SUPPLEMENTAL APPENDIX TO
FINAL BRIEF OF THE STATE OF NEVADA, INTERVENOR SUPPORTING RESPONDENTS

The Road to Yucca Mountain

THE DEVELOPMENT OF RADIOACTIVE WASTE POLICY IN THE UNITED STATES

J. SAMUEL WALKER

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assumptions and procedures. The AEC distorted or dismissed many of the complaints it received from the National Academy of Sciences committees on waste, in part because it found them unduly unfavorable and in part because it had no satisfactory response to offer. In this regard, it demonstrated complacency to the point of smugness. The National Academy panels were made up of distinguished professionals who pointed out the geologic uncertainties of AEC sites and the potential pitfalls of waste management practices. The failures in high-level liquid storage tanks at Hanford and Savannah River should have encouraged greater humility on the part of the AEC, especially in light of the assurances it provided that no leaks had been detected. Instead, agency officials largely disregarded the arguments of their critics, especially regarding the potential hazards of disposing of large quantities of unpackaged low-level waste. They relied on their own judgment about existing methods of handling wastes and the likelihood that means for permanent disposal would soon be developed. In his memoirs, published posthumously in 2001, Seaborg, who served as chairman of the AEC from 1961 to 1971, acknowledged that the agency "erred in dealing with nuclear waste [by leaving] behind a terrible legacy—the massive residue of contaminated wastes at Hanford and other nuclear materials production sites."[52]

The AEC's approach to its own wastes also applied in important ways to commercial wastes. It recognized that sound treatment of radioactive waste was essential for the future of nuclear power and believed that it was nearing a solution to the problem. The excessive optimism, unexamined assumptions, and underestimated uncertainties that were prominent in its own waste programs soon proved major obstacles in its quest for a permanent repository for high-level commercial wastes.

CHAPTER 3

An "Atomic Garbage Dump" for Kansas

As a result of the clamor over waste management in Idaho, the AEC made a tentative commitment to open a repository for high-level and transuranic materials by the end of the 1970s. When AEC chairman Seaborg told Senator Church that Idaho wastes would be transferred to a permanent site, he and his colleagues were counting heavily on the availability of an abandoned salt mine in Lyons, Kansas, for burial of high-level wastes from commercial nuclear plants, as well as materials from the National Reactor Testing Station. The AEC moved rapidly to carry out its pledge by investigating the suitability of the Lyons site and making preparations to develop it as the first high-level waste repository. In the process, it provoked growing opposition from scientists and politicians in Kansas, who complained that the agency failed to treat their concerns seriously and refused to fully explore vital technical issues. The AEC's efforts eventually collapsed on both political and technical grounds; it not only took actions that antagonized key leaders in Kansas but also found that the Lyons site was inappropriate for burying radioactive wastes. The outcome of the Lyons controversy was an enormous embarrassment for the AEC and a severe setback in the search for a high-level waste repository.

PROJECT SALT VAULT

In 1957 the National Academy of Sciences Committee on Waste Disposal had published a report in which it concluded that salt forma-

high-level radioactive wastes in large concrete and steel structures that would be placed above ground. Skubitz remained skeptical. In response to his inquiries, he received assurances in June 1974 from Dixy Lee Ray, who followed Schlesinger as AEC chairman, that the agency did "not plan to dispose of radioactive wastes in the State of Kansas" and that it intended to "manage all high level radioactive waste in retrievable surface storage." Nevertheless, Skubitz introduced a bill in Congress three years later that would require a referendum by the citizens of a state in which a nuclear waste repository would be located. His motive, he explained, was "to prevent the Lyons, Kansas, situation from ever developing again."[43]

The AEC's first effort to identify a suitable site for disposing of high-level radioactive wastes from commercial nuclear power failed spectacularly. In its haste to fulfill its pledge to Senator Church and to build a repository for the growing quantities of commercial reactor wastes, it not only selected a location that proved unsuitable but also offended political leaders and scientists whose backing for the project was essential. The AEC was not indifferent to the safety of the Lyons site or to the welfare of the citizens of Kansas, but its ham-handed treatment of controversial issues often made it appear that way. Preliminary investigations of the Carey mine were promising enough for the agency to explore its advantages as a permanent waste repository. But the AEC became so focused on Lyons that it too easily dismissed the serious questions that the Kansas Geological Survey raised. It dealt with the reservations of Hambleton and his colleagues in much the same way that it had responded to the comments on waste hazards at AEC installations that the National Academy of Sciences had provided during the 1960s. Rather than take its time to investigate scientific uncertainties and reach strongly defensible conclusions, it offered disputable assurances and pressed ahead. The AEC knew of the presence of another salt mine and oil and gas wells close to the proposed repository, but it took no action to study the risks of previous drilling until after the American Salt Corporation expressed concerns. Its refusal to fully assess the potential pitfalls of the Lyons project was an embarrassment that could have and should have been avoided by a more deliberate approach to the inherently complex problem of disposing of radioactive wastes.

The AEC handled the political aspects of the Lyons debate in an equally inept manner. It was aware that the construction of a waste repository would not proceed without the support of the local community, and it was committed to addressing public concerns. But it did not

deal adroitly with the political issues that arose in Kansas, in large part because it tended to view critics of the Lyons proposal as a monolithic whole. It failed to distinguish between the reservations that Hambleton cited and the much more strident and intractable position that Skubitz adopted. Docking and Hambleton were open-minded about the project at the outset; they eventually became disillusioned with the AEC after it dismissed or refused to aggressively investigate the questions they raised.

