

December 2001

# NUCLEAR WASTE

## Technical, Schedule, and Cost Uncertainties of the Yucca Mountain Repository Project



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## Abbreviations

DOE	Department of Energy
EPA	Environmental Protection Agency
GAO	General Accounting Office
NRC	Nuclear Regulatory Commission
OCRWM	Office of Civilian Radioactive Waste Management
USGS	U.S. Geological Survey



G A O

Accountability \* Integrity \* Reliability

United States General Accounting Office  
Washington, DC 20548

December 21, 2001

The Honorable Harry Reid  
Chairman, Subcommittee on Transportation,  
Infrastructure, and Nuclear Safety  
Committee on Environment and Public Works  
United States Senate

The Honorable Shelley Berkley  
House of Representatives

As reflected in the administration's energy policy, there is renewed interest in expanding nuclear power as a source of electricity. At the same time, the nation currently does not have a facility to permanently dispose of the highly radioactive spent (used) fuel from existing commercial nuclear power plants. In lieu of such a facility, plant owners are currently holding about 40,000 metric tons of spent fuel in temporary storage at 72 plant sites in 36 states. In addition, the Department of Energy (DOE) estimates that it has over 100 million gallons of highly radioactive waste and 2,500 metric tons of spent fuel from the development of nuclear weapons and from research activities in temporary storage. Because these wastes contain radioactive elements that remain active for hundreds of thousands of years, the permanent isolation of the wastes is critical for safeguarding public health, cleaning up DOE's nuclear facilities, and providing a reasonable basis for increasing the number of nuclear power plants.

As required by the Nuclear Waste Policy Act of 1982, as amended in 1987, DOE has been studying one site at Yucca Mountain, Nevada, to determine its suitability for disposing of highly radioactive wastes in a mined geologic repository. If the Secretary of Energy decides to recommend this site to the President, the recommendation would begin a statutory process for the approval or disapproval of the site that will involve the President, the state of Nevada, and the Congress. In addition, a subsequent presidential site recommendation would trigger statutory time frames for action by the state, the Congress, DOE, and the Nuclear Regulatory Commission (NRC). If the site is recommended and approved, DOE must apply to NRC for a license to construct a repository. If the site is not recommended and approved for a license application, or if NRC denied a license to construct a repository, the administration and the Congress would have to consider other options for the long-term management of existing and future nuclear wastes.

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Site investigation activities at Yucca Mountain include studies of the physical characteristics of the mountain and potential waste containers. The investigation also includes the development and use of mathematical models to measure the probability that various combinations of natural and engineered (man-made) features of a repository could safely contain wastes for 10,000 years. The Environmental Protection Agency (EPA) has set health and safety standards for a repository at Yucca Mountain that require a high probability of safety for at least that period of time. DOE's criteria for determining if the site is suitable for a repository and the NRC's licensing regulations are consistent with these standards. DOE has designated the nuclear waste program, including the site investigation, as a "major" program that is subject to senior management's attention and to its agencywide guidelines for managing such programs and projects. The guidelines require the development of a cost and schedule baseline, a system for managing changes to the baseline, and independent cost and schedule reviews. DOE is using a management contractor to carry out the work on the program. DOE's management contractor develops and maintains the baseline, but senior DOE managers must approve significant changes to cost or schedule estimates. In February 2001, DOE hired Bechtel SAIC Company, LLC (Bechtel), to manage the program and required the contractor to reassess the remaining technical work and the estimated schedule and cost to complete this work.

In 1996, the U.S. Court of Appeals for the District of Columbia Circuit ruled that the Nuclear Waste Policy Act obligated DOE to start disposing of the spent fuel from commercial nuclear power plants no later than January 31, 1998. In 1998, because DOE could not meet this deadline, the U.S. Court of Appeals for the Federal Circuit held in another case that plant owners are entitled to damages. One of the major issues in the determination of damages is the schedule under which DOE will begin accepting the spent fuel. DOE does not expect to complete the sequence of site approval, licensing, and construction of enough of the repository facilities at Yucca Mountain to open it until at least 2010. Courts in these 2 cases and 16 cases brought by other utilities are currently assessing the amount of damages that DOE owes the plant owners for delaying the disposal of their wastes by the estimated 12-year delay. Estimates of the potential damages vary widely, from DOE's estimate of about \$2 billion to the nuclear industry's estimate of \$50 billion.

Given these circumstances and questions raised about DOE's investigation of the Yucca Mountain site, you asked us to determine the extent to which

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- DOE has completed the work necessary to support a site recommendation for the development of a repository at Yucca Mountain and
  - DOE's goal of opening a repository at Yucca Mountain in 2010 is reasonable.

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## Results in Brief

Recommending to the President that the Yucca Mountain site is suitable for a repository is within the discretion of the Secretary of Energy but, for the reasons noted below, may be premature. Once the President considers the site qualified for a license application and recommends the site to the Congress, the Nuclear Waste Policy Act requires DOE to submit a license application to NRC within about 5 to 8 months.<sup>1</sup> On the basis of information we reviewed, DOE will not be able to submit an acceptable application to NRC<sup>2</sup> within the express statutory time frames for several years because it will take that long to resolve many technical issues. Specifically, DOE is currently gathering and analyzing technical information required to satisfy 293 agreements that it made with NRC. According to NRC, completing this ongoing technical work is essential for it to accept a license application from DOE. Some of these agreements, for example, provide for the additional study of how water would flow through the repository area to the underlying groundwater and the durability of waste containers to last for thousands of years. Many of the technical issues that were the subject of these agreements have also been of concern to the U.S. Nuclear Waste Technical Review Board, which was established by the Nuclear Waste Policy Act to review the technical and scientific validity of DOE's investigation of Yucca Mountain. Bechtel's September 2001 detailed reassessment of the work required to submit a license application, including the 293 agreements with NRC and assuming expected funding levels, concluded that DOE would be in a position to submit a license application to NRC in January 2006, or about 4 years from now. Under the Nuclear Waste Policy Act and DOE's siting guidelines,

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<sup>1</sup> If the President makes a recommendation to the Congress, Nevada has 60 days to disapprove the site. If disapproved, the Congress has 90 days of continuous session to enact legislation overriding a disapproval. If the Congress overrides the state's disapproval, the Secretary is required to submit a license application to NRC within 90 days after the site recommendation is effective. These time frames provide about 150 to 240 days, or about 5 to 8 months, from the time the President recommends the site until DOE submits a license application.

<sup>2</sup> The acceptance of a license application is not the same as approving an application. A decision to approve or disapprove any application would be made by NRC following extensive review and testing.

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while a site recommendation and a license application are separate processes, DOE will need to use essentially the same data for both.

On the basis of the information we reviewed, DOE is unlikely to achieve its goal of opening a repository at Yucca Mountain by 2010 and currently does not have a reliable estimate of when, and at what cost, such a repository can be opened. Since DOE stopped using the cost and schedule baseline to manage the site investigation in 1997, the repository program's baseline has not reflected changes in the program. For example, when the program's fiscal year 2000 appropriation was \$57.8 million less than requested, DOE deferred some planned technical work without adjusting the baseline to reflect this action. As a result, it was not clearly visible when, and at what cost, the site investigation would be completed and a license application submitted to NRC. Bechtel, in its September 2001 detailed reassessment, concluded, on the basis of expected program funding, that DOE could submit the application in January 2006 at a total cost of \$5.5 billion. This date is approximately 4 years later, and the \$5.5 billion figure is about \$1.4 billion more than DOE's projection in 1997. Using Bechtel's estimate, sufficient time would not be available for DOE to obtain a license from NRC and construct enough of the repository to open it in 2010. Therefore, DOE is exploring alternative approaches to opening a repository in 2010, such as developing surface facilities for storing waste at the site until sufficient underground disposal facilities can be constructed.

We are recommending that the Secretary of Energy fully consider the timing of the statutory process before he decides when to make a site recommendation to the President. We are also making recommendations to DOE to better manage the nuclear waste program and to prepare estimates of the schedule and costs for opening a repository at Yucca Mountain that are tied to a new baseline for the program.

