REPORT AND RECOMMENDATIONS OF THE NEVADA COMMISSION ON NUCLEAR PROJECTS

Presented to
the Governor and Legislature
of the State of Nevada

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INTRODUCTION

In the preface to the first report of the Nevada Commission on Nuclear Projects in 1986, former Governor and Chairman Grant Sawyer observed that, "[w]hen it established the Commission on Nuclear Projects, the 1985 Nevada Legislature did much more than simply create another State oversight body. It sent a clear message to the federal government that Nevada intends to exercise its full rights and responsibilities to assure that the health and safety of present and future Nevadans and our State's unique environment and economy are adequately protected in the face of continuing federal attempts to locate a high-level nuclear waste repository in Nevada."[1]

Fourteen years later, efforts to protect Nevada and its citizens from this federal program are reaching a critical stage. Today, Nevada and the nation must contend with what has become a single-minded, coercive federal effort to turn Yucca Mountain into a radioactive waste disposal site at any cost and by any means, while the mountain's flaws and the program's uncertainties continue to mount. Over the years, science has given way to raw politics as the U.S. Department of Energy (DOE) and supporters of DOE's repository project in Congress have sought to obfuscate and compensate for an ever-multiplying set of flaws and problems with the site and with the notion of transporting unprecedented amounts of deadly spent nuclear fuel and high-level nuclear waste across the country.

In that first Commission report, Governor Sawyer set forth what was then and what must be today the final criteria for decision-making with respect to a repository, whether in Nevada or anywhere else in the country:

> "[A] nuclear waste repository should not be built until it can be shown, beyond the shadow of a doubt, that the facility can, in fact, do what its advocates claim - isolate radioactive materials from the biosphere for more than 10,000 years - and that construction of such a repository will be benign in its effects upon the people, the environment and the economy of the state or region within which it would be located. We owe nothing less to our state or to our nation."[2]

This seventh report of the Commission on Nuclear Projects demonstrates that Yucca Mountain fails Grant Sawyer's test on all counts. What began in 1983 as a noble piece of federal legislation that sought to place science ahead of politics, and fairness, equity, and openness above congressional parochialism has degenerated into a technical and ethical quagmire, where facts are

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[1] "Report of the State of Nevada Commission on Nuclear Projects" (November 1986), p. 6.

[2] Ibid, p. 7.

routinely twisted to serve predetermined ends and where "might makes right" has replaced "consultation, concurrence, and cooperation" as the federal mantra for the program.

As we approach the New Year - the first official year of the new millennium - Nevada faces a series of major challenges with respect to the high-level nuclear waste program and the proposed Yucca Mountain repository site. If DOE's current schedule holds, a decision whether the Secretary of Energy should formally recommend that the President proceed with development of a repository at Yucca Mountain will be made in July, 2001. A decision in the affirmative, which is overwhelmingly likely given DOE's historical blindness to the site's flaws, will initiate a series of necessary actions on the part of the State of Nevada that will have lasting - some may say everlasting - ramifications.

The Site Recommendation Decision and Nevada's Response

Under the provisions of the federal Nuclear Waste Policy Act of 1983, as amended in 1987 (NWPA), the Secretary of Energy is required, upon completion of site characterization work at Yucca Mountain, to recommend to the President whether or not the site should be developed as a high-level radioactive waste repository. If the Secretary determines that Yucca Mountain is unsuitable for such a facility, the Secretary is directed to cease all work at the site, reclaim and remediate disturbed areas, and report back to Congress for instructions as to how to proceed.

If, however, the Secretary recommends that a repository be built at Yucca Mountain, the President is required to formally make that recommendation to Congress. The Secretary's recommendation is to be accompanied by a final environmental impact statement (EIS) for the Yucca Mountain program, prepared pursuant to the requirements of the NWPA and the National Environmental Policy Act (NEPA), together with the State of Nevada's report on impacts of the project to the State and affected communities. Once the recommendation is sent to Congress, the State of Nevada has sixty days of continuous session to submit a "notice of disapproval," accompanied by a "statement of reasons" why the State believes Yucca Mountain is unsuitable. To override the State's notice of disapproval requires a majority vote by both houses of Congress.

The State of Nevada must be prepared to submit a notice of disapproval, should the President recommend Yucca Mountain to Congress. This will require a strong and united front on the part of the Governor and Nevada Legislature, as well as close cooperation with the State's bipartisan congressional delegation. All parties in Nevada must be extraordinarily careful to assure that no actions are taken to weaken the State's position or lessen the State's opposition with respect to the Yucca Mountain issue.

The Yucca Mountain Environmental Impact Statement

In August 1999, DOE released for public comment a draft EIS for the Yucca Mountain repository project. After conducting an extensive review that resulted in the submission of over 500 pages of comments, the State of Nevada concluded that the draft EIS was seriously deficient, both legally and substantively.[3]

DOE's Yucca Mountain EIS is extremely important for several reasons. First, as noted above, the Secretary of Energy is required by law to include a final EIS with any site recommendation to the President. Without a final, statutorily adequate EIS, the site recommendation cannot go forward.

Second, the U.S. Nuclear Regulatory Commission (NRC) is required by the NWPA to adopt, "to the extent practicable," the DOE Yucca Mountain EIS as the NEPA compliance document governing any decision NRC makes with respect to granting a license to DOE to construct and operate a repository. If DOE's final EIS is shown to be legally deficient, that fact will seriously impact NRC's licensing process.

According to its current schedule, DOE plans to issue a final Yucca Mountain EIS sometime in the June - July 2001 time frame. The State of Nevada must be in a position, at that time, to mount a major legal challenge of that EIS. The Commission believes, based on the State's review of DOE's draft EIS and subsequent legal analysis, that Nevada has a very good chance of prevailing in such a challenge, especially if DOE moves ahead, as expected, with its current inadequate approach to NEPA compliance. To mount a successful legal challenge to the final EIS, however, will require adequate resources and specialized assistance in NEPA litigation.

U.S. Nuclear Regulatory Commission Licensing Proceedings

If DOE is successful in making a site recommendation and Congress overrides Nevada's notice of disapproval, DOE is required by law to apply to the NRC for a license to construct and, eventually, operate a repository at Yucca Mountain. The NRC licensing process is a formal, adjudicatory proceeding wherein the State of Nevada will be able to present its technical case against the project. However, like most governmental regulatory proceedings, this one is not as straightforward as it may appear.

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[3] "State of Nevada Comments on the U.S. Department of Energy's Draft Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada," Volumes I and II, by the Nevada Agency for Nuclear Projects (February 2000).

First, it is NRC that sets the ground rules for any licensing action. There is a long history - both temporal and legal - of NRC nuclear power plant licensing activities where procedures, rulings, court actions, and other intervening factors have established procedural and legal precedent that NRC will rely on in implementing the licensing process for Yucca Mountain.

Licensing is a legal jungle where even savvy and experienced participants have not always fared well. This is especially true with respect to interveners who have sought to have licence applications denied. There has developed around the NRC licensing process a body of law and procedure that requires highly skilled and specialized expertise and experience if a State like Nevada, with virtually no experience with such proceedings, hopes to not only prevail, but also make precedent in successfully opposing the award of a license for a Yucca Mountain repository.

A great deal of the groundwork for the State's intervention in the NRC licensing process has already been laid with the extensive body of technical work and over 16 years of Yucca Mountain oversight experience. Probably no other intervener in the history of NRC licensing proceedings has been as well prepared as the State of Nevada will be if it is required to challenge DOE's application. Nevertheless, it will take more than a strong technical case to prevail. It will require the best legal assistance from attorneys who specialize in NRC licensing law and procedures.

The National Arena - Where the Political Battle Must be Won

The many serious technical deficiencies of the Yucca Mountain site and DOE's flawed approach to geologic disposal notwithstanding, the most potentially explosive aspect of the federal program is the reality that tens of thousands of shipments of deadly spent nuclear fuel and high-level radioactive waste will travel the nation's highways and railroads - through 43 states and thousands of communities, day after day for upwards of 40 years. A very severe transportation accident or successful terrorist attack in an urban area could release radioactive materials to the environment, causing hundreds of latent cancer fatalities, and costing hundreds of millions, or even billions, of dollars for cleanup and compensation. DOE and its allies in Congress have long recognized that nuclear waste transportation is the Achilles' heel of the Yucca Mountain program. Once states and communities along potential shipping routes become aware of the unprecedented volumes of waste to be shipped, the duration of the required shipping campaign, and the potential adverse consequences of accidents and terrorist incidents, opposition to the entire effort is likely to increase throughout the country.