Long before the AEC realized that the project was technically flawed, it had lost the political support it needed. Although Kansas officials were favorably impressed with the staff members from Oak Ridge and the AEC whom they met, they were repeatedly frustrated and dumbfounded by the policy decisions of AEC headquarters. Erlewine's press conference in Topeka in June 1970 was the first in a series of political missteps the AEC took during the Lyons controversy. The agency's clumsy political performance was a result of its conviction that its procedures would assure the safety of the facility and of its unseemly rush to build a waste disposal repository. The AEC paid a heavy price for its errors. The Lyons debacle received national attention that diminished confidence in the agency and made its search for a solution to the waste problem immeasurably more difficult.

waste legislation as an essential step to counter the ills of the industry. "We're about to bring the nuclear industry to its knees unless we act now," Simpson declared in April 1982. In the House, waste proposals came under the jurisdiction of at least four committees that were much less favorably disposed toward nuclear power.[28]

When McClure introduced his bill, he attempted to resolve the question that had scuttled legislation in the previous session by stating that its requirements would apply strictly to high-level wastes from civilian reactors. Simpson and many of his colleagues, however, believed that Congress should not ignore the high-level wastes generated in the production of materials for nuclear weapons, which was about 90 percent of the total inventory that required disposal. The Subcommittee on Nuclear Regulation passed an amendment that finessed the issue. It placed the final decision on whether a site should be used for wastes from both nuclear power and "atomic energy defense activities" in the hands of the president. Unless the president found that separate facilities were necessary, DOE was instructed to develop a "unified system" for military and commercial wastes. This approach eventually prevailed in the Senate and served to focus attention on arrangements for storage and disposal of civilian waste.[29]

The compromise over inclusion of military wastes in the legislation settled one key dispute, but there were major differences on other issues. Although there was agreement on the need to find an appropriate geologic formation for high-level waste, the location of the facility and the role of the states in siting decisions continued to generate intense debate. Few members of Congress argued that individual states should be awarded an absolute veto over a site that detailed characterization showed to be suitable. State officials took the same position. The State Planning Council on Radioactive Waste Management, which Carter had established in 1980, commented in a report it submitted to Reagan in August 1981, "The Council believes that neither an absolute state veto nor the arbitrary preemptive imposition of Federal will is the appropriate way to resolve an impasse." Supporters of waste legislation concluded that the best method "to resolve an impasse" was to specify that Congress could override a state veto. But the questions of whether action by both the Senate and the House would be needed and where the burden would be placed for taking the initiative on sustaining a state's disapproval produced a great deal of animated discussion.[30]

Another highly divisive issue was away-from-reactor storage of spent fuel. *Nuclear Industry* reported that this was "perhaps the most con-

defeated an amendment that would have granted states and tribes an absolute veto over the location of a permanent repository, and, on this issue, it took a position consistent with the Senate by adopting the same procedures for overriding a veto.[35]

The bills passed by the House and Senate were divergent enough that agreement on a compromise measure was very much in doubt. But the proponents of legislation gradually found common ground. The timetable for selecting two sites for a geologic repository stretched the schedule in the Senate bill, but not by much. The legislation that reached the floor of each house directed DOE to conduct studies of five sites and recommend three of them to the president for detailed characterization by January 1, 1985. The president would designate one site and inform Congress by March 31, 1987, and the NRC would rule on the application for a construction permit within three years. Meanwhile, DOE would study at least five other sites and recommend three of them to the president as potential locations for a second repository by July 1, 1989. The president would decide on a second site by March 31, 1990. Utilities would be assessed a fee to pay for the costs of building a waste facility, and DOE would take possession of the spent fuel from their plants by December 31, 1998.

After tense negotiations, Udall and Johnston split the difference on the timing for DOE's planning report on monitored retrievable storage by stipulating that it should be completed within two and one-half years. The factious question of away-from-reactor storage was resolved largely along the lines that the House (and host-state senators) favored. Such a facility could be used for up to 1,900 metric tons of spent fuel, but it had to be located on existing federal property, which excluded West Valley, Barnwell, and Morris. Senator Strom Thurmond of South Carolina also won approval for an amendment that required removal of spent fuel from storage within three years after a permanent repository opened. With those and other issues settled, the prospects for enactment of a law looked promising as the congressional session neared its end.

The legislation almost failed, however, when Senator William Proxmire of Wisconsin, a potential location for a repository, threatened a filibuster unless states received greater authority to veto a site that DOE selected. In place of forcing a state to persuade one house of Congress to uphold its objection, he offered an amendment that would require both houses of Congress to override a state veto. Otherwise, the site would be eliminated. This assigned Congress the responsibility of taking action and seemed to its supporters to provide the states with more

influence in a siting decision. "We believe it is extremely important that the Nuclear Waste Policy Act require action of both houses to override state disapproval," the governors of New Mexico, Nevada, Utah, and Washington argued. "The burden of proof should rest with the US Department of Energy to sustain such an override. Requiring Western states with numerically small delegations to provide the burden of proof is an overwhelming and unfair task." Proxmire's willingness to filibuster this issue would have doomed the legislation, and the Senate promptly accepted his amendment. On December 20, 1982, the Senate approved the final form of the bill by a voice vote; the House followed suit a few hours later by a vote of 256–32.[36]

The Nuclear Waste Policy Act was a milestone achievement. After years of false starts, delays, and stalemate, it made clear the government's commitment to deal with a complex and controversial issue. Industry and DOE officials expressed hope that this would reassure the public and help restore confidence in nuclear power. Loring Mills, vice president of the Edison Electric Institute, commented, "Waste legislation sets a framework that allows us to say, in fact, we know how to resolve this issue, and it's no longer an impediment to going forward with nuclear power." Robert F. Bonitati, a special assistant to President Reagan, suggested, "[The act] provides the long overdue assurance that we now have a safe and effective solution to the nuclear waste problem." Other well-informed observers were less certain that the law provided a solution to the problem it addressed. An article in *Science* magazine made a comment about the original bill the Senate passed in April 1982 that was equally applicable to the final version of the law. "A bill like this would have to be considered only a hesitant first try at solving the nuclear waste problem," wrote Eliot Marshall of the journal's staff. "It deals with none of the technical disputes and leaves the highly difficult task of site selection to the bureaucracy."[37]

THE NUCLEAR WASTE POLICY ACT AMENDMENTS OF 1987

As Marshall cautioned, formidable technical and political uncertainties surrounding high-level disposal remained even after passage of the waste policy act. It was soon clear that the law did not provide the solution that optimists had predicted. DOE, in accordance with the requirements of the law, conducted environmental evaluations of possible disposal sites and selected five leading candidates: salt deposits in Mississippi, Texas, and Utah, basalt formations at Hanford, and tuff rock in Nevada.