DOE disagreed that it may be premature for the Secretary of Energy to make a site recommendation to the President on the grounds that we did not understand the statutory and regulatory requirements for a site recommendation. (See app. II.) We agree that the Secretary has the discretion to make such a recommendation at this time; however, we question the prudence and practicality of making such a recommendation at this time, given the express statutory time frames for a license application and the significant amount of work remaining to be done for NRC to accept a license application from DOE. Our conclusion is based on the relationship between a site recommendation and DOE's readiness to submit an acceptable license application to NRC, as set out in law and

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DOE's siting guidelines. Although we have clarified our discussion of the statutory and regulatory requirements for site recommendation, approval, and licensing, we continue to believe that the Secretary of Energy should consider the timing of this statutory process as he decides when to make a site recommendation to the President. Therefore, while we have modified the language, we have not changed the intent of our recommendation on this matter. (See p. 24 for our evaluation of DOE's comments.)

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## Background

Recognizing the critical need to address the issue of nuclear waste disposal, the Congress enacted the Nuclear Waste Policy Act of 1982 to establish a comprehensive policy and program for the safe, permanent disposal of commercial spent fuel and other highly radioactive wastes in one or more mined geologic repositories. In the act, the Congress stated that federal efforts to devise a permanent solution for disposing of radioactive waste had been inadequate. The act charged DOE with (1) establishing criteria for the recommendation of sites for repositories; (2) "characterizing" (investigating) three sites to determine each site's suitability for a repository; (3) recommending one suitable site to the President who, if he considers the site is qualified for a license application, submits a recommendation of such site to the Congress; and (4) upon approval of a recommended site, seeking a license from NRC to construct and operate a repository at the approved site. The act created the Office of Civilian Radioactive Waste Management within DOE to manage its nuclear waste program. When the act was passed, it was expected that a repository could be operational in 1998. Amendments to the act in 1987 directed DOE to investigate only the Yucca Mountain site. These amendments also established the Nuclear Waste Technical Review Board (the Board). The Board's mission is to review the technical and scientific validity of DOE's activities associated with investigating the site and packaging and transporting wastes, and to report its findings and recommendations to the Congress and DOE at least twice each year. The act does not require DOE to implement the Board's recommendations.

The Nuclear Waste Policy Act also set out important and complementary roles for other federal agencies. It required EPA to establish health and safety standards for the disposal of these wastes in repositories. EPA issued the standards for the Yucca Mountain site in June 2001.<sup>3</sup> The act

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<sup>3</sup> The Energy Policy Act of 1992 required EPA to establish specific health and safety standards for a repository at Yucca Mountain.

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also made NRC responsible for licensing and regulating repositories to ensure their compliance with EPA's standard. If the Yucca Mountain site is recommended to the President and approved, upon accepting a license application from DOE, NRC has, according to the act, 3 to 4 years to review the application and decide whether to issue a license to construct, and then to operate, a repository at the site. The act also required that, before the Secretary of Energy may recommend the site to the President, he or she must obtain NRC's preliminary comments on the sufficiency of DOE's site investigation for the purpose of a license application. NRC provided these comments in writing on November 13, 2001. From the beginning of the formal investigation of Yucca Mountain, therefore, NRC has been reviewing DOE's investigation activities, concentrating on the scientific and technical issues that need to be understood and clarified so that DOE will have adequate information for a license application. Finally, the Board's principal charge is to evaluate the technical and scientific validity of DOE's investigation of Yucca Mountain to ensure that the investigation is technically sound and scientifically credible. The Board must report to the Congress and the Secretary of Energy at least twice a year on issues surrounding the site investigation. Each of the Board's 11 members is appointed by the President from a list of candidates recommended by the National Academy of Sciences. Board members serve part-time and are assisted by a permanent staff.

In addition to the investigation of Yucca Mountain, the nuclear waste program includes preparations for eventually accepting and transporting spent fuel and other highly radioactive wastes from storage sites. Upon receipt of wastes at the site, DOE would put the wastes in metal containers and put the loaded containers in the repository. Both the natural features of the site and the design and materials of the waste containers and other engineered components of the repository system would contribute to restricting the release of radioactive materials from the repository over the 10,000-year period required by EPA's health and safety standards.

If DOE determines that the site is suitable for the development of a repository, according to the Nuclear Waste Policy Act, the Secretary may then recommend the site to the President at least 30 days after notifying the state of Nevada of the impending recommendation. However, before the Secretary may recommend the site to the President, the act requires that he hold local public hearings to inform the residents of the area and receive their comments on a possible site recommendation. DOE held the public hearings from May 2001 to December 2001. In addition, according to the Nuclear Waste Policy Act, the Secretary must prepare a



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comprehensive statement of the basis for the site's recommendation that includes, among other things, the following:

- NRC's preliminary comments on the sufficiency of the site investigation for a license application.
- Descriptions of the proposed repository and waste form or packaging and a discussion of the information obtained from the site investigation.
- An environmental impact statement prepared for the site along with the comments on the statement by the Department of the Interior, the Council for Environmental Quality, the EPA, and NRC.
- The views and comments of Nevada's governor and legislature and the Secretary's response to them.

If, after receiving a site recommendation from the Secretary of Energy, the President considers the Yucca Mountain site qualified for an application for construction authorization (a license) for a repository, then the President shall submit a recommendation of the site to the Congress. The Nuclear Waste Policy Act does not specify a time frame in which the President must act. However, the President's recommendation, if made, is automatically approved after 60 days unless Nevada's governor and legislature notify the Congress of their disapproval of the site. In that event, the site would not be approved unless the Congress enacted, within 90 days of continuous session, legislation overriding the state's disapproval. If the site is recommended and approved, the act requires the Secretary to submit a license application to NRC not later than 90 days after the effective date of the site's approval. NRC is required to issue or deny a license not later than 3 years after receiving a license application, unless it extends this period by not more than 1 year by reporting its reasons for doing so to the Secretary and the Congress.

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## It May Be Premature for DOE to Make a Site Recommendation

Although within his discretion, it may be premature for the Secretary of Energy to make a site recommendation in the near future because DOE is currently not prepared to submit an acceptable license application to NRC within the statutory limits that would take effect if the President recommended the site to the Congress within the next several years. DOE has entered into almost 300 agreements with NRC to gather and/or analyze additional technical information in preparation for a license application. DOE is also continuing to address technical issues raised by the Board. In September 2001, Bechtel completed a detailed reassessment of the plan for completing the necessary technical work for DOE and proposed January 2006 as the date when DOE would be ready to submit an acceptable license application to NRC. DOE has not accepted this estimate

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because, according to program officials, it would extend the license application date too far into the future. Instead, DOE is considering accepting only the planned work for fiscal year 2002 and asking the contractor to replan the work remaining to be completed after that fiscal year until the submission of a license application to NRC. Under the Nuclear Waste Policy Act and DOE's guidelines, while a site recommendation and a license application are separate processes, DOE will need to use essentially the same data for both.<sup>4</sup> Also, the act states that the recommendation that the President would make to the Congress is that he considers the site qualified for an application to NRC for a license. The President's recommendation also triggers an express statutory time frame that requires DOE to submit a license application to NRC within about 5 to 8 months. As a result, we believe that DOE should consider these factors in deciding when to make a site recommendation to the President. On the basis of the information we reviewed, DOE will not be able to submit an acceptable application to NRC within the express statutory time frames for several years because it will take that long to resolve many technical issues.

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## DOE Lacks Information for a License Application

Over the last 2 years, staff of DOE and NRC negotiated 293 agreements covering specific pieces of additional technical work that DOE agreed to perform as a part of preparing a license application that NRC would accept. Such agreements address areas of study within the program where NRC's staff determined that DOE needs to collect more scientific data and/or improve its technical assessment of the data. According to NRC's tracking system for the 293 agreements, as of November 30, 2001, NRC had received and is reviewing the information related to 47 of these agreements and DOE had completed work on another 15 of the agreements to NRC's satisfaction. Many of the technical issues that were the subject of the 293 agreements between DOE and NRC have also been of concern to the Board since it began reporting on the Yucca Mountain project in 1990. According to officials from NRC's waste management division, these issues generally relate to uncertainties about three aspects of the long-term performance of the proposed repository: (1) the expected lifetime of engineered barriers, particularly the waste containers; (2) the physical properties of the Yucca Mountain site; and (3) the supporting

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<sup>4</sup> See *General Guidelines for the Recommendation of Sites for Nuclear Waste Repositories; Yucca Mountain Site Suitability Guidelines* (preamble), 66 *Fed. Reg.* 57298, 57322 (Nov. 14, 2001).