DOE has gone to great lengths to keep the lid on this aspect of the Yucca Mountain project nationally. DOE has ceased any work on the identification of national routes for Yucca Mountain shipments. Funding for most transportation planning activities has been suspended, including termination of grants to regional organizations such as the Western Interstate Energy

Board. DOE's draft Yucca Mountain EIS intentionally concealed the specific routes used in DOE's national transportation impact assessment, and DOE went so far as to avoid any mention of shipping routes - or even the notion of nuclear waste shipments - in notices for public hearings on the draft Yucca Mountain EIS in communities outside Nevada where such hearings were held.

During the next two years, as Nevada challenges or confronts DOE, Congress, and, perhaps, the NRC concerning various aspects of the Yucca Mountain program, it will be equally important to undertake efforts to assure that the issue of radioactive waste shipments, including the routes such shipments will use and the cities and communities that will be impacted, is given wide exposure nationally. This will require an effort on the part of the State to identify potentially affected states and communities and target information to reach people, governments, and institutions in those places.

The Case Against Yucca Mountain

The Commission believes that the Yucca Mountain program poses significant and unacceptable risks not only for the State of Nevada, but also for the nation as a whole. The case against Yucca Mountain is set forth in summary below. It is a strong and compelling case that, when combined with the extraordinary impacts of the project on the country, clearly calls for a change in national nuclear waste policy and direction. Neither Nevada nor the nation can afford the risks or the costs of the current program.

As the Commission observed in its 1992 Report to the Governor and Legislature, "... the importance of a strong and consistent State policy relative to the [Yucca Mountain] issue ... cannot be over-emphasized in terms of helping to bring about [a] rethinking and reassessment of national policy. Consistent opposition to the biased, unfair, and heavy-handed Yucca Mountain program has prevented a repository from being sited in an unsuitable and potentially dangerous location. Tough, competent, and farsighted State oversight ... [has] helped to identify fundamental problems with the current program and point out ways these flaws can be avoided in future [federal] waste management efforts."[4]

As Nevada approaches critical junctures in 2001 with respect to Yucca Mountain and DOE's civilian radioactive waste management program, it is even more imperative today that we stay the course.

[4] "Report of the State of Nevada Commission on Nuclear Projects" (September 1992), p. x.

SITE SUITABILITY - THE TECHNICAL ARGUMENT

Background

The Nuclear Waste Policy Act of 1982 established a process for the detailed study, or characterization, of sites to determine their suitability for development as a repository for the nation's spent fuel from commercial nuclear power reactors and highly radioactive wastes from nuclear weapons production. The 1987 amendments to the Nuclear Waste Policy Act, based much more on politics than any science, voided the repository site screening process of the 1982 Act and declared that the Yucca Mountain site would be the only site characterized for the nation's high-level nuclear waste repository. Characterization of other candidate sites in Deaf Smith County, Texas and on the Department of Energy's (DOE) Hanford Reservation in Washington was terminated.

The basis for the Nuclear Waste Policy Act is a 1980 DOE Environmental Impact Statement (EIS) on the management of spent nuclear fuel and high-level radioactive waste. This EIS selected mined geologic repositories as the preferred alternative for the permanent disposal of these long-lived, dangerous wastes. The EIS determined that the long term isolation of the waste from the environment was to be accomplished primarily by the geologic and hydrologic characteristics of any site selected. The use of engineered barriers, such as metal waste containers, was only to enhance assurance that the waste would be fully contained during the early period after disposal while the shorter lived waste components underwent radioactive decay.

The Act required DOE to develop general guidelines for the Secretary of Energy's recommendation of sites to the President for development of geologic repositories. DOE published its site recommendation guidelines as a final rule in December, 1984 (10 CFR 960). These guidelines specified factors, mostly based on geological and hydrological characteristics, that would qualify or disqualify sites from consideration for repository development, as the Act required. The Act also required DOE to produce a Site Characterization Plan, designed to determine the suitability of the Yucca Mountain site for repository development based on its conformance with the site recommendation guidelines. The Site Characterization Plan was issued in 1988 and was the subject of public hearings in Nevada, as required by the Act. DOE actually initiated its studies at Yucca Mountain, adjacent to the southwest corner of the Nevada Test Site, in 1978. Those studies are still under way today.

Yucca Mountain is located in a geologically active area in southern Nevada. The site is known to contain numerous geologic and hydrologic characteristics that would, on initial examination, be features that would ordinarily be avoided in looking for viable sites for long term geologic disposal. However, because the site was selected by Congress in a political

process instead of a scientific one, these geologic/hydrologic features were either ignored or masked by the Department of Energy in Congressional deliberations. For example, in 1986 in testimony before the Senate Energy Committee, the Director of the Yucca Mountain project stated that the Yucca Mountain site was so good that it could meet the existing Environmental Protection Agency (EPA) standard for nuclear waste repositories by at least 5 orders of magnitude, and that he could not conceive of anything that would cause him to change his mind about the quality of the site. Yet, less than 5 years later, DOE began petitioning the EPA to change its standard because it had been proven that the site could not meet the EPA standard and would fail. DOE, later in 1992, got the Congress to vacate the standard and to order EPA to write a new, Yucca Mountain specific standard and to exclude the areas that caused the Yucca Mountain site to fail under the previous standard.

In 1999, the EPA proposed new site specific environmental and safety standards for the potential Yucca Mountain repository, pursuant to the Energy Policy Act of 1992. The Nuclear Regulatory Commission (NRC) also proposed a new site specific rule, just prior to the EPA proposal, for licensing a Yucca Mountain repository. And DOE, in 1999, proposed new site specific guidelines for the Yucca Mountain site that did not include specific factors to qualify or disqualify the site from consideration. Instead, the proposed guidelines now rely solely on total system performance assessment, as does the proposed NRC rule, to predict whether a Yucca Mountain repository will meet the environmental and safety standards proposed by the EPA.

The Yucca Mountain Site

The Yucca Mountain site is known to have numerous geologic and hydrologic characteristics that should have caused it to be avoided when DOE screened for a site to geologically isolate long-lived radioactive wastes. For example:

- There are 33 known geologic faults at or in the near vicinity of the Yucca Mountain site. In the past 20 years, there have been over 600 recorded seismic events of Magnitude 2.5 or greater within 50 miles of the site, the largest of which was a Magnitude 5.6 earthquake in 1992, known as the Little Skull Mountain earthquake. It was centered about 8 miles from the site, causing damage to DOE's Yucca Mountain project office at the Nevada Test Site (NTS). The maximum probable earthquake for the site is estimated at Magnitude 6.5 to 7.0. Of course, DOE believes it can design the underground repository and the operating surface facility to withstand this maximum probable seismic event.

- Relatively recent volcanism is evident in the area of the site. Volcanic cones, about 1 million years old, are adjacent to the site in Crater Flat, and a young cinder cone, active within the last few tens of thousands of years, is located at the south end of Yucca Mountain. DOE's current performance assessment indicates that the "only credible event" that could affect waste isolation in the next ten thousand years is a volcanic event

that intersects the repository area. Although considered as a low probability of occurrence, the consequences would be severe.

- The hydrologic picture at Yucca Mountain is complex and not well understood. The hydrology of Yucca Mountain consists of a thick, dry or unsaturated zone and a saturated zone, i.e., the water table below. The site was initially selected because, in part, the actual repository location would be in the dry, unsaturated zone, well above the water table. This was thought to be an advantage over other sites as they were all located beneath the water table. Since water is the primary vehicle by which radionuclides would escape from a repository, the Yucca Mountain site appeared to be preferable. However, subsequent investigations at the site have demonstrated that this is not the case. DOE has determined that water moves rapidly through the dry, unsaturated zone by the discovery of an isotope of chlorine at the repository horizon that is a residue from the above ground weapons testing program carried out in the Pacific Ocean in the 1950s. Chlorine 36 has traveled from the ground surface at Yucca Mountain to the repository horizon, some 800 feet, in less than 50 years. DOE had previously estimated that it would take many thousands of years for water to reach the repository horizon from the ground surface.

- In the saturated zone beneath the repository horizon, DOE originally speculated that water also moved very slowly, making the case that when radionuclides escaped from the repository, it would take centuries to reach the local aquifer, at which time the material would be less radioactive. However, the opposite has become reality. Water is now recognized to move very rapidly in the saturated zone and is capable of reaching the accessible environment in less than 500 years. State researchers maintain that it would reach the accessible environment in approximately 200 years. DOE believes that it would do so in about 500 years. The original siting guidelines call for the groundwater travel time to be more than 1000 years. So the hydrologic advantage that was once thought to be attributable to Yucca Mountain turns out to be a liability.