In May 1986 Secretary of Energy John S. Herrington disclosed that the three final choices for detailed characterization were sites in Deaf Smith County, Texas; Yucca Mountain, Nevada; and Hanford. DOE's decision stirred angry protests from the designated areas, whose representatives charged that the department's judgment was based more on political than technical considerations. Herrington also announced that the search for a second site would be suspended because the need for it was not pressing. Supporters of the waste policy act had reached an informal understanding that a second repository would be located in the eastern part of the country, and westerners denounced DOE's action. Congress responded by cutting off funds for site characterization. Congressman Udall complained in July 1987, "The program is in ruins and our goal of siting a repository seems further away than ever."[38]

Senator Bennett Johnston, who had become chairman of the Senate Committee on Energy and Natural Resources, sought to break the impasse. He and McClure introduced a bill that would effectively limit DOE's site characterization activities to a single location—Yucca Mountain. The proposal provoked bitter opposition from Nevada legislators; Senator Harry Reid labeled it the "Screw Nevada Bill" and complained that his state was targeted because it was "the small kid on the block." The protests from Nevada were to no avail. In December 1987 Congress, as a part of a budget bill, passed amendments to the waste policy act that directed DOE to conduct exploratory investigations at Yucca Mountain and to stop work at Hanford and in Deaf Smith County. If the department found Yucca Mountain unsuitable for burying high-level wastes, it was required to halt its search for a site until it received guidance from Congress. The 1987 amendments nullified the waste policy act's procedures for choosing a location for a repository. Congress removed site selection from DOE and the president and instead dictated its own decision. Johnston commented, "I think it's fair to say we've solved the nuclear waste problem with this legislation." An unnamed congressional staff member was more restrained. "It's a roll of the dice with Yucca Mountain," the aide remarked. "We have reason to believe it will work out, but if it doesn't[,] . . . man, we're in trouble."[39]

THE YUCCA MOUNTAIN CONTROVERSY

After passage of the 1987 amendments, the technical and political questions surrounding high-level waste and spent fuel disposal shifted from a broad setting to a focus on Yucca Mountain. Nevada officials ada-

mantly opposed development of the site and undertook a series of legal, political, and public relations efforts to block it. They cited many of the same objections that critics of waste programs had raised for years, including the risks of transporting spent fuel from distant locations on interstate highways and railroads. The state mounted a formidable campaign against Yucca Mountain, but its position was always subject to being overruled by majority votes in Congress. The technical issues that arose when DOE proceeded with its detailed characterization of the site were less predictable than Nevada's dissent and fueled the controversy. By 2001 DOE had spent about $4.5 billion to build tunnels and drill bore holes a thousand feet under the surface at Yucca Mountain. Its findings greatly expanded the technical bases for making a judgment about the suitability of the site. Its research also showed that the geology of the area was more complex than originally believed and that the underground environment was not as dry as anticipated. While DOE investigated the possible effects of water flow through fractures in rock, it also sought to address concerns about the long-term reliability of new designs for waste containers that were intended to limit the release of radiation to very small amounts for 10,000 years.[40]

In February 2002 Secretary of Energy Spencer Abraham, in accordance with the procedures specified in the Nuclear Waste Policy Act of 1982, formally recommended to President George W. Bush that Yucca Mountain be constructed as the nation's first high-level waste repository. He declared that after years of research, scientists who had studied the "safety and suitability" of the site were confident that "Yucca Mountain would be safe." He argued that analyses of possible but unlikely threats from earthquakes, volcanoes, and water damage demonstrated that the site could meet EPA's standards for population exposure to radiation, which had been published in 2001. Bush immediately approved Abraham's recommendation. Kenny Guinn, governor of Nevada, protested that DOE's judgment was not based on "sound science and common sense," and he vetoed the selection of Yucca Mountain. A few weeks later, both houses of Congress, as the waste policy act allowed, gave the Yucca Mountain project a green light by voting to override Guinn's veto.[41]

The action of Congress was an important step forward for supporters of Yucca Mountain, but they acknowledged that crucial design and technical issues remained to be addressed. DOE was still investigating both the geology of the site and the performance of storage containers, and its 2010 target date for opening the repository clearly was slipping. DOE received an unexpected setback in August 2004 when the U.S.

Statement by Sen. Bennett Johnston (D-La)
Congressional Record – Senate
128 Cong. Rec. D485 S4133 (daily ed. April 28, 1982)

Sen. Proxmire: May I say to my friend from Louisiana that earlier I asked the Senator from Idaho whether there have been any States that have been ruled out. I apologize that the Senator was not on the floor when I said that I understood Louisiana had been ruled out. I cited a press release from the office of Senator Bennett Johnston as indicating that there had been an arrangement that had been made in return for allowing a strategic petroleum reserve to be located in Louisiana. I wonder if that was true and whether it was ratified by President Reagan after President Carter initially accepted it.

Sen. Johnston: There was an agreement between the Department of Energy and the Governor of Louisiana that was reduced to some principles of understanding. It states:

> The parties hereby agree that to the extent permitted by law, they will use their best efforts to adhere to the following policies and practices with respect to development of a Strategic Petroleum Reserve in the State of Louisiana.

And then they list of number of things and No. 8 says: Nuclear storage:

> All Federal Government studies relating to nuclear waste disposal in the Vacherie Salt Dome in Webster Parish and the Rayburn's Salt Dome in Bienville Parish will be subject to this stipulation. The Department of Energy will not construct any nuclear waste repository for long-term disposal in Louisiana if the State objects. Studies of possible areas in Louisiana as well as in other states would continue with some test drilling which will always be preceded by complete discussions with state officials.