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information for the mathematical models used to evaluate the performance of the planned repository at the site.

The uncertainties related to engineered barriers revolve largely around the longevity of the waste containers that would be used to isolate the wastes. DOE currently expects that these containers would be constructed with a nickel-chromium alloy that would isolate the wastes from the environment for more than 10,000 years. Minimizing uncertainties about the container materials and the predicted performance of the waste containers over this long time period is especially critical because DOE's estimates of the repository system's performance depend heavily on the waste containers, in addition to the natural features of the site, to meet NRC's licensing regulations and EPA's health and safety standards. As part of its agreements with NRC, DOE will continue its research on the expected rate of corrosion of the container material and the anticipated effects of corrosion on the performance of the repository system. In addition, DOE formed a peer review panel to address uncertainties about how materials for waste containers would be expected to perform over time in the repository.<sup>5</sup> A September 2001 interim report by the panel found no evidence thus far to rule out the use of the proposed container materials but noted that significant work is needed to substantiate the technical basis for predicting the stability of these materials. The report also stated that the uncertainty about the containers' long-term performance probably could be reduced substantially through further experiments and analysis.

The uncertainties related to the physical characteristics of the site involve a wide variety of issues. According to DOE officials, while some of these issues have been and are continuing to be studied by DOE, remaining uncertainties include

- the faulting and fracturing of the repository rock over time;
- the flow of water through the heated portion of the repository;
- the flow of water through the saturated and unsaturated zones of the repository under natural (prerepository) conditions;<sup>6</sup>
- the stability of the repository under natural conditions, heated conditions, and conditions involving seismic events;

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<sup>5</sup> The peer review comprised recognized experts from industry and academia.

<sup>6</sup> The saturated zone is that area beneath the repository that is saturated with groundwater. The unsaturated zone is above the water table.

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- the movement of radioactive material through the repository in the event of a release of this material;
  - the effect of volcanic activity on the repository; and
  - the combined effects of heat, water, and chemical processes in and around the tunnels where the waste containers would be placed.

According to officials in DOE's repository project office, the amount of current scientific uncertainty within each of these areas varies. For example, the flow of water under natural conditions through the area where the repository would be located is relatively well understood. In contrast, there is much more current uncertainty about how the combination of heat, water, and chemical processes caused by the presence of nuclear waste in the repository would affect the flow of water through the repository.

The NRC staff's concerns over the supporting information for the mathematical models that DOE would use as its primary tool for assessing the performance of the repository revolved primarily around validating the models and verifying the information used in the models. Performance assessment is an analytical method that relies on computers to operate mathematical models to assess the performance of the repository against EPA's health and safety standards, NRC's licensing regulations, and DOE's guidelines for determining if the Yucca Mountain site is suitable for a repository. DOE uses the data collected during site characterization activities to model how a repository system, comprising both natural and engineered features, would perform at the Yucca Mountain site. Some of DOE's mathematical models describe the behavior of individual physical and chemical processes, such as how quickly water might travel from the surface to the repository. DOE then links the results of these individual models together into a computer model representing the performance of the overall repository system. DOE then uses this model, called a "performance assessment model," to estimate the release of radioactivity from a repository under a range of conditions and over thousands of years. The model also enables DOE to forecast the dose of radiation to hypothetical persons living in the vicinity of the repository and compare them with EPA's health and safety standards. DOE's agreements with NRC are centered on validating the models—presenting information to provide confidence that the models are valid for their intended use—and verifying the information that has been collected during the site investigation and used in these models.

In addition to the NRC staff's concerns about DOE's models, NRC's Advisory Committee on Nuclear Waste has raised concerns about the

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adequacy of the performance assessment model that DOE used to support the information discussed in the technical documents it has issued to support a site recommendation.<sup>7</sup> In a September 18, 2001, letter to the chairman of NRC, the committee concluded that the model did not provide a basis for estimating performance and did not inspire confidence in the modeling process. The committee's conclusions were based on its concern that the modeling

- is guided by an inconsistent set of assumptions, including a mixture of conservative and nonconservative bounding assumptions, that do not represent realistic conditions and
- relies on many assumption-based computations and analyses that do not support or link the assumptions with available evidence.

According to the director of DOE's repository project office, the additional work surrounding the 293 agreements with NRC's staff is an insignificant addition to the extensive amount of technical work already completed. Moreover, this official does not expect that completing the additional technical work will change DOE's current performance assessment of a repository at Yucca Mountain. Also, in commenting on a draft of our report, DOE stated that it has compiled an enormous body of scientific and technical work over the last 2 decades including some 600 papers cited in one of the recently published reports. The Department also cited a substantial body of analytic literature it has published in recent years.<sup>8</sup>

From NRC's perspective, however, the agreements provided the basis for it to give DOE, as required by the Nuclear Waste Policy Act, its preliminary comments on the sufficiency of DOE's investigation of the Yucca Mountain site for inclusion in a future license application. In a November 13, 2001, letter to the Under Secretary of Energy, the Chairman of the NRC commented that

"[a]lthough significant additional work is needed prior to the submission of a possible license application, we believe that agreements reached between DOE and NRC staff

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<sup>7</sup> The committee, established by NRC to advise it on nuclear waste regulatory issues, comprises experts in several disciplines, including risk assessment.

<sup>8</sup> DOE mentioned its Viability Assessment (1998), Preliminary Site Suitability Evaluation (2001), Supplemental Science and Performance Analyses (2001), Draft Environmental Impact Statement (1999), and Supplement to the draft EIS (2001).

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regarding the collection of additional information provide the basis for concluding that development of an acceptable license application is achievable.”

The NRC Chairman’s letter also pointed out that NRC’s Advisory Committee on Nuclear Waste noted, similar to the NRC staff, that substantial additional work by DOE is needed prior to its submission of a license application.

Since its first report to the Congress and Secretary of Energy in 1990, the Board has consistently raised issues and concerns over DOE’s understanding of the expected lifetime of the waste containers, the significance of the uncertainties involved in the modeling of the scientific data, and the need for an evaluation and comparison of a repository design having a higher temperature with a design having a lower temperature. The Board continues to reiterate these concerns in correspondence to DOE’s director of the nuclear waste program and in its reports to the Congress and the Secretary of Energy. For example, in an August 2000 letter to the Subcommittee on Energy and Power, House Committee on Commerce, the Board reported that the technical basis for DOE’s long-term projections of repository performance had “critical weaknesses.” The Board explained that some of the large uncertainties about the proposed repository’s performance over thousands of years—including the estimated corrosion rates of waste containers and predicted behavior of the geologic system—were greater at the higher temperatures that would result from DOE’s design of the repository. At a January 2001 public meeting with DOE, the Board told DOE that to determine whether the Yucca Mountain site is suitable for use as a repository, DOE must focus its attention on four priority issues: (1) quantifying the uncertainties in the models used to estimate the repository’s performance; (2) gaining a further understanding of the processes related to the corrosion of waste containers; (3) evaluating and comparing a repository design having a higher temperature with a design that has a lower temperature; and (4) developing evidence other than performance assessment modeling to support the estimates of repository performance.

In October 2001, the Board reported that, despite DOE’s progress in responding to the Board’s concerns, gaps in data and analyses make evaluation of DOE’s technical bases on whether to recommend the site more difficult. The Board provided several examples of these gaps. First, the Board noted that DOE has not yet completed a comparison, promised in a May 30, 2001, letter to the Board, between a high-temperature and a low-temperature repository design. The Board explained that a design with a lower temperature has the potential to reduce the level of

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uncertainty in DOE's modeling results. Second, DOE does not appear to have implemented the Board's suggestion, made in two previous letters to DOE, to examine more closely the contribution that each piece of natural and engineered barriers makes to the repository's overall performance. Third, the Board observed that DOE had not presented a clear and persuasive rationale for going forward with a site recommendation before resolving the important issue of the potential consequences to the repository from volcanic activity. Last, the Board asked that, if the analyses referred to in the letter would not be available before DOE's decision on whether to recommend the site to the President, DOE provide its rationale explaining why the analyses are not important for site recommendation as well as any plans for subsequently conducting the work if the site were recommended and approved for repository development.