- Because the geologic and hydrologic characteristics of the site are so poor, the DOE performance assessment model includes radionuclide dilution in the groundwater as a means of reducing potential doses to individuals in Amargosa Valley. In other words, DOE is planning to intentionally contaminate an aquifer currently used for human consumption and irrigation in order to try to meet the EPA standard. However, the proposed EPA environmental and safety standard sets a limit on the maximum radiation dose that residents in the farming community are allowed to receive from groundwater. If this standard becomes final, then DOE, hopefully, would not be able to use the aquifer to dilute the radiation dose enough to meet the standard. This same groundwater standard is in effect for the WIPP transuranic waste storage site in New Mexico and is the standard for drinking water throughout the country. Only at Yucca Mountain are the DOE and Congress attempting to circumvent this standard.

- Yucca Mountain lies in a known mining district. The possibility of future exploration for valuable natural resources that could disrupt the repository and create pathways for radionuclide escape cannot be ignored. While investigations have not resulted in the discovery of economic mineral or metal deposits at Yucca Mountain, the entire area will remain attractive for exploration in the future. The proposed EPA and NRC regulations require that an analysis of a hypothetical human intrusion be done to demonstrate that if, under the conditions specified in the rule, exploratory drilling intersects a waste container and the drilling continues to the water table, the radiation dose to individuals in Amargosa Valley will not exceed the EPA standard.

The Proposed Repository

DOE no longer claims that the proposed Yucca Mountain repository will fully isolate radioactive waste from the environment. Instead, it attempts to show through performance assessment predictive models how the natural and engineered repository systems will behave and that doses to individuals 12 miles from the repository will not exceed the levels established in the EPA environmental and safety standards.

Based on DOE's own performance assessment models, the majority of the isolation capabilities of the site are now attributed to the engineered barrier system (the waste package and the drip shield), not on the geologic and hydrologic characteristics of the site. The current design of the waste package uses a high nickel alloy, known as C-22 or Alloy 22, and a titanium drip shield that will be placed over the waste packages at the time of closure of the repository. DOE initially claimed that C-22 was so corrosion resistant that waste packages would last 750,000 years. Now those claims have dropped to "at least 10,000 years," conveniently past the regulatory period. However, State researchers have preliminary evidence that C-22 will not perform as claimed by DOE. In fact, this preliminary research indicates that the waste packages could corrode in as little as 500 years. DOE is now putting more reliance on the drip shield, but initial research by the State and the NRC indicates that it too may not last as long as DOE claims. Also, since the drip shield will not be emplaced until just before closure of the repository, there is a question as to whether Congress will appropriate the funds for the drip shields (now estimated at about $4 billion) since the Nuclear Waste Fund will have long been depleted.

DOE has identified the principle factors on which it relies in its performance assessment to control the radionuclide doses to individuals in Amargosa Valley. The factors affecting performance are the following:

* Limited seepage of water into the emplacement drifts
* Solubility limits of dissolved radionuclides in Yucca Mountain water
* Dilution of radionuclide concentrations in the geologic setting
* Retardation of radionuclide migration above and at the water table

* Performance of the drip shield
* Performance of the waste package

With each of these factors comes a broad range of uncertainty in the extent to which they affect performance, i.e., the radionuclide dose to the individual in Amargosa Valley. There is also uncertainty in the models that predict the behavior of each of the principle factors. The magnitude of these uncertainties are compounded when all these factors are combined in the total system performance assessment. This translates, ultimately, to broad uncertainty in projecting the dose to individuals over a 10,000 year period. The uncertainty can range up to about five orders of magnitude. If the dose is toward the higher end of the uncertainty, it could far exceed the EPA standard for allowable dose. DOE also shows that the peak dose, which comes later than the regulatory period, will exceed the EPA standard by a significant amount.

When the relative importance of each of these principle factors is evaluated, it becomes clear that compliance with the proposed EPA standard, over a 10,000 year period, depends entirely on the projected long life of the containers and drip shields. DOE's performance assessment indicates no releases of radionuclides from the repository in the first 10,000 years. If there were no containers or drip shields, or there were a few that failed early due to a fabrication or installation defect, doses exceeding the EPA standard could be realized in much less than 10,000 years. This could also be the case if the drip shields and containers are not as corrosion resistant as DOE has predicted from extrapolation of a short term, limited set of laboratory tests of the metals. As stated above, tests by State researchers suggest that this, in fact, may be the case.

Conclusion

For more than ten years, Nevada officials have maintained that the Yucca Mountain site should be disqualified from consideration for development of a repository. They have based this conclusion on DOE's own siting guidelines, which require that a repository site be disqualified if it fails to meet certain very specific conditions. DOE has long maintained that any Yucca Mountain siting decision will be based on sound science. However, when it appears that science dictates that the site be disqualified, DOE's response has been to change the rules.

For example, under the existing original DOE site recommendation guidelines, the groundwater travel time from the repository to the accessible environment is now know to be greater than that allowed in the disqualifying condition for this factor. However, this issue becomes moot if DOE is permitted to adopt new proposed guidelines that rely solely on performance assessment rather than specific criteria against which compliance can be measured. In the case of groundwater travel time, the rate is an important measure of repository safety for Yucca Mountain because the repository system is so heavily reliant on the projected long life of the containers and drip shields. These two engineered barriers do not contribute to waste

isolation. They merely serve to delay, for some greatly uncertain period of time, the release of the waste. The site itself, without the engineered barriers, has only a minimal capability of isolating the waste because of the nature of the fractured rock and the ability of infiltrating water to flow rapidly through the rock and contact the waste.

Using DOE's performance assessment for a Yucca Mountain repository, including the very long expected life of the engineered barriers, the peak dose expected for individuals in Amargosa Valley from the groundwater is 250 times higher than the EPA proposed groundwater protection standard for a Yucca Mountain repository. DOE's use of engineered barriers only serves to delay this projected peak dose to a time long after the 10,000 year regulatory period of the EPA standard. If the expected peak dose from a Yucca Mountain repository vastly exceeds the safety standard established for the repository, Yucca Mountain is not a suitable site for a high-level nuclear waste repository. The use of highly uncertain performance assessment models and establishing an artificial cut-off date after which the safety standard does not apply does not make Yucca Mountain a safe site.

Twice now the State of Nevada had demonstrated that the site could not meet existing federal regulations and should be disqualified. Each time, however, either the regulation was changed or DOE simply refused to acknowledge the validity of the State's analysis. In order to resolve this situation, DOE announced that the siting guidelines would be changed from containing specific disqualifiers in the geology/hydrology area to an exclusive focus on a total systems analysis approach to attempt to demonstrate compliance. In other words, there is a change from a situation where a single negative factor could eliminate the site as the law requires, to one where all of the system components need to be analyzed together and only the systems analysis would be the basis for recommendation for development as a repository. If, through this approach, the site could meet the overall performance goal that the regulations require, then the site should be recommended and not eliminated. After all, in DOE's reasoning, why disqualify a site because it has negative features that could be compensated for through the application of engineering measures, such as a robust waste package.

One can show from the performance assessment models that DOE now believes the actual Yucca Mountain site, despite previous assurances, is so poor that it can be counted upon for less than 5% of the overall system performance with engineering measures, such as high-tech metal disposal containers, needed to make up the remaining 95% of the total performance of the system. Not only is this proposal in violation of the underlying premise of the Nuclear Waste Policy Act that geology must be the primary barrier, but it also undermines the recommendation of the National Academy of Sciences that manmade materials cannot be used in a repository to compensate for faulty geology or hydrology. That is the reason Congress required that the suitability of any site be determined by the natural setting through the application of the required siting guidelines, with engineering measures added to provide redundancy to the system. The DOE proposed strategy to determine Yucca Mountain's suitability by relying on metal disposal

canisters to make up for poor natural conditions as a means of demonstrating compliance with a project regulatory target is illegal and bound to fail. The only way that DOE can now find the Yucca Mountain site suitable is for Congress to exempt the site from virtually all health and safety regulations. There simply is no other way that DOE can demonstrate that the site is safe.

SOCIOECONOMIC IMPACTS OF A YUCCA MOUNTAIN REPOSITORY

Overview

From the beginning, the Yucca Mountain program presented the State of Nevada with significant impacts and risks that are separate from and in addition to those related to the geotechnical failings of the site. An elite team of social science researchers[5] was assembled in 1986 and has closely studied the socioeconomic impacts of the federal program on the State of Nevada over the last 14 years. The findings from this unprecedented research effort demonstrate conclusively that the Yucca Mountain repository and spent fuel and high-level waste transportation associated with it will have major negative effects on the State, local communities, and special populations throughout Nevada. The State's research effort confirms the critical importance of socioeconomic factors and impacts in evaluating the nation's efforts to site a repository. Disturbingly, Nevada's impact assessment efforts also confirm that the federal government is neither prepared nor motivated to address the effects of such a project on either the State or the country as a whole.