That is signed, for the Department of Energy, by John O'Leary, Deputy Secretary, and for the State of Louisiana by Edwin Edwards, Governor.

Again, it states:

> The parties hereby agree that to the extent permitted by law, they will use their best efforts to adhere to the following policies and practices with respect to development of the Strategic Petroleum Reserve in the State of Louisiana.

That is what it says. I will leave it up to the distinguished Senator from Wisconsin to say what it means.

Sen. Proxmire: May I say to my friend from Louisiana, that he and his distinguished senior colleague, Senator Long, are two of the most effective Senators and this is an example of the great work they do for their State.

In the judgment of the Senator from Louisiana, would this apply to the present administration since there is a new administration now? Would this be a permanent agreement?

Sen. Johnston: Let me say what the two sides say in respect to this agreement. Those who are unfriendly to the agreement say it is not worth the paper it is written on; that the Department of Energy has no right to contract with the State; that even a President could not, but certainty not the Department of Energy; and in any event, this would be superseded, so the argument would go, by the specific provisions of this act which set a whole matrix and system whereby State participation and what is close to but not quite a State veto is provided in this act. They would say that this is superseded by that.

I am sure the Senator from Wisconsin would not want to get me to say that this is the effect of this provision.

I would, of course, argue that it is at least a gentlemen's agreement. And Ronald Reagan is a gentlemen and he certainly would not breach a gentlemen's agreement.

I know of very few people in Louisiana, and no lawyers whom I have heard say that this constitutes a veto power of the State of Louisiana over the location of geologic nuclear waste disposal sites under the provisions of this bill.

100TH CONGRESS
1st Session

SENATE

REPORT
100-152

NUCLEAR WASTE POLICY ACT AMENDMENTS ACT OF 1987

SEPTEMBER 1, 1987.—Ordered to be printed

Filed under authority of the order of the Senate of August 7 (legislative day, August 5), 1987

Mr. JOHNSTON, from the Committee on Energy and Natural Resources, submitted the following

REPORT

together with

ADDITIONAL VIEWS

[To accompany S. 1668]

The Committee on Energy and Natural Resources, having considered the same, reports favorably an original bill, to redirect the program for the disposal of spent nuclear fuel and high-level radioactive waste under the Nuclear Waste Policy Act of 1982 to achieve budget savings, and for other purposes, and recommends that the bill do pass.

PURPOSE OF THE MEASURE

The purpose of the bill is to redirect the program for the management and disposal of spent nuclear fuel and high-level radioactive waste under the Nuclear Waste Policy Act of 1982 (NWPA) to provide for—

Sequential characterization of candidate sites for a geologic respository for disposal of nuclear waste;

Construction of a monitored retrievable storage facility for spent nuclear fuel as part of an integrated nuclear waste management system; and

Benefits payments with respect to a repository or a monitored retrievable storage facility to States, Indian tribes and units of local government as appropriate.

76-701

191. Based on these regulations, the Department has created a hierarchical structure of issues to evaluate in a systematic manner the site and demonstration of its capabilities for isolating waste for 10,000 years.

Data developed during the initial site investigations have established a fundamental understanding of the site. The Environmental Assessment, along with the Multiattribute Utility Analysis of Sites Nominated for the First Radioactive Waste Repository, presented this preliminary data in the context of the requirements to make a decision. Comments received on these documents did not identify any new areas of concern of which the Department was not already cognizant. If the comments had a common denominator, it was the statement that not enough is known about the sites to establish a final conclusion. This means that more measurements, analyses and interpretations are required before all issues are resolved and a final decision is made. This is the purpose of site characterization.

While all issues revealed in the development of the site's description must be successfully addressed, some are more challenging to unravel or are known to have a larger effect on isolation. For the Yucca Mountain site, the issues that are of specific concern fall into three major categories: groundwater characteristics, seismic-tectonic characteristics, and potential for human intrusion. Each of these characteristics can be subdivided into groups of technical issues in the following manner:

e currently investigating the need to improve the capability of
e network to quantitatively define the magnitude of the ground
tion and more accurately pinpoint the location of earthquake
icenters and determine the mechanism causing them. We further
an to involve the State and the NRC in the discussion of the
oposed changes in this network and offer the State research
am a satellite link so that they will have real time access to
ta measured in the field.

Evaluation of the Effects of Earthquakes and Fault Movements
Waste Isolation After the Repository Is Sealed - The 32 known
ults in the 425 square mile area surrounding Yucca Mountain
at have shown movement in the Quaternary Period has supported
eculation that they could also affect the site's ability to
olate the waste. Some of the faults may be capable of moving
ns of centimeters in a single event. Since these events have
average recurrence time measured in tens of thousands of
ars, there is a likelihood that earthquakes and fault movements
ll occur within the 10,000 year period after the repository is
aled. After the repository is closed, however, the direct
fect of earthquakes and fault movements on waste isolation is
pected to be minimal. This is principally because little
oundwater is expected to be available to dissolve and move the
ste even if a waste canister is damaged. Of more concern is
e possibility that fault movements or other tectonic activity
ght change the current hydrologic conditions of the site.
ch changes could conceivably cause the water table to rise, or
crease the rate of groundwater movement to the water table.

in preparing high quality site characterization plans. As you know, Mr. Chairman, from our previous testimony and correspondence, we noted in this letter to DOE that DOE had made significant efforts to respond to each of the NRC staff's major comments on the draft EA's and had resolved many of these comments. However, in each of the final EA's, the staff review identified some remaining potential licensing issues.

For example, at the Hanford site we feel that the groundwater flow system and the ability to construct a repository in a medium (basalt) with high stresses must be better understood. Additional data and analysis about such characteristics as tectonic stability and the ability of the basalt system to retard movement of radionuclides are needed to determine whether regulatory requirements are met. Additionally, container lifetime estimates for Hanford will require considerably more analysis by DOE.

At the Yucca Mountain site, the major issues include geological concerns such as the presence of potentially active faults and related ground motion, the potential for volcanism, and the origin and significance of mineral veins in the area. Hydrology is also a concern in the saturated and unsaturated zones; groundwater flow patterns and regimes and travel times have yet to be fully determined. As at Hanford, the ability of the medium (tuff) to retard movement of radionuclides is not yet well understood.