Recent reports to DOE by the U.S. Geological Survey and an international peer review team provide further insights into DOE's site investigation. An October 2001 letter from the U.S. Geological Survey (USGS), which has long played an active role in the site investigation, stated that the scientific work performed to date supports a decision to recommend the site for development as a repository. However, USGS qualified its position by noting that it was commenting only within the scope of its earth science expertise and was neutral regarding other information the Secretary might consider. USGS also pointed out that additional studies need to be performed even after a site recommendation.

In November 2001 an international peer review panel released an executive summary of the results of its review of DOE's performance assessment modeling for a potential site recommendation. The panel, which performed the review at DOE's request, was organized by the Nuclear Energy Agency of the Organization for Economic Cooperation and Development and the International Atomic Energy Agency of the United Nations. The panel did not comment on the results of DOE's modeling efforts but found that DOE's methodology is soundly based and implemented in a competent manner. Overall, the panel stated, DOE's approach provides an adequate basis for supporting a statement on likely compliance within the regulatory period of 10,000 years and for a site recommendation decision. The panel also qualified its findings, however, by stating that the findings were based on a brief review and not an in-depth analysis. The panel also called for a number of improvements in DOE's approach to performance assessment, including demonstrating an understanding of the behavior of the overall repository system rather than

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focusing on the numerical results of the assessment, and identifying and treating all types of uncertainty in the modeling.

As recently as May 2001, DOE projected that it could submit a license application to NRC in 2003. It now appears, however, that DOE may not complete all of the additional technical work that it has agreed to do to prepare an acceptable license application until January 2006. In September 2001, Bechtel completed, at DOE's direction, a detailed reassessment in an effort to reestablish a cost and schedule baseline. Bechtel estimated that DOE could complete the outstanding technical work agreed to with NRC and submit a license application in January 2006. This estimate was based on guidance from DOE that, in part, directed the contractor to assume annual funding for the nuclear waste program of \$410 million in fiscal year 2002, \$455 million in fiscal year 2003, and \$465 million in fiscal year 2004 and thereafter. DOE has not accepted this estimate because, according to program officials, the estimate would extend the date for submitting a license application too far into the future. Instead, DOE is now considering accepting only the fiscal year 2002 portion of Bechtel's detailed work plan and requesting Bechtel to prepare another work plan for fiscal year 2003 through submission of a license application.

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### Essentially the Same Information Is Needed for a Site Recommendation and a License Application

Under the Nuclear Waste Policy Act and DOE's site suitability guidelines, while the site recommendation and a license application are separate processes, DOE will need to use essentially the same data for both. Further, site recommendation and license application are connected by law with specific timeframes that require DOE to submit a license application to NRC within about 5 to 8 months once the President considers the site qualified for a license application and makes a site recommendation to the Congress.

Under the act, DOE's site characterization activities are to provide information necessary to evaluate the Yucca Mountain site's suitability for submitting a license application to NRC for placing a repository at the site. In implementing the act, DOE's guidelines provide that the site will be suitable as a waste repository if the site is likely to meet the radiation protection standards that NRC would use to reach a licensing decision on the proposed repository. Thus, as stated in the preamble (introduction) to DOE's guidelines, DOE expects to use essentially the same data for the site recommendation and the license application.

In addition, the act specifies that, having received a site recommendation from the Secretary, the President shall submit a recommendation of the



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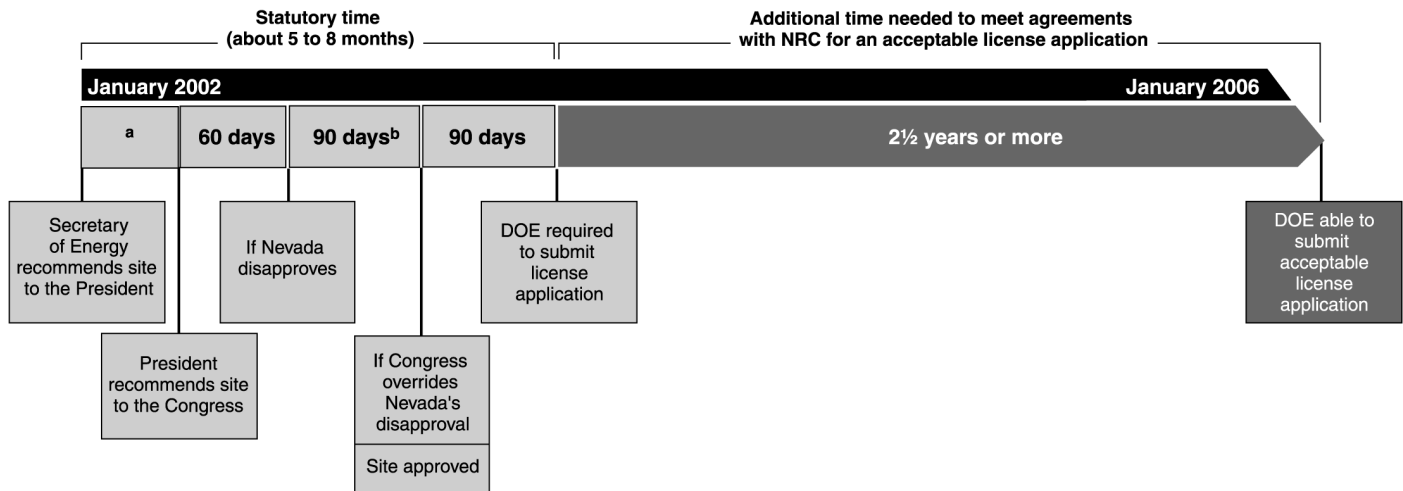
site to the Congress if the President considers the site qualified for a license application. Under the process laid out in the Nuclear Waste Policy Act, once the Secretary makes a site recommendation, there is no time limit under which the President must act on the Secretary's recommendation. However, once the President makes a recommendation to the Congress that it approve the site, specific statutory time frames are triggered for the next steps in the process. Figure 1 shows the approximate statutory time needed between a site recommendation and submission of a license application and the additional time needed for DOE to meet the conditions for an acceptable license application. For illustrative purposes, figure 1 assumes that the Secretary recommends the site to the President on January 30, 2002 and the President recommends the site to the Congress 6 months later on July 30, 2002. The figure also assumes that Nevada disapproves the site but that the Congress overrides the state's disapproval. As shown in the figure, Nevada has 60 days to disapprove the site, and if disapproved, the Congress has 90 days (of continuous session) in which to enact legislation overriding the state's disapproval. If the Congress overrides the state's disapproval and the site designation takes effect, the next step is for the Secretary to submit a license application to NRC within 90 days after the site designation is effective. On the basis of Bechtel's latest program reassessment, DOE would be in a position to submit a license application to NRC in January 2006.

These statutory time frames provide about 150 to 240 days, or about 5 to 8 months, from the time the President makes a recommendation to DOE's submittal of a license application. DOE, however, will not be ready to file an acceptable application with NRC for several years.<sup>9</sup> (See fig. 1.) Therefore, the Secretary of Energy should consider the timing of this statutory process as he decides when to make a site recommendation to the President.

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<sup>9</sup> In the congressional conference report on fiscal year 2002 appropriations for energy and water development, the conferees stated that they expect DOE to deliver the final site recommendation report and environmental impact statement to the Congress by Feb. 28, 2002. They recognized that certain scientific and engineering work is directly related to the site's recommendation and to resolving technical concerns of NRC and the Board, and that "such work should not automatically terminate upon submission of the site recommendation." H.R.Rep. No. 107-258, at 122 (2001).