Nevada's research program has developed a convincing body of evidence demonstrating that the greatest potential socioeconomic threat from the proposed repository stems from what has been termed the "special effects" of the project. These are impacts directly linked to intense negative perceptions and stigma associated by the public with a high-level radioactive waste repository, combined with the vulnerability of Nevada's unique economy to changes in its public image. Because of the high profile nature of the nuclear waste disposal program and people's extreme aversion to things nuclear, the potential exists for Nevada and its major tourist center in Las Vegas to become associated with these negative perceptions, thereby damaging substantially and perhaps irrevocably the ability to attract tourists, conventions, migrants, and diversified new industry to the State and/or the Las Vegas area. This would be especially disastrous in the event any form of nuclear waste accident were to occur in or near Las Vegas, stigmatizing the area and causing visitors to stay away in significant numbers. The work to date demonstrates that Nevada is uniquely vulnerable to such stigmatizing effects because of its tourism-dependent economy and State's taxation and revenue structure.

The following describes some of the key findings of the State's socioeconomic research. A complete and in-depth treatment of the impact studies and their findings can be found in the

[5] The study team for the State socioeconomic program is comprised of respected academic researchers and consultants from around the country. The team was originally put together as a result of the extensive planning process that preceded the awarding of the contract. While members have been added and deleted over the years, the core group of researchers has remained with the program. Represented on the team are experts in an array of socioeconomic disciplines from the Nevada universities, the Wharton School of the University of Pennsylvania, Clark University, Arizona State University, University of Oregon, University of South Florida, Utah State University, and consultants from the private sector.

three major summary reports on the Nevada socioeconomic studies published in 1989, 1993, and 1995, respectively.[6] In addition, two major books dealing with the policy implications of the findings of Nevada's socioeconomic research have been published by the Agency's study team.[7] The Agency's Technical Review Committee has also issued two reports of its findings with respect to the studies, and a summary of the Nevada research was published in the ***Proceedings*** of the National Academy of Sciences.[8]

Nuclear Waste and Nuclear Stigma

The most serious and possibly catastrophic economic risk for Nevada stemming directly from the Yucca Mountain project is the potential for stigma impacts on the tourist and visitor industry. Such impacts could produce significant losses to an economy dominated by visitor-based revenues. Studies carried out to date indicate that populations important to Nevada's economic well being are highly sensitive to the radioactive risks associated with a repository and spent fuel/HLW transportation, and that the attractiveness of the state as a place to visit, move to, or invest in could be seriously and negatively impacted.

In the event of a radioactive waste accident or incident that caused Las Vegas to become even moderately associated with radioactive imagery, direct impacts to the visitor economy, in-migration, and economic development could result in substantial negative economic costs. Estimates of 5, 10, and 20 percent or larger reductions in key economic sectors are consistent with the empirical evidence gathered.

A one percent drop in visitors in the year 2010[9] would result in a decline of about $155 million in spending in the Las Vegas area; a five percent drop would mean a decline of more than

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[6] Ref. (1) "An Interim Report on the State of Nevada Socioeconomic Studies," (June, 1989); (2)"State of Nevada Socioeconomic Studies of Yucca Mountain 1986 - 1992: An Annotated Guide and Research Summary," (June 1993); and (3) "State of Nevada Socioeconomic Studies Biannual Report: 1993 - 1995," (June, 1995).

[7] Ref. One Hundred Centuries of Solitude, by James Flynn, et al., Westview Press, Boulder, Colorado (1995); and The Dilemma of Siting a High-Level Nuclear Waste Repository, by D. Easterling and H. Kunreuther, Kluwer Academic Publishers (1995).

[8] Ref. "Interim Statement of the Technical Review Committee on the Yucca Mountain Socioeconomic Project," by G. F. White, et al. (January, 1990); "Nuclear Waste's Human Dimension," by K. Erikson, et al., in Forum for Applied Research and Public Policy, Fall, 1994; and "Socioeconomic Studies of High-Level Nuclear Waste Disposal," in Proceedings of the National Academy of Sciences, Vol. 91, pp. 10786 - 10789, November, 1994.

[9] The year 2010 was used in the modeling exercise since it is a point in time when the risks from transportation, packaging, handling, and storage will all be present. It should be noted that these estimates of economic impacts were done initially over 8 years ago, and the impacts using current economic conditions could be substantially greater. The impacts reflected here should be viewed as a "best case" scenario.

$775 million; and a ten percent drop would mean a decline of over $1.5 billion. (For comparison, the recessions of 1980 and 1981 resulted in Las Vegas visitor drops of about 1% for 1980 and 1.5% for 1981.) This research further suggests that for each one percent drop in tourism, State revenues would be reduced by approximately $7 million and employment in Clark County would drop by approximately 7,000 jobs.[10]

In addition to the negative economic impacts that derive from the stigmatizing effects of the Yucca Mountain project, even the so-called beneficial effects of a program of this size will have negative overall impacts on Nevada's economy. This is because, under current State tax laws, repository-related increases in population will cost the State and local governments more for providing public services than they provide in revenues, a difference of between $670 and $1,000 per person, per year.[11] If these conservative figures are applied to the estimated Yucca Mountain-related peak population increase of 3,716 (per DOE's Draft Yucca Mountain Environmental Impact Statement), the project will cost the State and local jurisdictions between $2.5 million and $3.7 million annually. This is a consequence of the "standard effects" of the project and is separate from any stigma-induced economic effects that may occur during the life of the program.

Especially Hard Hit - Conventions

Conventions, a major contributor to the Nevada and Las Vegas economy, stand to be especially hard hit by the negative impacts of the Yucca Mountain project. Convention planners are extremely averse to holding a convention in a city located near or associated with a HLW repository. Even under a benign (e.g., no accident) scenario, over one-third of the planners surveyed by the Nevada research team substantially reduced their preference for Las Vegas. This figure increased dramatically when planners were presented with scenarios in which the repository program experienced a series of accidents.

Yucca Mountain could also reduce the propensity of people to attend a Nevada/Las Vegas convention. One-fourth (25 percent) of convention attendees studied reported they would not

[10] These figures are expressed in terms of 1989 dollars and used 1988 employment baseline projections. Projections using more recent data would result in larger losses/reductions.

[11] The dependence of Nevada state and local jurisdictions on revenue contributions of visitors is unique and results from the fiscal structure of the state. Other economic developments, private or public, that do not expand the contributions of visitor spending also will have negative fiscal impacts. Public expenditures per person would have to be provided for repository-related population in excess of the revenues that these people would contributed through taxes, fees, etc. This means that, in the absence of payments made by DOE for mitigation or compensation or changes in the Nevada tax/revenue structure, the repository program will consistently produce significant negative fiscal impacts even without negative stigma-related effects.

attend a convention if a repository were located 100 miles away (this compares to only 1 percent who would avoid a city near a prison).

Major Impacts to Property Values

Studies undertaken by State of Nevada researchers found that the value of property, especially along potential nuclear waste shipping routes in Clark County, stand to be dramatically affected should the Yucca Mountain project go forward.[12] Even under the most benign conditions (i.e., where there are no projected radioactive waste accidents), property value losses are likely along shipping corridors, as well as at distances of up to three miles from the actual highway or rail route. The findings indicate that an accident, even without a release of radioactive waste, will significantly increase the rate of property value diminution. Further, if a major accident were to occur, the property value loss would be devastating.

The researchers found that, in the event of an accident involving a radioactive waste shipment destined for Yucca Mountain, property value declines could reach 30 percent or more for residential properties within the shipment corridors. Declines of between 20 and 30 percent can also be anticipated for commercial-office and industrial buildings as well.

Even without an accident occurring, shipments of spent nuclear fuel and high-level radioactive waste along highways in southern Nevada will likely result in property value losses for all three real estate segments of the economy - residential, commercial, and industrial. The largest declines under the no-accident scenario (around 4 percent) will be experienced in the residential sector within one mile of shipment routes. Declines will also be realized in both commercial and industrial properties, but less than what is likely in the residential sector. The researchers concluded that property value diminution will result from the mere implementation of the shipment program alone along designated routes, even without accident events.

For the residential property sector, fear, risk, and stigma factors were identified as the principal reasons for the diminution. Other factors including higher risk premiums, loss of prestige location, product tainting, and the loss of productivity in case of accidents were recognized as influencing the value of office and industrial properties.