At the Deaf Smith site, most of the licensing uncertainty has to do with the characteristics of the salt in which the repository would be located. Salt can dissolve unevenly along faults, leading to undesired flow of water. The

U.S. DEPARTMENT OF ENERGY
OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT

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Yucca Mountain Repository License Application

SAFETY ANALYSIS REPORT

Chapter 2: Repository Safety After Permanent Closure

none of the waste forms is expected to be exposed to water during this period. As a result, no release of radionuclides is expected to occur during the first 10,000 years after closure of the repository in the absence of disruptive events. The small possibility of early failure of some waste packages due to fabrication errors or unexpected localized corrosion has been considered in assessing the overall barrier capability. The engineered features that comprise the EBS and a description of their contribution to EBS function are summarized below. The possibility that disruptive seismic and volcanic events may occur has also been considered, as described below.

The emplacement drift feature provides a stable environment for the other engineered features. The mechanical effects of the degradation of the emplacement drifts, such as rockfall and drift collapse, do not significantly affect the performance of the drip shield and waste package except during low probability disruptive seismic and volcanic events. However, during the period beyond 10,000 years, within the period of geologic stability as prescribed by proposed 10 CFR Part 63, all types of engineered features are expected to be degraded by corrosion. The TSPA considers the effects of the degradation of the engineered features over time, including uncertainty with respect to the rate of degradation.

The drip shield is designed to divert seepage away from the waste package. It prevents water from contacting the waste package as long as it remains intact. Similarly, as long as the waste packages are intact, water cannot contact the waste forms. The cladding on SNF also prevents the contact of seepage water with that portion of the SNF that is inside of the cladding as long as it remains intact. However, for the purposes of the TSPA analyses, commercial and DOE SNF cladding are assumed to be instantaneously degraded when the waste packages are breached. The effect of naval SNF structure on radionuclide release is accounted for in the TSPA analyses. The capability of the drip shields, waste packages, and SNF cladding depends on their integrity over time. The degradation rates for general corrosion for titanium are determined to be sufficiently low that none of the drip shields are expected to breach by this mode of corrosion before 10,000 years after closure of the repository. Stress corrosion cracking may occur as a result of rockfall onto the drip shields caused by low probability seismic events. Even with corrosion of the drip shields, the small width of any stress cracks impedes water movement onto the waste packages. For the calculations for the period beyond 10,000 years, within the period of geologic stability as prescribed by proposed 10 CFR Part 63, degradation and failure of the drip shields is expected to occur: the rate and extent of degradation and associated uncertainty are included in the TSPA analyses.

The degradation rates for general corrosion for Alloy 22 (UNS N06022), the material the outer shell of the waste packages is constructed of, are sufficiently low that none of the waste packages are expected to breach as a result of general corrosion mechanisms before 10,000 years after closure of the repository. Stress corrosion cracking may occur in the weld regions of some of the waste packages. Mitigation techniques (e.g., low plasticity burnishing) are employed to reduce residual stresses below the stress corrosion cracking threshold, but there remains the potential for breaches of some waste packages before 10,000 years after closure of the repository. Early failure of a very small fraction (less than 0.01% on average) of waste packages may occur due to flaws that are undetected during fabrication or as a result of damage during handling. The probability for early failure due to manufacturing- or handling-induced defects is small because of the quality control and inspection measures employed, such as nondestructive examination techniques. For the calculation involving the period beyond 10,000 years, within the period of geologic stability as

around them depends on the characteristics of the rock matrix and fractures, and on the connectivity and permeability of the fracture network. In addition, seepage rates are affected by the characteristics of the drift openings (e.g., asperities on the drift walls and flow in fractures that may have modified hydrologic properties in the disturbed zone created by drift excavation or heat from emplacement waste). For a period of time, the decay heat of the emplaced waste is great enough to heat the rock near the emplacement drifts above boiling. As long as the temperature is above the boiling point of water at the drift wall, the water vapor will be driven away from the emplacement drift wall surfaces. This thermal effect, combined with the capillary effects, further prevents or substantially reduces seepage into the emplacement drifts.

The model that simulates seepage into the emplacement drifts under both the ambient and thermally perturbed conditions is described in Section 2.3.3. The drift seepage model considers the matrix and fracture hydrologic properties of the TSw unit and the design of the emplacement drifts. The drift seepage model and analysis supporting the development of the abstraction of drift seepage model described in Section 2.3.3 uses a continuum fracture model, and samples the uncertain stochastic distributions for the fracture permeability and capillary strength parameters to estimate the probability and amount of seepage. For the modeled future glacial-transition climate, on average, only about 30% of the drip shield locations are expected to experience any seepage in the 10,000 years after closure.

The following summary illustrates the barrier capability in the fractured rock at and above the repository horizon. The results of the probabilistic seepage analysis for intact drifts are described in terms of the mean seepage rate, the mean seepage percentage (i.e., ratio of mean seepage rate to mean percolation flux), and the seepage fraction (i.e., fraction of waste packages in a percolation region experiencing seepage), during the present-day, the monsoon, and the glacial transition climate states (Section 2.3.3.4.2). The four unsaturated zone flow fields corresponding to the 10th, 30th, 50th and 90th percentile infiltration scenarios arrive at four different sets of seepage results. For the flow field based on the 10th percentile infiltration scenario—the most likely flow field with a relative probability of approximately 62%—seepage is expected to occur at about 8% of all waste packages during the present-day climate, rising to about 13% of waste packages during the monsoon climate, and to about 17% during the glacial-transition climate (Section 2.3.3.4.2; Figure 2.3.3-49). On average over all waste packages, the amount of seeping water is 1.2, 4.6, and 14.4 kg/yr per waste package for the present-day, monsoon, and glacial-transition climate states, respectively (Section 2.3.3.4.2; Figure 2.3.3-47). This translates to mean seepage percentages of 1.1%, 2.2%, and 4.7% (Section 2.3.3.4.2; Figure 2.3.3-48). In other words, during the present-day climate, on average about 99% of the percolation flux would be diverted around intact drifts in the Tptpll unit (Section 2.3.3.4.2). For the wetter climate stages of the monsoon and the glacial-transition period, the mean percentage of diverted flux would be smaller, but still at about 98% and 95%, respectively (Section 2.3.3.4.2).