**Figure 1: Comparison of Statutory Site Approval Process With DOE's Projected Schedule**



<sup>a</sup>No prescribed statutory time frame.

<sup>b</sup>90 calendar days of continuous session of the Congress.

## DOE Is Unlikely to Open a Repository in 2010 as Planned

DOE, in a document that would support a potential site recommendation, states that it may be able to open a repository at Yucca Mountain in 2010. This expectation is predicated on the submission of a license application to NRC in 2003, receipt of the construction authorization in 2006, and construction of enough surface and underground facilities to begin putting wastes into the repository in 2010. However, according to Bechtel's September 2001 detailed reassessment of the nuclear waste program, in which it proposed to reestablish a baseline for the program, a more realistic date for submitting the license application may be January 2006. Reestablishing the program's baseline is necessary because DOE stopped using the baseline to manage the program in March 1997. Since then, program officials have used revised estimates for the license application date in various internal and external reports, but none of these changes were approved as required and the program's cost and schedule baseline has never been revised to reflect these changes. As a result, DOE does not have a baseline estimate of the program's schedule and cost that is based on all the work that it expects to complete through the submission of a license application. Because of uncertainty over when DOE may be able to open the repository, the Department is exploring alternatives that might still permit it to begin accepting commercial spent fuel in 2010.

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## DOE's Current License Application Milestone Date Is Not Supported by the Program's Baseline

In its most recent report on the program's estimated cost, DOE states that it expects to submit the application to NRC in 2003.<sup>10</sup> This date reflects a delay in the license application milestone date last approved by DOE in March 1997 that targeted March 2002 for submitting a license application. The 2003 date was not formally approved by DOE's senior managers or incorporated into the program's cost and schedule baseline, as required by the management procedures that were in effect for the program. At least three extensions for the license application date have been proposed, but none of the three proposals have been approved as required.

DOE designates some of its programs and projects, such as the nuclear waste program, to receive special attention from senior DOE managers because of the complexity or estimated costs of the programs and projects. DOE's guidance for managing these designated programs and projects requires, among other things, that senior managers establish a baseline for managing the program or project. The baseline describes the program's mission—in this case, the safe disposal of highly radioactive waste in a geologic repository—and the expected technical requirements, schedule, and cost to complete the program. Procedures for controlling changes to an approved baseline are designed to ensure that program managers consider the expected effects of adding, deleting, or modifying technical work, as well as the effects of unanticipated events, such as funding shortfalls, on the project's mission and baseline. In this way, alternative courses of action can be assessed on the basis of each action's potential effect on the baseline. DOE's procedures for managing the nuclear waste program require that program managers revise the baseline, as appropriate, to reflect any significant changes to the program.

After March 1997, according to DOE officials, they did not always follow these control procedures to account for proposed changes to the program's baseline, including the changes proposed to extend the date for license application. According to these same officials, they stopped following the control procedures because the Secretary of Energy did not approve proposed extensions to the license application milestone. As a result, the official baseline did not accurately reflect the program's cost and schedule to complete the remaining work necessary to submit a license application.

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<sup>10</sup> See *Analysis of the Total System Life Cycle Cost of the Civilian Radioactive Waste Management Program* (DOE/RW-0533, May 2001).

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In November 1999, the Yucca Mountain site investigation office proposed extending the license application milestone date by 10 months, from March to December 2002, to compensate for a \$57.8 million drop in funding for fiscal year 2000. According to the specific management procedures that DOE adopted for the nuclear waste program, a proposed extension in the license application milestone required the approval of both the Director of the nuclear waste program and the Secretary of Energy. Neither of these officials approved this proposed change nor was the baseline revised to reflect this change even though the Director subsequently began reporting the December 2002 date in quarterly performance reports to the Deputy Secretary of Energy.

Less than a year later, in September 2000, the site investigation office once again proposed an extension to the license application milestone to July 2003 because of reduced funding and added technical work. Then, in February 2001, the site investigation office proposed another extension in the milestone, to December 2003. As with the November 1999 extension request, neither the Director of the nuclear waste program nor the Secretary of Energy approved either of the latter two requests, nor was either extension date for the license application milestone incorporated into the baseline for the program. Furthermore, as with the November 1999 proposed change, DOE began to use the unapproved milestone dates in both internal and external reports and communications. For example, the Director used the unapproved 2003 date for submitting a license application twice in congressional testimony in May 2001. Later, in a September 2001 memorandum to the DOE Under Secretary discussing the goals of the nuclear waste program through January 2005, the Director established 2004 as his goal for submitting a license application.

Because senior managers did not approve these proposed changes for incorporation into the baseline for the program, program managers did not adjust the program's cost and schedule baseline. By not accounting for these and other changes to the program's technical work, milestone dates, and estimated costs in the program's baseline since March 1997, DOE has not had baseline estimates of all of the technical work that it expected to

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complete through submission of a license application and the estimated schedule and cost to complete this work.<sup>11</sup>

When Bechtel was contracted to manage the nuclear waste program, one of its first assignments was to document the remaining technical work that had to be completed to support the submission of a license application and to estimate the time and cost to complete this work. The contractor's revised, unofficial baseline for the program shows that it will take until January 2006 to complete essential technical work and submit an acceptable license application. DOE also estimated that completing the remaining technical work would add about \$1.4 billion to the cumulative cost of the program, bringing the total cost of the Yucca Mountain project's portion of the nuclear waste program to \$5.5 billion.<sup>12</sup> As noted above, DOE has not accepted Bechtel's proposed new baseline extending out until January 2006. Instead, DOE is considering accepting, at present, only that portion of the baseline that Bechtel proposed to complete in fiscal year 2002.

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### Extension of License Application Date Will Likely Postpone 2010 Repository Goal

An extension of the license application date to 2006 would almost certainly preclude DOE from achieving its long-standing goal of opening a repository in 2010. According to DOE's May 2001 report on the program's estimated cost, after submitting a license application in 2003, DOE estimates that it could receive an authorization to construct the repository in 2006 and complete the construction of enough surface and underground facilities to open the repository in 2010, or 7 years after submitting the license application. This 7-year estimate from submittal of the license application to the initial construction and operation of the repository assumes that NRC would grant an authorization to construct the facility in 3 years, followed by 4 years of construction. Assuming these same estimates of time, submitting a license application in January 2006 would extend the opening date for the repository until about 2013.

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<sup>11</sup> In 1998 and 2000, independent cost and schedule reviews of the program were performed by DOE contractors. On the latter review, the contractor concluded that DOE's schedule for licensing, constructing, and opening the repository by 2010 was optimistic by about 2 years and that DOE's estimate of the total cost of the program over its 100-plus-year lifetime—\$58 billion (2000 dollars)—was understated by about \$3 billion.

<sup>12</sup> DOE estimated that the program cost \$4.1 billion, on the basis of year-of-expenditure dollars from the program's inception in 1983 through March 2002. The \$5.5 billion estimate for the license application is based on year-of-expenditure dollars from 1983 through January 2006.

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Furthermore, opening the repository in 2013 may be questionable for several reasons. First, a repository at Yucca Mountain would be a first-of-a-kind facility, meaning that any schedule projections may be optimistic. DOE has deferred its original target date for opening a repository from 1998 to 2003 to 2010. Second, although the Nuclear Waste Policy Act states that NRC has 3 years to decide on a construction license, a fourth year may be added if NRC certifies that it is necessary. Third, the 4-year time period for construction that DOE's current schedule allows from the issuance of a construction authorization to the opening of the repository may be too short. For example, a contractor hired by DOE to independently review the estimated costs and schedule for the nuclear waste program reported that the 4-year construction period was too optimistic and recommended that the construction phase be extended by a year-and-a-half.<sup>13</sup> Bechtel anticipates a 5-year period of construction between the receipt of a construction authorization from NRC to the opening of the repository. Thus, on the bases of a 4-year licensing period and a 5-year period for initial construction, the repository might not be ready to open until about 2015 if DOE does not apply for a license until January 2006.

