uncertainty associated with estimates of repository performance would never be possible at any repository site.”

The bottom line of a technical suitability determination is whether a repository at Yucca Mountain is likely to meet the radiation protection standards established by the Environmental Protection Agency. EPA has established a dose standard of 15 millirem per year, with an overlapping four millirem per year standard for exposure from groundwater. The Recommendation Document’s discussion of radiation protection begins with the question, “What level of radiation exposure is acceptable?” then provides information that would enable the average reader to answer that question for himself or herself and to understand the Secretary’s conclusion. Implicit in this discussion are two questions: first, will the repository meet the standards set by EPA, and second, what does 15 millirem of potential radiation exposure really mean? To help the reader address these questions, the document provides a brief background lesson on what radiation is and how humans are exposed to it and gives real-world comparisons to illustrate the potential impact of additional exposure at the level permitted by the EPA standard.

Table I. Summary of Comparisons Used to Explain Radiation Exposure

EPA Yucca Mountain standard 15 mrem/year	Is equivalent to	<ul style="list-style-type: none">• Slightly over 4% of average annual background radiation• Difference in exposure between living in Philadelphia and living in Denver• Added exposure from 3 round-trip flights between East Coast and Las Vegas• Added exposure from living in a brick house
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Comparisons also aid in understanding the preclosure and postclosure safety case. The Yucca Mountain Site Suitability Guidelines require the Secretary to determine whether it is likely that the repository will continue to isolate radionuclides for 10,000 years after it is sealed, so that an individual living 18 kilometers away is not exposed to annual radiation doses above the level set in the EPA standard. Here again, the Recommendation Document provides both a technical discussion with summary-level data and comparisons that help the reader place that information in a usable context. Here, comparisons help to explain timeframes. To explain the difficulty of making predictions far into the future, events similarly distant in the past are cited.

Table II. Summary of Comparisons Used to Explain Preclosure and Postclosure Timeframes

<p>Maximum analyzed preclosure period 300 years into the future</p>	<p>Is equivalent to</p>	<p>Three generations longer than the United States has existed</p>
<p>Postclosure period 10,000 years into the future</p>	<p>Is equivalent to</p>	<ul style="list-style-type: none"> • 10,000 years in the past, when plants were domesticated • Five times the time elapsed since the Roman Empire flourished • Two times the time elapsed since the pyramids were built

Another approach to making the science easily accessible is a narrative illustration of how total system performance assessment was used to predict repository behavior over 10,000 years. The illustration uses simple language to explore a “single most pressing concern”: whether radionuclides from material emplaced in a repository could contaminate a water supply. Over two decades, a tremendous amount of scientific site characterization and analytical work was done to address this question. The Recommendation Document describes a series of extremely unlikely events – movement of water 800 feet through the mountain and into an emplacement tunnel, penetration of a titanium drip shield, the existence of manufacturing defects in a waste package and consequent breaching, and further water movement 800 feet down to the water table – to illustrate the “deliberately pessimistic assumptions” used in performance assessment analyses. The Recommendation Document states that not only would the groundwater radiation dose resulting from such an event fall well within the radiation standard, “even if all of the waste packages were breached in [this] fashion... the resulting contribution to annual dose would still be below the radiation standards, and less than one percent of the natural background [radiation level].” By showing that conditions at the far extremes of probability produce effects that remain within standards, the document implicitly encompasses all of the less extreme analyses and bounds the risk.

It is important to note that the Recommendation Document, as a capstone on all the work that had been done before, provides pointers to the supporting documents where detailed analyses can be found. It would have been neither possible nor desirable to summarize all the scientific and technical findings contained in the supporting documents, yet some discussion of radiation exposure, performance analyses, and other technical topics was needed to make the document meaningful for the average reader. The Recommendation Document characterized the suitability judgment the Secretary needed to make, identified the essential components of suitability, and focused on making those essentials clear.

ADDRESSING THE NATIONAL INTEREST AND COUNTERVAILING CONSIDERATIONS

The Secretary's consideration of the Yucca Mountain site represented a notable transition in the Department of Energy's efforts to fulfill the mandate of the Nuclear Waste Policy Act. During the site characterization phase, scientists and engineers worked to develop data that would feed the suitability determination. The Act, as amended, specified the site to be studied and the information to be developed; broader questions of whether a repository at Yucca Mountain is in the national interest were not part of this work.

By placing the responsibility on the Secretary of Energy and the President for making and submitting a recommendation and by establishing roles for the State of Nevada and the Congress, the Act signaled that national policy implications should be part of the site consideration and approval process.

As it did with regard to site suitability, the Recommendation Document defines the issue by means of simple, straightforward questions: "Are there compelling national interests favoring going forward with a repository at Yucca Mountain? If so, are there countervailing considerations of sufficient weight to overcome those interests?"