Retirees and Businesses Likely to See Losses

[12] "Final Report: Results From Key Informant Interviews About Potential Property Value Impacts From the Shipment of High-Level Nuclear Waste and Spent Fuel Through Clark County, Nevada," by Urban Environmental Research, LLC (August, 2000) and "Clark County Residents and Key Informant Surveys: Beliefs, Opinions, and Perceptions about Property Value Impacts From the Shipment of High-Level Nuclear Waste and Spent Fuel Through Clark County, Nevada," by Urban Environmental Research, LLC (December, 2000).

In addition to the direct impacts on Nevada's tourism economy and property values, the research strongly suggests that a Yucca Mountain repository will have significant impacts on business location decisions, economic development, and retirees moving into the State. The Nevada studies showed that retirement decisions would be strongly influenced by the mere existence of a repository in southern Nevada. For example, a majority of respondents in national surveys said they would pay higher housing costs - in some cases, up to $3,000 a year or more - to retire in an area away from a repository.

The studies revealed a disturbing aversion to a nuclear waste repository on the part of corporate decision-makers when considering business location or relocation decisions. While southern Nevada (i.e., Clark County) is considered a competitive area for attracting technology-driven, consumer products, and producer services businesses, the existence of a high-level nuclear waste repository in southern Nevada would act as a deterrent, causing many firms to locate elsewhere.

The Nevada research found that, absent a repository, Clark County would be competitive for attracting as many as 300 types of manufacturing industries. However, if a nuclear waste storage or disposal facility were located at Yucca Mountain, the area could lose a third of its target industries to other locations and face a more difficult job in recruiting the remainder. The impact would be most devastating on efforts to attract producer services businesses (i.e., reservations centers, such as distribution centers and facilities, management and consulting firms, accounting services, survey research organizations, customer billing centers, and other consumer-related businesses).

It was also found that, in the 1990s, Las Vegas had become a competitive location for most types of administrative offices and business and professional services firms serving western markets. The presence of a nuclear waste repository, the investigators found, could knock Las Vegas out of the competitive race for most types of these businesses.

Fiscal Impacts to State Agencies

The repository project, even if it were not accompanied by risk/stigma effects, would act as a net drain on the State General Fund. The positive revenue effects would derive chiefly from the state sales and use tax. On the average, General Fund revenues would increase by $5 million annually during repository construction, and about $1.5 million annually during emplacement. However, economic modeling done as part of the State's research found that additional General Fund expenditures required as a result of the repository-related population increases would be approximately $9.6 million during construction and about $3.1 million during emplacement, with almost half of the additional expenditures made for educational purposes (primarily the Distributive School Fund). The net projected fiscal shortfall is estimated at about $27.3 million during construction and $40.5 million during emplacement.

The estimated costs outlined for a sample of state agencies identified as potentially most affected by the repository project total $498 million, just for the first 3 years of dealing with Yucca Mountain operations (one year of gearing up for the repository's opening and the first two years of operations). Costs to the Department of Transportation alone could reach over $800 million when all necessary route segments are included.[13]

Native Americans - Especially Vulnerable and Disenfranchised

Native American tribes in the area around Yucca Mountain and along transportation routes have unique governments. As independent, federally recognized entities, tribal governments have a role equivalent to states in most federal undertakings. They also have a special status according to various environmental and cultural protection acts and in the Nuclear Waste Policy Act of 1982. To date, however, none of the tribes in Nevada has been granted "affected Indian Tribe" status under the NWPA, although several have applied.

The repository project has also spilled over into the campaign by the Western Shoshone National Council, a political entity made up of representatives from many Western Shoshone tribes, to reclaim lands under the Treaty of Ruby Valley of 1863. This has brought the Western Shoshone and other tribal government entities into conflict with DOE, as well as with other federal and state agencies. Because of the unique governmental position of tribes, their interests are not likely to be well protected or even properly represented in deliberations over the repository. They may also come into conflict with neighboring local governments over differences in positions regarding the repository, thus increasing their isolation from intergovernmental interaction.

Most Native Americans in Nevada do not want the disturbance of cultural resources that they see as the inevitable outcome of the Yucca Mountain project. Mitigation of disturbed archaeological sites is seen as an unacceptable alternative, and they would prefer that no disturbance take place at all.

Native American tribes in the immediate vicinity of the Yucca Mountain project area and along potential transportation routes are, for the most part, economically disadvantaged. Reservations and communities in Nye, Lincoln, and Inyo counties are rural and isolated, and either lack a land base or have land bases too small to support their populations by ranching or other locally common means. A large number of people are unemployed, underemployed, and/or are living below the poverty level. Educational levels have improved in recent years, but without job opportunities in local communities, people must leave to take advantage of their training.

[13] This analysis was initially done in 1989 and updated for certain agencies in 1990, 1992, and 1998. Changes in the proposed federal program (such as the addition of heavy haul transport along state highways) will likely increase the costs to State agencies substantially from the figures reported here.

Any negative statewide economic impacts associated with or caused by the repository or repository-related nuclear waste transportation will have a disproportionate impact on such communities because of these depressed baseline conditions.

Conclusion: Yucca Mountain is a Bad Deal for Nevada

The analyses and studies undertaken to date indicate that the development of a Yucca Mountain repository represents a significant gamble for Nevada's future economy and socioeconomic well-being. The nature of that gamble cannot be specified precisely, given the uncertainties inherent in the federal program, but the characteristics of Nevada's economy make it uniquely vulnerable to the risk-related impacts associated with high-level radioactive waste transportation and storage. The State's research has demonstrated that there exist credible possibilities of losses to the visitor economy, the retirement economy, and the business economy. These losses are likely to be large and, under certain conditions, long-lasting.

SPENT FUEL AND HIGH-LEVEL RADIOACTIVE WASTE TRANSPORTATION RISKS AND IMPACTS

Background

The transport of spent nuclear fuel and high-level radioactive waste to the proposed Yucca Mountain repository site in southern Nevada has the potential to dramatically and significantly impact communities throughout Nevada and across the nation. Depending on assumptions about the mix of shipping modes, handling and shipping capabilities at points of origin (e.g., reactor sites), size of the shipping canister or cask, and other factors, a Yucca Mountain repository, if constructed and opened, would receive between 23,500 and 96,300 shipments[14] of spent nuclear fuel (SNF) from civilian nuclear power plants and high-level radioactive waste (HLW) from DOE weapons facilities. The repository would also receive an unknown number of shipments of so-called "miscellaneous wastes requiring geologic disposal," adding to the overall number of radioactive materials shipments that would be required.

Studies by the State of Nevada and DOE indicate that 43 states would be directly impacted by SNF and HLW shipments to the proposed Yucca Mountain repository. A study by DOE identified 109 cities with populations over 100,000 that would be affected by such shipments.[15] The DOE report parallels an analysis done by State researchers in 1995 and updated in 1996. The Nevada report examined shipping routes, both rail and highway, in relation to the impacts various alternatives would have on communities nationwide. The State's analysis shows that many of the reactors that would ship waste during the first 10 years of repository operations will likely use truck transport regardless of the availability of rail access to Yucca Mountain, thereby impacting a larger number of cities and communities than reflected in the DOE report.

Transportation issues are critically important to the State and local Nevada communities. Nuclear waste transportation will be the most visible and dramatic "driver" of potential repository impacts for Nevada. Despite this fact, DOE has done almost nothing to evaluate

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[14] Under a scenario where most of the waste is shipped using legal weight trucks, there would be 96,000 truck shipments plus 300 Naval spent fuel shipments that would have to come by rail from Idaho National Engineering and Environmental Laboratory, due to the size and configuration of the Navy packaging. Under a scenario where most waste is transported by rail, there would be 19,800 rail shipments plus 3,700 truck shipments from reactors that are not rail capable. (Both of these shipment scenarios are taken from DOE's Draft Environmental Impact Statement for the Yucca Mountain Repository project, which was release in August, 1999.) Due to the fact that there is no rail access to Yucca Mountain or the Nevada Test Site and the cost of constructing such access could exceed $1 billion, the State of Nevada considers it much more likely that spent fuel and high-level waste would be transported to the site by legal weight truck.

[15] The report titled, "Nevada Potential Repository Preliminary Transportation Strategy Study 2," was released in February 1996 by TRW Environmental Safety Systems, Inc., DOE's management and operations contractor for the Yucca Mountain project.

impacts, either in Nevada or nationally. The few feeble attempts that DOE has made to address the transportation issue, as in the draft Yucca Mountain EIS, have been wholly inadequate and designed to obfuscate risks and impacts rather than deal with them forthrightly.

This is especially true in the national arena, where DOE has actively sought to downplay impacts of radioactive materials transportation related to the repository program. DOE went so far as to purposely mislead citizens and communities in other parts of the country when hearings on the draft Yucca Mountain EIS were held in late 1999 and early 2000. Instead of advising people in areas where the hearings were held of transportation routes, numbers and types of nuclear waste shipments through their communities, and the impacts that could be expected, DOE noticed the meetings as if they involved only a proposal for a repository facility in southern Nevada. In fact, the transportation issue was ignored in every public notice DOE issued on the draft EIS hearings.