Finally, these simple projections do not account for any other factors that could adversely affect this 7- to 9-year schedule for licensing, constructing, and opening the repository. Annual appropriations for the program in recent years have been less than \$400 million. In contrast, according to DOE, it needs between \$750 million to \$1.5 billion in annual appropriations during most of the 7- to 9-year licensing and construction period in order to open the repository on that schedule. In its August 2001 report on alternative means for financing and managing the program, DOE stated that unless the program's funding is increased, the budget might become the "determining factor" whether DOE will be able to accept wastes in 2010.<sup>14</sup>

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<sup>13</sup> See *Independent Cost Estimate Review of the Civilian Radioactive Waste Management Program, 2001 Total System Life Cycle Cost* (Jan. 2001).

<sup>14</sup> See *Alternative Means of Financing and Managing the Civilian Radioactive Waste Management Program* (DOE/RW-0546, Aug. 2001).

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## DOE Is Reviewing Alternative Ways to Accept Wastes in 2010

Because of the uncertainty of achieving the 2010 goal for opening the Yucca Mountain repository, DOE is examining alternative approaches that would permit it to meet the goal. In May 2001, DOE released a report on potential options for constructing and operating the repository.<sup>15</sup> It is also sponsoring a National Research Council study on possible approaches to developing a repository in stages over a longer duration.

DOE's May report evaluates a range of approaches to developing and operating the repository system and strategies for implementing these approaches. For example, to reduce the uncertainties of receiving substantially higher appropriations needed to open the repository as planned, DOE examined approaches that might permit it to begin accepting wastes at the repository site in 2010 while spreading out the construction of repository facilities over a longer time period. The study recommended developing the repository on a modular basis, separating the rate of accepting wastes at the repository site from the rate of waste emplacement in the underground disposal areas by relying on the surface storage of received wastes until the capacity to move wastes into the repository has been increased. For example, relatively modest-sized surface facilities to handle wastes could be expanded later to handle larger volumes of waste. Such a modular approach, according to the study results, would permit partial construction and limited waste emplacement in the repository, at lower than earlier estimated annual costs, in advance of the more costly construction of the facility as originally planned. Also, by implementing a modular approach, DOE would be capable of accepting wastes at the repository earlier than if it constructed the repository described in documents, such as the Science and Engineering Report that the Secretary would use to support a site recommendation.

In addition, DOE has contracted with the National Research Council to provide recommendations on design and operating strategies for developing a geologic repository in stages, which is to include reviewing DOE's modular approach. The Council is addressing such issues as the

- technical, policy, and societal objectives and risks for developing a staged repository;

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<sup>15</sup> See *CRWMS Modular Design/Construction and Operation Options Report* (DOE/OCRWM, TDR-CRW-MD-000002, Rev. 03, May 2001).

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- effects of developing a staged repository on the safety and security of the facility and the effects on the cost and public acceptance of such a facility; and
  - strategies for developing a staged system including the design, construction, operation, and closing of such a facility.

The Council expects to publish interim and final reports on the study in about March 2002 and December 2002, respectively.

In part, DOE's desire to meet the 2010 goal is linked to the court decisions that the Nuclear Waste Policy Act, as implemented by DOE's contracts with owners of commercial spent fuel, obligated DOE to begin accepting spent fuel from contract holders not later than January 31, 1998, or be held liable for damages. Courts are currently assessing the amount of damages that DOE must pay to holders of spent fuel disposal contracts. Estimates of potential damages for the estimated 12-year delay from 1998 to 2010 range widely from the Department's estimate of \$2 billion to \$3 billion to the nuclear industry's estimate of at least \$50 billion. The damage estimates are based in part on the expectation that DOE would begin accepting spent fuel from contract holders in 2010. The actual damages could be higher or lower, depending on when DOE begins accepting spent fuel.

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## Conclusions

In addition to studying the Yucca Mountain site, DOE is taking the other steps, such as public hearings and obtaining NRC's sufficiency comments, that are required for the Secretary to make a site recommendation in the near future. Making a site recommendation at this time, however, may be premature. Under the Nuclear Waste Policy Act and DOE's siting guidelines, a site recommendation and a license application will need to be based on essentially the same data. Furthermore, the act lays out a process with specific time frames that requires DOE to submit a license application to NRC within about 5 to 8 months after the President makes a site recommendation to the Congress. DOE's contractor estimates that it will not have all of the additional information that NRC has said will be needed for an acceptable license application for another 4 years. Waiting until DOE is closer to submitting a license application for the additional information would put DOE in a position to be able to submit a license application that is acceptable to NRC within the time frames set out in the law, and to be able to better respond to questions and challenges that may emanate from the statutory review process subsequent to the President's recommendation.



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Another benefit of waiting for the additional technical information is that the repository's design and development schedule described in the documents that support a site recommendation may not describe the facilities that DOE would actually develop. These documents generally describe surface and underground facilities that DOE would design and build on a schedule permitting it to open the repository in 2010. This schedule, however, is unrealistic if one assumes that DOE's existing preclicensing and construction time frames continue to be valid. This uncertainty is compounded by questions about whether DOE can obtain the increases in annual funding required to meet its schedule. On the other hand, a compelling incentive exists to open the repository in 2010 because DOE is liable for damages, in amounts not yet determined by the courts, for not beginning to accept utilities' spent fuel by 1998. The damage amounts will in part be based on when DOE can begin to accept and deliver spent fuel to the repository. For these reasons, DOE is exploring alternative approaches to developing a repository, such as initially storing spent fuel at the repository site before constructing underground disposal facilities that could still enable it to accept spent fuel by 2010. Thus, deferring a site recommendation until DOE has substantially completed the remaining technical work needed for an acceptable license application would also enable DOE to complete its consideration of alternative approaches to developing a repository at Yucca Mountain. DOE could then ensure that the site recommendation is based on the approach that the Department intends to follow. This would enable DOE to develop the estimated schedule to design and build the preferred approach and estimate its cost, including the annual funding requirements, as part of the information on which to make a site recommendation.

DOE needs to reestablish a baseline for the nuclear waste program that accounts for all of the outstanding technical work needed to prepare an acceptable license application and the estimated schedule and cost to achieve this milestone. In conjunction with reestablishing a baseline for the program, DOE needs to resume using the baseline as a tool for managing the program, in accordance with the Department's policies and procedures for managing major projects.

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## Recommendations for Executive Action

To ensure that DOE will be prepared to submit an acceptable license application within the timeframes set out in the Nuclear Waste Policy Act, the Secretary of Energy should consider (1) deferring a site recommendation until it can meet the express statutory time frames that are triggered by a site recommendation by the President to the Congress and (2) including the results of DOE's ongoing technical work for NRC and

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the results of analyses of alternative approaches to the proposed repository in the Secretary's comprehensive statement of the basis for a site recommendation.

To improve the management of the nuclear waste program and to provide the Congress and the public with accurate information on the repository program, we further recommend that the Secretary of Energy

- reestablish the baseline for the nuclear waste program through the submission of a license application, including incorporating the remaining technical work required to submit the application and the estimated cost and schedule to complete this work, and
- follow the Department's requirements for managing major programs and projects, including a formal change control procedure.

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## Agency Comments and Our Evaluation

We provided DOE with a draft of this report for review and comment. DOE disagreed with our report, contending that we did not understand the relevant statutory and regulatory requirements related to a site recommendation. Bechtel, DOE's management contractor, also provided us with a letter asserting unspecified factual and legal inaccuracies in our draft report; however, the company added that it would provide specific comments through DOE. While it was not clear from DOE's comments which ones had come from Bechtel, we are responding to all comments received on the following pages. According to DOE, our misunderstanding of the requirements resulted in a contention in the draft report that it is premature for DOE to make a site recommendation because all the technical work for license application is not complete. (DOE's comments are in app. II.) We agree that the Secretary has the discretion to make such a recommendation at this time; however, we question the prudence and practicality of making such a recommendation at this time, given the express statutory time frames for license application and the significant amount of work remaining to be done for NRC to accept a license application from DOE. Our conclusion is based on the relationship between a site recommendation and DOE's readiness to submit an acceptable license application to NRC, as set out in DOE's siting guidelines and the Nuclear Waste Policy Act. The preamble to DOE's siting guidelines states that DOE expects to use essentially the same data for a site recommendation and a license application. Also, the Nuclear Waste Policy Act states that a presidential site recommendation is to be made if the President considers the site qualified for a license application and sets out a time frame that could be as short as 5 to 8 months from a presidential site recommendation to a license application. This includes

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the requirement that the Secretary of Energy submit a license application not later than 90 days following congressional approval of the site. Thus, the statutory time frame is decidedly shorter than the 4-year estimate between site recommendation and license application that was recently proposed by DOE's management contractor.