The key theme of this section of the Recommendation Document is that the risks involved in constructing, operating, and closing a repository must be weighed against the real risks the Nation would face by not moving forward toward that goal. As the Recommendation Document states, "Our choice is not between, on the one hand, a disposal site with costs and risks held to a minimum, and, on the other, a magic disposal system with no costs and risks at all."

The discussion of national interests aims not only to show the Secretary's thought process but also to make citizens throughout the United States aware of their integral stake in solving the nuclear waste problem. What has frequently been viewed as a Nevada-only issue actually involves risks and benefits that apply throughout the Nation and will have an effect across many generations. These considerations are categorized as energy security; national security; environmental protection; continuation of research, medical, and humanitarian programs; and support for domestic anti-terrorism programs.

The analysis of national interests makes it clear that licensing and building a repository is not an academic exercise. The Recommendation Document alludes to the history of the nuclear age, to the nuclear defense programs that benefited the United States during the Cold War and the defense

complex cleanups that are the resulting national legacy. Regardless of whether an individual supports nuclear power or not, it is impossible to turn back the clock and erase this history. Similarly, agreements under which the Federal government is to accept commercial spent nuclear fuel, though overly optimistic in their timetables, cannot be denied, and the responsibilities they impose must be met.

Table III. National Interests and National Impacts

National Interest	Benefit Conveyed by Activities that Produce SNF/HLW	Potential Result if No Path Forward for Disposal Exists	National Risks
Energy security	<ul style="list-style-type: none"> 20% of Nation's electricity produced from nuclear power 	<ul style="list-style-type: none"> Premature commercial nuclear power plant shutdown Lack of investment in new plants 	<ul style="list-style-type: none"> Unbalanced energy policy – vulnerability to shortages and price spikes
National security: nuclear Navy	<ul style="list-style-type: none"> Nuclear-powered submarines and aircraft carriers 	<ul style="list-style-type: none"> Inability to meet agreement to remove Naval SNF from Idaho 	<ul style="list-style-type: none"> Serious future uncertainties regarding Naval capabilities
National security: nonproliferation	<ul style="list-style-type: none"> National security benefits during Cold War 	<ul style="list-style-type: none"> No disposal path for byproducts and MOX SNF from decommissioning of nuclear weapons 	<ul style="list-style-type: none"> Inability to continue U.S. decommissioning programs; likely disincentive for other nations to decommission their weapons Resulting risk of proliferation/diversion of weapons materials abroad and at home
Environmental protection: cleanup of defense sites	<ul style="list-style-type: none"> National security benefits during Cold War 	<ul style="list-style-type: none"> Inability to complete cleanup of former defense sites 	<ul style="list-style-type: none"> Continuing costs and increasing environmental impacts from stored materials
Environmental protection: removal of SNF from current storage sites	<ul style="list-style-type: none"> 20% of Nation's electricity produced from nuclear power 	<ul style="list-style-type: none"> SNF remains at temporary storage sites close to major bodies of water 	<ul style="list-style-type: none"> Continuing costs and increasing environmental risks from temporary storage close to major bodies of water Reliance by default on electricity sources that produce greenhouse gas emissions
Continuation of research, medical, and humanitarian programs	<ul style="list-style-type: none"> Wide range of medical applications of radioisotopes 	<ul style="list-style-type: none"> Erosion of capacity for medical research 	<ul style="list-style-type: none"> Negative impact on medical research, and potential unavailability of nuclear-based therapies
Domestic anti-terrorism programs	<ul style="list-style-type: none"> Not applicable 	<ul style="list-style-type: none"> Materials remain at 131 sites in 39 states 	<ul style="list-style-type: none"> Need to secure all 131 sites in 39 states Disincentive for other nations to secure their own nuclear materials

Some national interests identified in the Recommendation represent potential opportunities that may be secured or lost, depending on whether a disposal path for spent nuclear fuel and high-level waste exists. The prime example is continuation of nuclear-based medical research, which in the future could yield cures or benefits that are not even foreseeable yet. Another is the positive influence that U.S. progress toward nuclear waste disposal may have on other nuclear nations; this progress – or the lack thereof – is likely to have many global security and environmental reverberations.

The discussion of national interests in the Recommendation Document clearly provides the rationale for the Secretary's conclusion that compelling national interests exist for licensing and building a repository. The final section of the document presents a "check" inherent in the Secretary's decision process: having determined that site suitability permits a positive recommendation, and that national interests are in its favor, the Secretary considered whether any opposing argument outweighed the considerations for moving forward. In this section, the Secretary responds point-by-point to arguments made by opponents.

Addressing the principal arguments made in opposition to moving ahead with the repository serves two purposes. First, it provides assurance that the Secretary gave due consideration to the comments of the State of Nevada, to the views of individuals who provided comments during the public comment period, and to arguments voiced in other fora. Second, it enables persons who have heard these arguments to read an authoritative response.