The higher infiltration scenarios would result in more seepage, as described in Section 2.3.3.4.2 and shown in Figures 2.3.3-47 through 2.3.3-49. For the 30th percentile infiltration scenario, the seepage fraction varies from 16.7% for the present-day climate, to 22.8% during the monsoon period, to 29.5% during the glacial-transition climate. The respective mean seepage percentages are 3.0%, 4.9%, and 8.0%. Most seepage is seen for the 90th percentile infiltration scenario, with the seepage fraction as high as 52.6% during the monsoon climate. The mean seepage percentage during this climate state is 19.5%. Thus, even for the least likely of the four unsaturated zone flow

S. HRG. 107–483

YUCCA MOUNTAIN REPOSITORY DEVELOPMENT

HEARINGS

BEFORE THE

COMMITTEE ON ENERGY AND NATURAL RESOURCES UNITED STATES SENATE

ONE HUNDRED SEVENTH CONGRESS

FIRST SESSION

ON

S.J. RES. 34

APPROVING THE SITE AT YUCCA MOUNTAIN, NEVADA, FOR THE DEVELOPMENT OF A REPOSITORY FOR THE DISPOSAL OF HIGH-LEVEL RADIOACTIVE WASTE AND SPENT NUCLEAR FUEL, PURSUANT TO THE NUCLEAR WASTE POLICY ACT OF 1982.

MAY 16, 2002

MAY 22, 2002

MAY 23, 2002

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Committee on Energy and Natural Resources

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the vote facing the Senate is as follows: A "yes" vote is simply a decision to allow the expert and independent Nuclear Regulatory Commission to have the opportunity to rule on the safety on the Department's license application. If we fail to pass the rigorous and open review by the NRC, then no repository will be built.

A "no" vote will indicate that the Senate either rejects more than two decades of national policy on creating deep geologic repository, or that this site policy is so hopelessly flawed that the NRC should be prohibited from ruling on its safety.

A "no" vote is not a vote to delay or review or modify the proposal. Rather, a "no" vote terminates this entire process in its tracks, demobilizes the Yucca Mountain project and leaves DOE without congressional authorization to pursue any other path forward.

Secondly, transportation: A "yes" vote, in DOE's interpretation, allows the DOE under NRC and other regulations to expand on its already substantial and successful shipping campaign to develop and implement a sophisticated shipping system to transport this material.

A "no" vote does not stop either the substantial shipping taking place today or whatever makeshift and ad hoc shipping system that may arise from the actions and decisions of individual States and utilities to respond to the problem of managing would-be orphaned waste located at 131 sites in 39 States.

Thirdly, on capacity: While Congress has chosen to initially limit the capacity at Yucca Mountain to 70,000 metric tons, there is adequate potential capacity at the site for all of the high-level waste likely to be generated by all—and I repeat, "all"—of the current waste sources, even assuming reasonable life extensions for the current fleet of nuclear powerplants.

Thank you.

The CHAIRMAN. Well, thank you all for your testimony.

Let me ask a few questions, and then defer to my colleagues here.

Dr. Cohon, as I understand your position, the position the Technical Review Board, you have—you believe or the Board believes that the Department of Energy has yet to make a convincing case that nuclear waste can safely be buried at Yucca Mountain. But you have not found any reason that would justify Congress terminating the project at this point.

You believe that DOE may yet find a convincing case or yet may make a convincing case to the Nuclear Regulatory Commission. Is that a fair summary of where you come out on this, or not?

Dr. COHON. It is not unfair, but I cannot give you a clear yes. I would like to qualify it a bit, if you do not mind, which I am sure you expected.

The CHAIRMAN. Yes.

Dr. COHON. We do not use the word "convincing." We talk about both the strength of the case and that is what led to the phrase "weak to moderate."

And we also talk about confidence. We think that is actually a very key concept, both in a technical sense for the Board and for policy makers. On that score, we say our confidence is low, or low to moderate—I do not want to misquote myself from our letter—

U.S.NRC
UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

PLAN FOR INTEGRATING SPENT NUCLEAR FUEL REGULATORY ACTIVITIES

Revision 00

June 21, 2010

Enclosure 1

APPENDIX C: EXTENDED STORAGE AND TRANSPORTATION

Background

Currently, more than 50 independent spent fuel storage installations across the United States store more than 45,000 spent nuclear fuel assemblies and greater-than-Class-C waste in more than 1,200 dry storage casks. These installations operate under both site-specific licenses and the general license granted to all reactor licensees. Many reactor facilities have reached their spent fuel pool capacity limits and will continue to rely on dry cask storage as an interim spent fuel management solution to maintain operational capability. It now appears that spent fuel storage at utility sites could be necessary for a period of time beyond an interim dry cask storage period of 60 years. Therefore, it is important to bolster or confirm the technical and regulatory basis of the U.S. Nuclear Regulatory Commission's (NRC's) regulatory framework to support extended periods of storage and transportation in the areas of safety, security, and environmental protection.

Objective

Enhance the technical and regulatory basis for extended storage and transportation (EST) in the areas of safety, security, and environmental protection.