DOE also pointed out the difference between the decision at hand—determining whether a potential site is licensable—and the licensing by NRC of a repository facility at the site. The latter decision would come at the end of a 3- to 4-year licensing proceeding. In contrast, our report addresses the relationship between a site recommendation and the submission of the license application.

DOE said that our draft report incorrectly states that DOE's siting guidelines require the Secretary, in making a site recommendation, to determine if the site currently complies with NRC's licensing requirements rather than determining if the site is "likely" to meet NRC's radiation protection standards. We agree that the standard in DOE's guidelines is "likely" and have added this language to the report. The report accurately states the relationship between a site recommendation and a license application under the Nuclear Waste Policy Act and the siting guidelines.

In addition, DOE stated that the Nuclear Waste Policy Act charges the Secretary with establishing criteria for determining the suitability of a site for a repository and that the Department's standards (siting guidelines) are the most important legally relevant guidance on the question of whether the Department is ready to make a site recommendation. Our report, DOE said, ignores these standards and instead asserts a standard of our own devising. Contrary to DOE's assertion, we did not evaluate DOE's performance against a standard we devised. We used the Nuclear Waste Policy Act and DOE's standards—that the site is likely to meet NRC's radiation protection standards—for a site suitability recommendation. Moreover, a presidential site recommendation triggers statutory time frames that require DOE to submit a license application to NRC within about 5 to 8 months. Thus, our conclusion regarding whether DOE should make a site recommendation relies on both the relationship between the standards for site recommendation and license application and the statutory time frames. While recommending to the President that the Yucca Mountain site is suitable for a repository is within the discretion of the Secretary of Energy, such a recommendation may be premature because of the large number of technical issues remaining to be resolved before an acceptable license application can be filed with NRC.

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DOE also stated that NRC's licensing process is an iterative and continuous process; even the license application is not expected to be "set in concrete." We agree with DOE's statement. The important point, however, is that DOE and NRC have made 293 specific agreements on technical work that DOE will need to complete and incorporate into a license application that would be acceptable to NRC. This also assumes that no new issues surface that would need to be addressed.

DOE said that our draft report emphasized the inventory of issues between DOE and NRC but completely ignored the technical work that has been done over the past 2 decades and the technical groups who have said that DOE's data are sufficient for a site recommendation. We have added information to the report recognizing the body of work that DOE has completed to date and the views of other technical parties mentioned by DOE. As discussed above, however, the central issue is not whether technical parties are of the opinion that DOE has enough information for a site recommendation but the relationship, in statute and regulation, between the site recommendation and the submission of an acceptable license application.

DOE also said our report gives short shrift to NRC's recent "sufficiency letter" that, according to DOE, memorializes NRC's conclusion that the data and analyses existing and under way likely will be sufficient for a license application. Instead, DOE added, our report over-relies on the views of an NRC advisory committee. Our characterization of NRC's sufficiency comments is accurate. NRC did state that the agreements between DOE's and NRC's staffs regarding the collection of additional information provide the basis for concluding that the development of an acceptable license application is achievable; however, NRC conditioned this comment on DOE's successful completion of "significant" additional work prior to a license application. Also, the Nuclear Waste Policy Act does not refer to work "underway," but uses the phrase "seem to be sufficient." Finally, we included the views of NRC's advisory committee because NRC's letter included these views.

In addition, DOE stated that our report prominently emphasizes the views of the Board as requiring the Department to accommodate them before a site determination is made. DOE added that the report does not emphasize that the substance of the Board's criticisms is directed to licensing—not site recommendation. Contrary to DOE's assertion, we did not assert that DOE is "required" to accommodate the Board. We discussed the Board's continuing concerns as outlined in its October 2001 letter to DOE. In that letter, the Board noted that gaps in data and

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analyses make the evaluation of DOE's technical bases on whether to recommend the site—not apply for a license—more difficult. Also, we gave the Board's current concerns about DOE's site characterization work, as summarized in its October letter, prominent mention in our report because of the Board's statutory mission to independently evaluate the technical and scientific validity of DOE's investigation of Yucca Mountain.

Finally, DOE said that our statement that delaying a site recommendation decision will have no effect on the timing of the ultimate opening of a repository is contrary to all common sense and experience. We have removed that statement from the report. However, we note that the key factors that bear on opening a repository currently lie in the licensing arena. One such factor is the 4 more years of licensing-related work that Bechtel, in its September 2001 detailed reassessment that proposed a new cost and schedule baseline, estimates would be needed to submit a license application that is acceptable to NRC. In addition, other licensing-related conditions could continue to affect the timetable for developing a repository. For example, Bechtel characterized its reassessment leading to the submission of a license application in January 2006 as a high-risk schedule that does not include any contingency or reserve—in effect, an optimistic schedule. Also, NRC, in its preliminary comments on the sufficiency of site characterization, stated that if DOE adopts a low-temperature repository operating approach, such as described in a recent technical document, then additional information would be needed for a potential license application.

Although we have clarified our discussion of the statutory and regulatory requirements for site recommendation, approval, and licensing, we continue to believe that the Secretary of Energy should consider the timing of this statutory process as he decides when to make a site recommendation to the President. Therefore, while we have modified the language, we have not changed the intent of our recommendation on this matter. DOE did not comment on our findings, conclusions, and recommendations about (1) potential delays on, and alternatives to, its proposed repository design and (2) its management of the nuclear waste program.

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## Scope and Methodology

We performed our review at DOE's headquarters in Washington, D.C., and its project office in Las Vegas, Nevada. We also met with officials of NRC in Rockville, Maryland; the Nuclear Waste Technical Review Board in Clarendon, Virginia; and the state of Nevada's Agency for Nuclear Projects in Carson City, Nevada. We conducted our review from April through

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December 2001 in accordance with generally accepted government auditing standards. (See app. I for details of our scope and methodology.)

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We will send copies of this report to the Secretary of Energy; the Director, Office of Management and Budget; and other interested parties. We will make copies available upon request. If you or you staff have any questions about this report, please call me at (202) 512-3841. Key contributors to this report are listed in appendix III.

A handwritten signature in black ink that reads "Gary L. Jones". The signature is written in a cursive style with a large, stylized "G" and "J".

(Ms.) Gary L. Jones  
Director, Natural Resources  
and Environment

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# Appendix I: Objectives, Scope, and Methodology

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Our objectives for this report were to determine whether (1) the Department of Energy (DOE) has completed the work necessary to support a site recommendation for the development of a repository at Yucca Mountain, and (2) DOE's goal of opening a repository at Yucca Mountain in 2010 is reasonable.

To determine whether DOE, through its Office of Civilian Radioactive Waste Management (OCRWM), has completed the work necessary to support a site recommendation, we discussed with DOE officials the nature and extent of such work and their relationship to the two processes. We also discussed technical issues still outstanding with staff of the Nuclear Waste Technical Review Board, the Board's Chairman, and the staff of the Nuclear Regulatory Commission's (NRC) Office of Nuclear Materials Safety and Safeguards. We analyzed the Board's annual reports and other correspondence to DOE, and summarized issues of concern affecting a site recommendation raised by the Board to DOE. We also reviewed documents obtained from NRC to identify key technical issues affecting readiness to submit an acceptable license application. We visited DOE's Yucca Mountain Site Characterization Office in Las Vegas, Nevada, and interviewed officials in that office on the Department's response to the issues raised by the Board and NRC. We also reviewed project management documents at OCRWM's headquarters and at the project office to identify and characterize how OCRWM's response to the issues raised had been incorporated into the project's work plans and guidance to the office's management contractor for the nuclear waste program. We interviewed officials of Bechtel SAIC Company, LLC, DOE's management contractor, and obtained and analyzed documents prepared by the contractor—such as its September 2001 detailed reassessment of the nuclear waste program—to determine how ongoing and future project work would address these issues, and the subsequent effects on the project schedule and milestones.