The State's transportation impact assessment efforts over the past 14 years have resulted in numerous disturbing findings with respect to spent fuel and high-level waste transportation and its impacts on the Nevada and the nation.

The Historical Record - Cause for Concern About Safety

DOE and the commercial nuclear power industry are eager to point to the past history of commercial spent fuel transportation as hard and fast evidence that repository shipments can be accomplished safely. Such assurances are disingenuous at best. The fact is that there will be more spent fuel shipments in the first year of repository operations alone than in the last 40 years of commercial utility shipments combined. The shipping campaign needed for Yucca Mountain will be larger, of much longer duration, more complex, and far riskier than anything ever attempted in the United States or anywhere else in the world.

The reality is that there have been less than 2,600 spent fuel shipments nationwide since 1964. While there have been no documented cases of radioactive releases involving these shipments, a number of transportation and unloading accidents have occurred, and there have been instances of equipment failure that could have resulted in more serious accidents under the right circumstances. In addition, at least one case of attempted sabotage of a shipment is known to have occurred. These accidents and incidents occurred even though past shipments have been made under extraordinarily strict and controlled conditions - conditions that were much more stringent than can be expected for the tens of thousands of shipments needed to move waste to a repository.

There is no reason to expect that the commercial nuclear industry's past experience is a good predictor of the safety of future DOE shipments to Yucca Mountain. U.S. utilities have had relatively little experience with long-distance rail shipments. By contrast, the lowest estimate of

the amount of spent fuel to be shipped to Yucca Mountain (63,000 MTU) is more than thirty times the total amount of waste shipped in this country between 1964 and 1990. The average length of shipments to Yucca Mountain would be about 2,000 miles, compared to an average distance of about 550 miles for previous utility shipments (if only past rail shipments are considered, the average distance was 327 miles), creating additional opportunities for human error and equipment failure. Moreover, DOE's track record as a self-regulated shipper of spent nuclear fuel includes instances of risk-taking that would be unacceptable or illegal if committed by an NRC licensee. For example, DOE knowingly used a cask with questionable safety margins (the M-1A) for shipments of research reactor fuel through the New York metropolitan area.[16]

Another factor that makes it impossible to compare a DOE sponsored Yucca Mountain shipping campaign with past spent fuel shipments is DOE's plan for a "market driven" transportation system that will rely on up to three regional contractors and an unknown number of subcontractors to be selected on the basis of lowest bids and to be operated in a for profit manner. Incentives under this type of arrangement will be for the contractors to seek to operate the transport system in such a way to minimize cost and maximize profits. In the case of historical utility shipments of spent fuel, most of which have been individual shipments handled in a one-of-a-kind manner, extraordinary and even extra-regulatory precautions have been taken to minimize risk, even if these precautions resulted in greater costs.

Radiological Health Effects of Routine Shipments

Spent nuclear fuel is extremely radioactive and very deadly. It requires extraordinary precautions and shielding in order to safeguard the public and others from its lethal effects. A person standing one yard away from an unshielded, 10 year old fuel assembly, for example, would receive a lethal dose of radiation (500 rem) in less than three minutes and would incur significant damage within seconds.

The surface dose rate of spent fuel is so great (10,000 rem/hour or more) that shipping containers with enough shielding to completely contain all emissions are too heavy to transport economically. Consequently, NRC regulations allow a certain amount of neutron and gamma radiation to be emitted from shipping casks during routine operations and transport (1,000 mrem/hr at the cask surface and 10 mrem/hr 2 meters from the cask surface). While the significance of human exposure to low levels of radiation, which may cause health effects less obvious than cancer or birth defects, is not fully understood and is the subject of much controversy in the medical and health physics communities, there is a risk of serious adverse health effects from routine emissions (i.e., without accidents occurring or radioactive materials being released from the shipping casks) to train crews due to emissions from rail casks,

[16] See U.S. General Accounting Office, "DOE Needs to Take Further Actions to Ensure Safe Transportation of Radioactive Materials," GAO/RCED-88-195, September, 1988.

especially on dedicated trains; to truck drivers and others involved in truck transport of the waste; to inspectors dealing with large numbers of shipments over long periods of time; and to members of the public from truck casks during gridlock incidents. Another aspect of this issue is the excessive level of surface contamination (the so-called "weeping" phenomenon) on casks loaded in wet storage pools.

State of Nevada researchers, using DOE's shipment number figures and computer models, have estimated that the Yucca Mountain shipping campaign, even without a radiological accident occurring, would result in the following exposures:

- Truck safety inspectors would receive 2,500 millirems per year (mrem/yr);
- Occupants of a vehicle next to a spent fuel truck in a traffic situation lasting one to four hours would receive 10 - 40 mrem per person per incident;
- Members of the public along potential legal weight truck routes in Nevada could receive between 150 - 260 mrem/yr.

Such exposures could add up to substantial amounts of radiation when multiplied over the 28 - 35 year duration of a Yucca Mountain shipping campaign. People exposed repeatedly, over long periods of time, to such spent fuel and high-level waste shipments could experience serious and even life threatening radiation-induced health effects.

Spent Nuclear Fuel and High-Level Radioactive Waste Accidents

While there is uncertainty over the long-term effects of exposure to lower doses of radiation, there is no disagreement about the health impacts of a major radiological release. State of Nevada researchers have estimated that a credible, worst case accident involving a spent fuel rail shipment would result in between 356 to 432 latent cancer fatalities, if the accident occurred in a populated area. In addition, there would be thousands of people who would suffer non-lethal effects such as cancers, genetic damage, nervous system disorders, etc.

Such an accident, if it occurred in an urban area, would have economic impacts of between $63 and $108 billion, excluding any costs resulting from lost business or opportunity costs resulting from the stigmatizing effects of such an accident.[17]

[17] Estimated economic costs include clean up and decontamination; razing and reconstructing contaminated buildings, infrastructure, etc.; environmental damage; public health and safety costs; and other costs associated with the response to and remediation for such an accident.

Probability of Severe Accidents

Despite DOE and nuclear industry claims of infallibility, accidents involving spent fuel and high-level waste shipments can and will happen, and it is very possible that at least some of these accidents will be severe enough to result in the release of radioactive materials. An estimate of the number of accidents likely to occur during spent fuel shipments to a repository can be obtained by multiplying the historical anticipated accident rates by the anticipated cumulative shipment miles. If all spent fuel were to be shipped to the repository by truck in large-capacity casks, requiring about 96,000 shipments and over 100 million shipment miles, 129 accidents and over 1,900 incidents would be expected over the operating life of the repository. Under the mostly rail shipping scenario, about 440 accidents and almost 1,000 incidents would be expected.

Overall accident rates could be considerably higher depending on the accident histories of the actual routes to be used. None of DOE's risk assessments consider unique local conditions along specific route segments that could increase the probability or the consequences of severe accidents. Nor has DOE considered potential changes in the transportation environment that may significantly influence future accident rates: higher highway speed limits; higher average train speeds and the introduction of high-speed passenger trains; industry deregulation and profitability; higher rates of infrastructure failure; urban freeway congestion and gridlock; and other factors. Perhaps the single most important factor, and the most difficult to assess, is human error. None of DOE's risk estimates has encompassed the full spectrum of human factors. Organizational and individual error will significantly affect not only the probability of severe accidents, but also the accuracy of efforts to estimate the probability and consequences of severe accidents.

Shipping Cask Performance in Severe Accidents and Sabotage or Terrorism Incidents

The assumption by DOE, NRC, and the nuclear power industry that shipping casks will survive the most severe accidents, sabotage, or terrorist incidents without loss of shielding or containment is not only unsubstantiated, but dangerously irresponsible. Agency-sponsored research indicates that the NRC cask performance standards do not reflect credible worst-case accident or attack scenarios. None of the casks currently in use have been physically tested to determine if they comply with current standards because full-scale testing is not required by the NRC. DOE has no plans for full-scale testing of the new cask designs that would be used for repository shipments, even though they will differ significantly from current designs.[18] Furthermore, DOE has not adequately considered human factors in all phases of cask

[18] Casks to be used for repository shipments are being designed to hold much more spent fuel than current casks. The new casks will be less heavily shielded; manufactured with new, different, and lighter weight materials; and mass-produced in large quantities instead of being hand built like existing casks.

development and deployment. Human error may affect cask performance in the design phase, in fabrication, in licensing, in operations, and in maintenance. DOE's consideration of human factors in cask design has been inadequate, as documented in the Agency's review of the preliminary design reports for the GA-4/9 and BR-100 casks. Human factors management will be especially important in DOE's transportation system because the large cask fleet will require mass production and large-scale maintenance operations.