Activities and Schedule

In February 2010, the Commission issued staff requirements memorandum (SRM) SRM-COMDEK-09-0001, which directed NRC staff to undertake a thorough review of the regulatory programs for spent fuel storage and transportation to evaluate their adequacy for ensuring safe and secure storage and transportation of spent nuclear fuel for extended periods beyond the 120 years considered up to this point. The SRM also directed NRC staff to undertake research to bolster the technical bases of the NRC's regulatory framework for extended storage periods; identify risk-informed, performance-based enhancements that will increase the predictability of regulatory processes; investigate ways to incentivize the processes to encourage adoption of state-of-the-art technology for storage and transportation; consider opportunities for comparing and, where appropriate, harmonizing international standards for transportation and storage; and conduct the review in a transparent and collaborative manner with NRC stakeholders. The SRM requires NRC staff to develop a project plan for Commission approval, including objectives, plans, potential policy issues, projected schedules, performance measures, and projected resource requirements.

NRC staff has developed a project plan, for Commission approval, that will include a number of activities shared with other NRC offices. The plan was provided to the Commission on June 15, 2010 for consideration (COMSECY-10-0007, "Project Plan for the Regulatory Program Review to Support the Extended Storage and Transportation of Spent Nuclear Fuel," [ML101390216]). This section will be updated to reflect key components of the project plan (related to integration with reprocessing and disposal activities), upon approval and further Commission direction. The project plan includes two main goals to enhance the regulatory programs for both interim storage and extended storage and transportation: (1) identification and implementation of regulatory

97TH CONGRESS
1st Session

HOUSE OF REPRESENTATIVES

REPT. 97–
411 Part 1

HIGH LEVEL RADIOACTIVE WASTE MANAGEMENT AND POLICY ACT

DECEMBER 15, 1981.—Ordered to be printed

Mr. FUQUA, from the Committee on Science and Technology, submitted the following

REPORT

together with

ADDITIONAL AND DISSENTING VIEWS

[To accompany H.R. 5016]

[Including cost estimate of the Congressional Budget Office]

The Committee on Science and Technology, to whom was jointly referred the bill (H.R. 5016) to establish a Federal policy with respect to the disposal of high-level radioactive waste from civilian nuclear activities, to provide for the construction, operation, and maintenance of waste disposal facilities, to provide for a program of nuclear waste and spent fuel research and development, and for other purposes, having considered the same, report favorably thereon (with amendments) and recommend that those provisions most generally referred to as nonmilitary research and development provisions in the bill (as amended) do pass.

DDITIONAL VIEWS OF HON. MARILYN L. BOUQUARD, HON. ROBERT A. ROE, HON. RONNIE G. FLIPPO, HON. ROBERT A. YOUNG, HON, RICHARD C. WHITE, HON. HAROLD L. VOLKMER, HON. RALPH M. HALL, HON. LARRY WINN, JR., HON. BARRY M. GOLDWATER, JR., HON. MANUEL LUJAN, JR., HON. ROBERT S. WALKER, HON. EDWIN B. FORSYTHE, HON. WILLIAM CARNEY, HON. JUDD GREGG, HON. RAYMOND J. McGRATH, HON. JOE SKEEN, HON. JIM DUNN, AND HON. BILL LOWERY REGARDING A COMPREHENSIVE NUCLEAR WASTE PROGRAM

The bill, H.R. 5016, is a comprehensive nuclear waste management bill and therefore contains a combination of provisions that are either solely under the jurisdiction of the Science and Technology Committee, jointly under the jurisdiction of the Committee, or nominally under the jurisdiction of other Committees. This comprehensive approach was adopted because there was an overwhelming agreement of Committee Members that such legislation should be considered and that a bill which authorized solely R&D activities was only a partial answer. Thus, the intention of the full Committee was to carefully integrate the research and development program which the Subcommittee on Energy Research and Production had proposed by incorporating the Test and Evaluation (T&E) Facility concept into the overall waste management program. Integrated in this way, the Test and Evaluation Facility becomes oriented toward enhancing public confidence in the geologic and man-made systems for nuclear waste isolation while also increasing public confidence in licensing through early resolution of technical issues. This strong role of the T&E Facility, which will be used to scope the parameters and verify the capability of the first repository, is a major reason why the schedule for achieving repository construction and operation in the middle 1990s can be achieved. We feel that it is imperative that the repository operation should be scheduled for no later than 1997, thus allowing 15 years to reach the ultimate program goal.

However, from comments made by staff of both the DOE and the NRC, such a schedule is not achievable without a more practical approach to the regulatory approval process for the repository. We feel that the hybrid and interim licensing provisions of H.R. 5016 are, therefore, necessary to preclude the unnecessary delay which would result from application of existing licensing procedures. The hybrid licensing procedures of the bill are similar to the amendments to the Administrative Procedures Act, H.R. 764, which was introduced, with 27 cosponsors, including 10 from the Judiciary Committee, and which is now under active consideration in that Committee. The new licensing procedure would allow for major scoping and focusing of the issues involved so as to avoid repetitious hearing of the issues. The salient aspects of this procedure

are, (1) discovery, followed by (2) an oral-evidentiary hearing to scope the issues, followed by (3) a formal, adjudicatory hearing, and finally by (4) a Commission decision. The significant difference from present NRC procedure is the inclusion of the oral-evidentiary hearing step to scope the issues, rather than using the summary disposition procedure (an inherently judicial, rather than administrative procedure).

We also endorse the concept of interim licensing as used here. The interim licensing provisions would allow NRC to maintain this repository schedule, where all requirements of law are met. Furthermore, interim licensing has been repeatedly supported by the Commission, and by the House. In a letter to Chairman Bevill of the Appropriations Committee, the Commission requested such interim licensing for nuclear power plants, which was approved by the House. Further, in testimony before the Senate Committee on Energy and Natural Resources, Chairman Palladino expressed the strong support by a majority of the Commission for interim licensing authority for interim storage of spent fuel, on-site. We feel that this authority is also highly desirable at the construction authorization phase for the permanent repository, and at the licensing phase.

Furthermore, the differences between a repository and a nuclear power plant justify a more practical approach to licensing. First of all, a civilian waste repository is a passive system, not dynamic, such as a nuclear power plant. Secondly, the repository will be built with retrievability of waste assured through the first three to five decades of its existence. This later requirement of complete reversibility should provide even more justification for this more practical licensing process.