To determine whether DOE's goal of opening a repository at Yucca Mountain in 2010 was reasonable, we analyzed OCRWM's reports and project documents. We interviewed officials in OCRWM's headquarters and the project office to determine how total project and program costs had been captured, estimated, and reported to the Congress and the public. We summarized the estimated program costs and associated reasons for the milestones and changes over time. We also determined the procedures used by DOE to revise its cost and schedule estimates for site recommendation and license application, and assessed its use of those procedures.

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**Appendix I: Objectives, Scope, and  
Methodology**

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Our work was conducted from April through December 2001, in accordance with generally accepted government auditing standards.



# Appendix II: Comments From the Department of Energy



**The Under Secretary of Energy**  
Washington, DC 20585

December 5, 2001

The Honorable David M. Walker  
Comptroller General  
U.S. General Accounting Office  
441 G Street, N.W.  
Washington, D.C. 20548

Dear Mr. Comptroller General:

The Department has received, by November 28 letter, the General Accounting Office's proposed report, "Nuclear Waste: Technical, Schedule, and Cost Uncertainties on the Yucca Mountain Repository Project." The proposed report addresses the question whether the Department of Energy is ready to make a recommendation to the President regarding whether Yucca Mountain is a suitable site for a potential repository -- a recommendation the Secretary of Energy is called upon to make by the Nuclear Waste Policy Act of 1982.

Let me emphasize at the outset that, press reports to the contrary, the Secretary has not decided on a firm time frame for determining whether or not to recommend Yucca Mountain for this purpose, let alone having decided what the content of such a recommendation might be. That being said, the Department believes the approach the proposed report takes to these issues is profoundly flawed for reasons we explain below.

The proposed report asks, in effect, "why now?" about making a site determination regarding the Yucca Mountain project. What it realistically leaves unanswered is "then when?" should the results of years of scientific inquiry reveal that the Secretary of Energy and the President have enough information to make their determinations on the merits. The Nuclear Waste Policy Act instructs that the Secretary's recommendation is to be made under Department siting guidelines that use the standard that a facility at the site is likely to meet NRC radiation protection standards, and after receiving the conclusion of the NRC whether the information developed and underway will be sufficient for a license application. The NRC recently rendered the sufficiency advice called for by the Act.

Avoidance of a timely decision -- should it be otherwise called for on its merits -- would be a dereliction of duty owed to current and future generations of Americans to pursue with thoughtful expedition the task of making safe all high

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level nuclear waste. Because the proposed report is a “Brandeis brief” for delay, we must in these comments critically evaluate its major points.

The central contention of the proposed report is that it is premature for the Department to make a site recommendation for Yucca Mountain because the Department has yet to complete all the remaining technical work needed for a license application. This contention reflects a profound lack of understanding of the statutory and regulatory requirements based on an inaccurate depiction of their context.

First, the decision at hand involves determining a potential site, not the licensing of a facility. The construction and operation of a facility – here the repository – would be licensed by the Nuclear Regulatory Commission after site determination. The site itself is not licensed; instead its features may affect design of the facility which is licensed. Thus determining a site must occur before beginning the licensing procedure.

That is why the Nuclear Waste Policy Act specifically envisions two distinct decisions: one by the President, on the advice of the Secretary of Energy, as to whether a hypothetical repository at Yucca Mountain is potentially licensable by the NRC; then one by the NRC as to whether a proposed repository, complete with design specifications, should be allowed to be built and ultimately operate there.

Second, the proposed report misstates, in its brief treatment of them, the Department’s siting guidelines as requiring the judgment that the site currently complies with NRC licensing requirements. Not only is this not what the Department’s guidelines require, but during the notice and comment rulemaking held on them over a period many years, not a single commenter suggested that the Department adopt such a standard. Rather, consistent with the structure outlined above, the Department’s guidelines call for the judgment that a facility at the site is likely to meet NRC radiation protection standards – a predictive judgment that inherently embraces the existence of incompletely resolved potential licensing issues.

Third, because the NWPA charges the Secretary with establishing “criteria to be used to determine the suitability of [a] site for the location of a repository,” the Department’s standards – in which the NRC has concurred, as the NWPA also requires – provide the most important legally relevant guidance on the question whether the Department is ready to make a site recommendation. Yet the proposed report, despite purporting to answer that question, ignores these standards altogether and instead evaluates the Department’s readiness against a standard of its own devising.

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Fourth, the NRC licensing process is one that the NRC has described as “iterative” and an “integrated and continuous process.” That means that even the license application envisioned by the NWPA was not expected to be set in concrete on its submission but was instead expected to experience refinement and amendment during the licensing process, as was indicated in the NRC regulations in effect when the Nuclear Waste Policy Act was adopted by Congress in 1982.

Fifth, the proposed report affords heavy and central emphasis to the existence of an inventory of issues as to which the Department has agreed with the NRC further to develop for licensing purposes. At the same time it completely ignores the enormous body of scientific and technical work completed regarding the site over the last two decades, including the inventory of some 600 papers cited in the Department’s May, 2001 Science and Engineering Report on Yucca Mountain. Nor does the proposed report touch upon – or even acknowledge the existence of – the substantial body of recent, directly relevant analytic literature published by the Department, including the 1998 Viability Assessment, the 2001 Preliminary Site Suitability Evaluation, the 2001 Supplemental Science and Performance Analyses, the 1999 Draft Environmental Impact Statement, and the 2001 Supplement to the Draft EIS.

Much less does the proposed report attempt to evaluate the significance of the unresolved issues as compared with those that have been addressed and resolved in assessing the appropriate timing for a site recommendation. Nor does it address the recent formal conclusions of independent, technically-literate bodies like the U.S. Geological Survey, the International Peer Review Team of the International Atomic Energy Agency and the Organization of Economic Cooperation and Development’s Nuclear Energy Agency, and the Energy Committee of the Council on Engineering of the American Society of Mechanical Engineers. In substance each of these has advised the Department that, from the standpoint of the disciplines within its institutional expertise, the information adduced to date is sufficient for a site recommendation.

Sixth, the proposed report gives short shrift to the NRC’s recent “sufficiency letter,” that memorializes a site determination judgment called for specifically by the Nuclear Waste Policy Act to the effect that the NRC has concluded that the data and analyses existing and underway likely will be sufficient for a license application. Instead the proposed report centers its attention on views attributed to an advisory committee to the NRC, ignoring that it is the NRC, rather than any of its individual or collective advisors, that is responsible under the Nuclear Waste Policy Act (as in all else) for the conduct of its statutory functions.

Seventh, and in a similar vein, the proposed report prominently emphasizes the views of the Nuclear Waste Technical Review Board as requiring the Department to accommodate them before a site determination is to be made. The Department regards the Board’s advice as extremely valuable and anticipates continuing to

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receive that advice throughout the entirety of the program. Nonetheless, beyond this advisory function, Congress gave the Board no formal role in the siting process when it established this body. And in any event what is not emphasized in the proposed report is that the substance of the Board's criticisms is directed to factors that bear on licensing the facility, not the identity of the site.

Finally, the proposed report asserts that delaying a site recommendation decision will have no effect on the timing of the ultimate opening of a repository. That is contrary to all common sense and experience. Yet this assertion plays a critical role in the structure of the report. Had the report made the only realistic assumption on this question – that delay on site recommendation will indeed lead to delay in opening a repository – it would have had to come to grips with the costs as well as the benefits of delay. For example: high level radioactive waste is currently stored in surface facilities at 129 sites in 39 States around the country, with attendant vulnerabilities. Yet the report gives no weight to the interests of the communities where this waste is located in having a decision on a site for a repository made promptly one way or the other as soon as it can be made responsibly.

We look forward to working with the GAO on this important issue.

Sincerely,

*Robert G. Card*

Robert G. Card

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# Appendix III: GAO Contact and Staff Acknowledgments

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## GAO Contact

Dwayne E. Weigel (202) 512-6876

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