In addition, none of the casks to be used to ship spent fuel and high-level radioactive waste are required to be physically tested. NRC allows manufacturers to use computer simulations to demonstrate compliance with safety regulations. State researchers and others have strongly criticized not only the lack of physical testing for casks, but also the NRC cask safety regulations themselves as being too lenient and not representative of real world accident conditions.

A 1985 DOE contractor report concluded that a maximum severe, credible accident involving a single, current-generation rail cask (one that holds considerably less spent fuel than the casks proposed for repository shipments) could result in the release of a significant amount of radioactive materials to the environment. The study assumed a severe impact followed by a fire fed by large quantities of fuel. According to the study, the release of only a small fraction of the cask's contents would be sufficient to contaminate a 42 square mile area. The costs of cleanup after such an accident in a rural area would exceed $620 million, and the cleanup effort would require 460 days. An alternative analysis by a State of Nevada researcher estimated cleanup costs for the same rural accident that ranged from $176 million to $19.4 billion, depending primarily upon permissible post-accident soil concentrations of cobalt-60, cesium-134, and cesium-137, and upon regulatory requirements for disposal of the contaminated soil. Cleanup after a similar accident in a typical urban area would be considerably more expensive and time consuming (between $62 and $108 billion).

Terrorism Risks in High-Level Waste Transportation

State of Nevada research into the potential risks associated with terrorism or sabotage against repository shipments indicates that such risks are substantial and grossly underestimated by DOE, NRC, and the nuclear industry. Years of relative quiet on the national scene with respect to nuclear facilities and nuclear shipments have fostered complacency and what one researcher called an "atrophy of vigilance." Research conducted by the State indicates that past NRC and DOE evaluations of the terrorist threat are deficient with respect to the terrorist threat in the 21st century.[19] The type of terrorism (domestic as well as international), the methods that might be employed, and the weapons that are available to terrorist groups have changed markedly

[19] Ref. "A Preliminary Study of Sabotage and Terrorism as Transportation Risk Factors Associated with the Proposed Yucca Mountain High-Level Nuclear Waste Facility," by James David Ballard (September, 1996).

over the past 20 years. As a result, the risks of terrorist action and the consequences of such action against spent fuel or HLW shipments may be much greater than current estimates indicate.

The outcome of a terrorist attack on a SNF or HLW shipment will vary according to the type of attack, the weaponry used, the location, and other variables. The armor penetration capability of currently available weapons that could be used to attack a shipping cask is considerably greater and more effective than the capability that was assumed in the DOE and NRC assessments of the 1970s and 1980s. Guerrilla armies around the world are known to be equipped with older anti-armor missiles such as the Soviet RPG-7 and the American M72. With the ability to penetrate up to 10 - 14 inches of armor plate, these weapons pose a considerable threat to a nuclear waste shipping cask. Terrorists could conceivably obtain one of the dozen or more antitank weapons currently capable of penetrating 12 - 30 inches of tank armor.[20]

DOE's draft Yucca Mountain EIS includes an analysis of acts of sabotage against spent fuel shipping casks. DOE acknowledges that high-energy explosive devices available to terrorists are "capable of penetrating a cask's shield wall, leading to the dispersal of radioactive contaminants to the environment." [page 6-33]. DOE estimated that a successful attack on a truck cask in an urban area could release enough material to cause 15 latent cancer fatalities.

State of Nevada staff and contractors have replicated DOE's accident and sabotage consequence analyses, using the RADTRAN and RISKIND models, and have evaluated DOE's accident and sabotage scenarios using credible alternative assumptions. Nevada believes that the Draft EIS underestimates the impacts of a successful terrorist attack on a truck cask by at least a factor of 10. The population dose from the postulated attack could be at least 310,000 person-rem, resulting in at least 150 fatal cancers. Adverse economic impacts, including business losses and cleanup costs, could be as high as $20 billion.

Nevada's Attorney General filed a petition for rulemaking with the NRC in June 1999. The petition requests amendments to the current transportation safeguards regulations and a comprehensive reexamination of the consequences of radiological sabotage against SNF/HLW shipments. In September 1999, the NRC accepted and published for public comment Nevada's Petition for Rulemaking. The Western Governors' Association endorsed Nevada's petition, as did nine individual states. As of December 2000, NRC staff are still reviewing the petition and public comments.

Meanwhile, in September 2000, the National Council on Radiation Protection and Measurements (NCRP) published a draft report on radiation protection issues related to terrorist

[20] In fact, one such weapon, a U.S. Army "Super Dragon" anti-tank missile launcher, was recently found in a cave in Churchill County, Nevada by hikers. Neither the Army nor the Nevada National Guard could account for the weapon.

activities intended to disperse radioactive material. (Radiation Protection Issues Related To Terrorist Activities That Result in the Dispersal of Radioactive Materials, NCRP Draft Report No. SC 46-14, September, 2000) The NCRP report states: "Nuclear reactors, adjacent spent fuel storage depots, nuclear fuel reprocessing facilities, transport vehicles, or any high level waste site are potential targets for the use of high explosives to disperse into the atmosphere the very high levels of radioactivity associated with materials at these facilities." [page 15].

Nevada's petition states that three major changes have occurred in the nature of the terrorist threat that argue for a strengthening of the safeguards regulations: (1) the increasing lethality of terrorist attacks in the United States; (2) an increase in serious terrorist attacks and threats against transportation systems; and (3) renewed concerns about nuclear terrorism generally, and specifically, terrorist actions involving potential radioactive contamination.

Developments in two related areas have increased the vulnerability of spent fuel shipping casks to terrorist attacks involving high-energy explosive devices. First, the capabilities and availability of explosive devices, especially antitank weapons, have increased significantly. Second, new spent fuel shipping cask designs, developed to increase payloads without exceeding specified weight limits, appear to be more vulnerable to attacks involving past, current, and future weapons systems and commercial explosives.

Spent nuclear fuel shipments to a geologic repository and/or centralized interim storage facility will be dramatically different from past shipments in the United States. The following differences will create greater opportunities for terrorist attacks and/or sabotage against SNF/HLW shipments and may also increase the consequences of any incidents that occur:

(a) long duration, highly visible, nationwide shipping campaign;

(b) regular and predictable shipments to a single destination;

(c) large increase in amount of spent fuel shipped and increased numbers of truck and rail shipments annually, averaging several cask shipments per day, every day, for 30 years;

(d) substantial increase in number of active routes and average shipment distances, with potential implications for selection of targets and attack locations;

(e) significant concentration of shipments along certain highway and rail routes west of the Mississippi River, with implications for shipments through heavily populated areas and through locations that place shipments in significantly disadvantageous tactical positions;

(f) potential use of routes within Nevada with marginal safety design features, limited rest and refueling locations, and low likelihood of swift local law enforcement agency response; and

(g) DOE's planned use of a "market driven" transport system (i.e., a system of regional contractors and subcontractors selected on the basis of lowest cost), thereby complicating security for shipments and potentially increasing risks.

Nevada believes that a national repository or interim storage facility may have a greater symbolic value to terrorists as a target for attack than current at-reactor storage facilities, and that the enhanced symbolic value of the facility as a target may extend to SNF shipments to such a facility. Nevada further believes that a storage or disposal facility operated by DOE, the U.S. government agency responsible for producing nuclear weapons, may have greater symbolic value to terrorists as a target for attack than commercial storage facilities and that the enhanced symbolic value may extend to DOE's shipments of SNF and HLW to such a facility.

Combine the attractiveness of repository shipments as targets and the prominence of Las Vegas (or Reno) as a major resort area and media market, and there exists a not insignificant potential for terrorism or sabotage within Nevada. In addition, many of the geographic and terrain features in the State, such as long expanses of unpopulated rural highways and railroads, rugged mountain areas that provide ideal cover and facilitate escape, etc., also combine to increase the risks of terrorism against spent fuel and high-level waste shipments.

Conclusion: Transportation Risks are Substantial and Unwarranted

State of Nevada research has documented that there are substantial risks to Nevada communities and to communities in other states along potential shipping routes from the transport of spent nuclear fuel and high-level waste to a repository or interim storage facility in Nevada. These risks are significant "drivers" of many of the socioeconomic and related impacts associated with the federal program. DOE's and the federal government's activities in the area of transportation analysis, planning, and risk management have done little to attenuate these risks and, instead, have either obfuscated or actually exacerbate risks and their consequences.