We hasten to point out that we do not presume to tell the other Committees how best to draft licensing reform provisions, but simply point out that the licensing reforms of the type that were included in the bill H.R. 5016 are necessary because we cannot afford to delay this program for frivolous or repetitious consideration of issues. Both the fact that the T&E facility provides an unprecedented basis for producing technical confidence as a basis for licensing, and the fact that the repository presents a greatly reduced risk as compared to a power reactor, mean that there is a greater margin of safety involved in modifying the licensing procedures of the NRC.

We think it is also important to recognize two other principal features of this bill. One is the enhanced state participation through consultation and cooperation beginning in the earliest phase of the program. The second is the authorization of a utility fee derived from contracts negotiated by the DOE so that all program cost will be covered except the generic R&D activities. With regard to the state role, the Committee envisions a WIPP-type agreement between the state and the DOE to provide a vehicle for resolution of institutional issues. This should go far in improving the public's perception of the Federal program as both constructive and responsive. Third, the fact that the users of nuclear energy will pay a relatively modest fee, estimated to be about 1 mil per kilowatt hour, to pay for the Test and Evaluation Facility and the

COMSECY-10-0007

June 15, 2010

MEMORANDUM TO: Chairman Jaczko
Commissioner Svinicki
Commissioner Apostolakis
Commissioner Magwood
Commissioner Ostendorff

FROM: R. W. Borchardt ***/RA by Michael F. Weber for/***
Executive Director for Operations

SUBJECT: PROJECT PLAN FOR THE REGULATORY PROGRAM REVIEW TO SUPPORT EXTENDED STORAGE AND TRANSPORTATION OF SPENT NUCLEAR FUEL

The purpose of this memorandum is to request Commission approval of the Project Plan for the Extended Storage and Transportation Regulatory Program Review in Enclosure 1. The staff developed this plan in response to staff requirements memorandum (SRM) COMDEK-09-0001, "Revisiting the Paradigm for Spent Fuel Storage and Transportation Regulatory Programs." In this SRM, the Commission directed the staff to develop a project plan to conduct a thorough review of the regulatory programs for spent nuclear fuel (SNF) storage and transportation, and to evaluate their adequacy for ensuring safe and secure storage of SNF for extended periods beyond 120 years. The Commission also directed the staff to undertake research to bolster the technical bases of the regulatory framework in support of extended periods, and to leverage ongoing improvement initiatives.

The staff has developed a plan for Integrating Spent Nuclear Fuel Regulatory Activities (ISNFRA) to address future regulatory challenges related to the management of SNF and high-level waste. The three core areas of the ISNFRA plan are storage and transportation, reprocessing, and disposal. As part of the ISNFRA plan, the staff will coordinate the extended storage and transportation regulatory program review with the reprocessing and disposal regulatory program activities, as appropriate, to address changes to national policy and industry programs related to SNF management.

The staff believes that the current regulatory framework can be enhanced to ensure the safety and security of extended storage and transportation with additional research, guidance, review processes, and potential rule changes. The project plan includes two main goals to enhance the regulatory programs for both interim storage and extended storage and transportation:

CONTACT: Michael Waters, NMSS/SFST
(301) 492-3297

Project Plan for the Extended Storage and Transportation Regulatory Program Review

- Revision 0 -

- June 2010 -

Enclosure 1

of cask service. The 60-year safety basis with aging management is supported by the results of the U.S. Department of Energy (DOE) Cask Demonstration Program that examined a cask loaded with lower burnup fuel (approximately 30 GWd/MTU). Following 15 years of storage, the cask internals and fuel did not show any significant degradation. The data from this study can be extrapolated to maintain a licensing safety finding that low-burnup SNF can be safely stored in a dry storage mode for at least 60 years with an appropriate aging management plan. The evidence also indicates that dry storage of SNF can likely be maintained up to 100 years without the need for significant aging management mitigation actions; however, licensees have not developed a safety basis and the NRC has not reviewed such a request for extended periods of storage.

While a spent fuel cask system maintains an independent confinement system, the spent fuel cladding is credited as the primary fission product barrier during interim storage and transportation. However, industry has limited operational experience with the transport of HBU fuel, and there is little operational or experimental data regarding HBU fuel behavior during storage and transportation. This gap in data should be resolved because industry intends to seal HBU fuel in dry storage casks under 10 CFR Part 72 and later transport it under 10 CFR Part 71, without reopening the cask. This may also be an important consideration for future ISFSI sites at decommissioned reactors that may request to load HBU fuel in storage, and later decommission fuel-handling facilities (e.g., spent fuel pools).

The scope of data varies with potential long-term degradation phenomena of cask SSCs, such as concrete, steel, resins, seal materials, and unique basket materials. These materials and structures will be credited with providing adequate structural integrity, confinement of SNF, criticality safety, shielding, and heat removal for SNF during EST. These SSCs will need to continue to perform their safety functions for normal conditions, accidents, and natural phenomena over EST timeframes.

Gap Assessments and Short-Term Research for Dry Cask EST

During the first phase of the safety review, the staff will perform gap assessments to identify technical issues that require research and analyses for EST. This will involve revisiting the conclusions of previous evaluations underlying the current technical and regulatory basis to identify information and technical research needed to enhance the framework for effective regulation of EST scenarios. The staff expects that the outcome of the gap assessments will include a prioritized list of information needs and a recommendation of the most effective means (e.g., confirmatory testing) to obtain the information.

The gap assessments should identify phenomena warranting further investigation through analyses and short-term research. One phenomena of consideration will likely be the aging effects on cladding integrity in various combinations of extended wet storage and dry storage modes. Through frequent communication and coordination, the staff will also maintain awareness of industry, Department of Energy (DOE), and Electric Power Research Institute (EPRI) plans to conduct research to justify EST safety. The staff will independently observe and review research data that is provided by these groups.

As part of this coordination, the staff is participating in an ESCP led by EPRI. The program group includes EPRI, DOE, the Nuclear Waste Technical Review Board, cask vendors, and utilities. The group also intends to establish a long-term cask demonstration program to monitor