Some of these arguments have a highly subjective element: they raise issues of fairness, how much science is enough, how people might behave in the future, and what we should do when a current situation differs from what was predicted in the past. To confront these issues, a less subjective framework was established. Where clear standards – regulatory or statutory requirements – bear on an argument, those standards are identified and compliance with them is assessed. Statistics and historical facts are cited to support evaluation of the argument and, where it is useful, comparisons are used to provide context.

One of the opposing arguments that has received widespread press coverage and has been a focal point for activists' campaigns is the presumed danger of nuclear waste transportation. Opponents have made use of catchphrases such as "Mobile Chernobyl," predictions of terrorist attacks, and extrapolations from transportation incidents that had nothing to do with spent nuclear fuel or high-level waste. It has also been asserted that nuclear waste transportation will endanger people all along transportation corridors, and will have a negative impact on the tourism-based economy of Las Vegas.

Context is a critical element of the Recommendation Document's rebuttal of these arguments. Fears about transportation must be viewed in the context of the excellent transportation safety record that has been established in the U.S. and Europe. Las Vegas, due to its status as a tourist destination and its geographic singularity as the only major city close to Yucca Mountain, has acquired something of a mystique, with repository opponents charging that it will be uniquely affected by a repository. However, the Recommendation Document makes clear that, in the national context, proximity to a nuclear facility is far from unique. "161 million Americans are closer to a nuclear facility than anyone in Las Vegas is to Yucca Mountain," the document states. Moreover, "many cities with strong tourism industries are located closer to existing storage

facilities than Las Vegas would be to a repository at Yucca Mountain.” Population proximity charts reinforce this point and enable readers to ascertain the distance between their homes and a nuclear facility.

Table IV. Opposing Arguments and Information Supporting Secretary’s Conclusions

<i>Allegation</i>	<i>Standards/Regulations</i>	<i>Statistics/Historical Facts</i>	<i>Comparisons</i>	<i>Conclusion</i>
Citizens of Nevada were denied adequate opportunity to be heard	NWPA requirements for providing notice and comment opportunities	<ul style="list-style-type: none"> • Issuance of extra-statutory documents • Statistics on hearings, public meetings, comment days, comments, tours 		“...Opportunities... were abundant and met any procedural measure of fairness.”
Project has received inadequate study		Table of types of tests performed	Comparison with Hoover Dam and Manhattan Project	There is “...a more than adequate technical basis to designate the Yucca Mountain site...”
DOE changed the rules to fit the site	<ul style="list-style-type: none"> • Regulatory framework with which DOE must conform, as directed in NWPA 	History – evolution of regulatory framework, when and why changes were made		“...DOE had no choice but to amend its guidelines to conform with the new regulatory framework...”
Process tramples States’ rights	Special state role in NWPA	<ul style="list-style-type: none"> • Extra-statutory consideration • History of funding given to Nevada 	Nevada funding is more than any other state has been given for any remotely similar purpose	“...Assertion of an infringement on states’ rights is incorrect.”
Transportation is disruptive and dangerous	<ul style="list-style-type: none"> • DOT route evaluation process • NRC route and security plan approval • NRC cask certification 	<ul style="list-style-type: none"> • Record of safe transportation • Eventual need to transport nuclear waste somewhere 	<ul style="list-style-type: none"> • Transportation vs. leaving material at current sites • Planned vs. ad hoc transport • Comparison with European transport 	“Stated concerns about transportation are ill-founded...”
Transportation will have dramatically negative economic impact on Las Vegas			<ul style="list-style-type: none"> • Experience of other tourist cities near reactors or routes • Comparison of distance to nuclear facilities 	“These assertions are largely unsupported by any evidence...”
It is premature to make a site recommendation	<ul style="list-style-type: none"> • Recommendation and licensing in NWPA • NRC site sufficiency letter, provided in accordance with NWPA 	<ul style="list-style-type: none"> • History of GAO reports • Nature of DOE-NRC agreements 		“I believe I have the information necessary to allow me to determine that the site is scientifically and technically suitable...”

The contention that nuclear waste should remain where it is currently stored must be evaluated in the context of the real-world necessity of managing spent nuclear fuel and high-level waste means that some action must be taken, with attendant risks and consequences. Waste may be left to accumulate in temporary facilities near cities and towns, or it may be transported on an ad-hoc basis to new temporary storage areas; any judgment on the danger of transporting waste to a repository needs to consider the relative risks of these likely alternatives.

CONCLUSION

The Nuclear Waste Policy Act assigned the Secretary of Energy the responsibility for the first step in deciding how to proceed toward the management of spent nuclear fuel and high-level radioactive waste. In determining whether to recommend the Yucca Mountain site to the President, Secretary Abraham discharged his individual responsibility and acted on behalf of, and with consideration for the interests of, all U.S. citizens. The Recommendation Document was a vehicle for shining light on his decision process, communicating his conclusions at each step and in total, and accessibly laying out the information that supported those conclusions.