Not only are the risks from spent fuel and high-level waste shipments potentially great, but they are also unnecessary. These materials have long been - and are currently being - stored in safe, secure locations where risks are minimized. With currently available dry storage technology, spent fuel can continue to be safely and economically stored on site for the next 100 years or more. Exposing millions of people in 43 states and thousands of communities to needless risks from the transportation of these materials is more than unwarranted - it is irresponsible and foolhardy.

RECOMMENDATIONS

Nevada and, indeed, the nation are approaching a critical juncture with respect to the federal high-level radioactive waste program. During the next year, DOE will, under the current schedule, issue a final environmental impact statement for the Yucca Mountain project and determine whether to formally recommend Yucca Mountain for development as a repository. Following DOE's actions, the new President will have to decide whether to ask Congress to endorse the site recommendation.

For Nevada, these decision points in the federal program represent both challenges and opportunities. On one hand, they constitute the "end game" wherein DOE and its allies in Congress will try to override the State's objections and seek to force the Yucca Mountain project on Nevada. On the other hand, the upcoming statutorily prescribed actions represent the first time the State will have the opportunity to formally challenge final decisions on Yucca Mountain's suitability and the legal, procedural, and technical processes that underlie those decisions.

The Commission believes that the technical case against a Yucca Mountain repository is compelling. Over the past two decades, the State of Nevada has amassed an impressive array of technical information pointing to serious flaws in the site. DOE's own data, when not obscured by biased manipulations that characterize the performance assessment computer models used to make the site appear favorable, also clearly demonstrate that disqualifying conditions exist.

The ultimate decision about Yucca Mountain's future, however, will not be made solely on the basis of scientific and technical suitability. It will also be made in the courts and in the political arena. The Commission believes that Nevada must be prepared to fight the Yucca Mountain battle in each of these arenas during the next two years.

No single factor will be more important in assuring Nevada's success in this battle than the continuation of strong, consistent, and ***unified*** opposition on the part of the governor, the legislature, the attorney general, the State's congressional delegation, and local governments. In this regard, advice originally articulated in the Commission's first report in 1986 and repeated often since then remains central to a successful strategy for opposing this dangerous and ill-conceived federal project:

> "... The Commission believes that strong and effective dissent on the part of the State's Governor, Legislature, and congressional delegation is essential. Nevada is too small a state (in the national political context) to be able to afford conflicting positions on the part of key elected officials on this crucial issue. If congressional representatives from other states perceive equivocation or passive acquiescence on the part of Nevada's representatives, the stage will be set for a truly political solution to the nation's nuclear

waste problem - a solution that may result in a Nevada repository regardless of the technical merits of the Yucca Mountain site."[21]

The recommendations which follow are intended to help guide the governor and legislature in dealing with the critical decisions and milestones that are forthcoming in the near future and, ultimately, in successfully opposing any attempt by the federal government to move ahead with a Yucca Mountain repository over the State's objections.

Specific Recommendations

(1) The Commission urges the governor and legislature to continue to speak with a single voice in opposing the Yucca Mountain program, especially in light of DOE's anticipated recommendation, sometime in mid-2001, that Yucca Mountain be developed as a repository.

Discussion: The State's ability to successfully challenge upcoming Yucca Mountain decisions and to prevail in anticipated legal and adjudicatory proceedings would be irrevocably damaged by any weakening of Nevada's opposition or by any disunity (real or perceived) on the part of the governor and legislature on this critical issue. With DOE's site recommendation decision on the horizon, the governor and legislature should anticipate that there will be calls from the commercial nuclear power industry and its surrogates in Nevada to lessen State opposition and initiate some form of negotiations for benefits in exchange for accepting - or not actively opposing - the Yucca Mountain project. Pressure for adopting such a position may be especially apparent in the upcoming legislative session, where Yucca Mountain supporters and industry lobbyists can be expected to be active.

The Commission believes, as it has stated consistently in reports and recommendations since 1986, that strong, consistent, and unified opposition to the ill-conceived Yucca Mountain project is essential if Nevada is to prevail in halting the program. A DOE decision to recommend Yucca Mountain as a high-level waste repository does not mark the end of Nevada's battle. It is just the beginning. The State can prevail, but only by staying the course and resisting attempts by repository proponents to divide and weaken Nevada's strong and united opposition.

(2) The Commission strongly recommends that the governor and legislature continue to support funding, both state and federal, for the Agency for Nuclear Projects to continue its oversight and impact assessment work, including funding for adequate legal counsel to

[21] "Report of the State of Nevada Commission on Nuclear Projects" (November 1986), p. 43.

review the final Yucca Mountain EIS and the site recommendation decision, and for related legal and constitutional challenges.

Discussion: The Commission commends the governor and legislature for their steadfast support of funding, both State and federal, for the Agency for Nuclear Projects and its important work in overseeing DOE's activities. In the past, DOE and its supporters in Congress have used the threat of withdrawal of federal nuclear waste funds (as well as the actual withholding of funds) to influence and actually impede Nevada's ability to carry out its responsibilities under the provisions of the Nuclear Waste Policy Act. Between 1996 and 1998, when Congress and DOE failed to provide federal funds for State oversight, the Legislature allocated State General Funds for Agency operations and continued that funding in the FY 2000 - FY 2001 biennium. Just last year, Governor Guinn and Senator Reid were successful in restoring federal oversight funds, albeit with significant constraints as to how those monies can be used.

It is essential that Nevada's Yucca Mountain oversight program not be hostage to the willingness of Congress to continue providing federal funds for Agency activities. This will be especially true in the next few years when it is likely that the State will be forced into adversarial positions with the federal government over decisions regarding site suitability, the final Yucca Mountain EIS, and the ultimate recommendation of Yucca Mountain as a repository. A base level of State funding sufficient for the Agency to carry out critical oversight work that cannot be done with federal funds is essential. State funds are also critical should Congress again withdraw funds as a result of future actions and inevitable State-federal conflicts.

(3) The Commission advises that the governor and legislature should anticipate that the State will likely be required to litigate federal agencies over pending rulemakings that will establish the health and safety standards for Yucca Mountain and urges that such litigation be supported with adequate resources.

Discussion: DOE, NRC, and the Environmental Protection Agency have all published draft rules related to standards for the Yucca Mountain site. Based upon reviews of draft regulations and revisions to existing regulations, it is anticipated that the State will likely challenge one or more of these rules. DOE is proposing, for example, to abandon the specific qualifying and disqualifying conditions that must currently be used to determine site suitability for a geologic repository and replace them with a process that ignores specific disqualifying factors in favor of a general and more subjective performance assessment-based evaluation. State scientists believe that Yucca Mountain would have to be disqualified under the existing siting guidelines, hence the push by DOE to change the rules. Likewise, the anticipated EPA radiation protection standard and NRC's proposed

revisions to its repository licensing regulations are considered to afford inadequate protection to the public from radiation releases from a Yucca Mountain facility.

Because DOE can make Yucca Mountain appear marginally suitable only by altering regulations that are seen as impediments to the federal program, successful challenges to any of these proposed regulatory initiatives will dramatically affect the course of the federal program and greatly enhance Nevada's case against the project.

(4) The Commission recommends in the strongest possible sense that the governor and legislature reject any efforts to negotiate for benefits tied to the Yucca Mountain program or to any scheme to locate an interim spent fuel storage facility at the Nevada Test Site.

Discussion: As noted in the discussions above, there remains a long way to go in the repository siting process. Simply because DOE moves to recommend that Yucca Mountain be developed as a repository does not mean that this decision will be upheld by the President or the courts or that NRC will ultimately issue a license to construct a facility. Nevertheless, there will undoubtedly be attempts during the upcoming legislative session to present Yucca Mountain as a "done deal" and to urge legislators to opt for some sort of negotiated benefits arrangement. The Commission believes strongly that to even consider negotiations at this stage of the process will irrevocably damage Nevada's ability to successfully oppose the project and could lead to congressional passage of legislation to weaken environmental, health, and safety standards and even authorize the location of an above-ground, interim spent nuclear fuel storage facility at the NTS. Such legislation has been attempted in the past and was defeated largely due to Nevada's strong, determined, and united opposition. It is no coincidence that the commercial nuclear power industry and its surrogates in Nevada are urging negotiations at a time when Nevada is about to finally have its day in court.

(5) The Commission recommends that the governor and legislature support efforts on the part of the State to carry out a national information campaign to raise awareness of the risks and impacts associated with the unprecedented radiological transportation campaign required to implement a Yucca Mountain repository.

Discussion: The Commission believes that there is an as yet untapped groundswell of opposition to the unprecedented and potentially dangerous nuclear waste shipping campaign that would be required if a repository is built at Yucca Mountain. DOE and the commercial nuclear industry have gone to great lengths to downplay the transportation aspects of the repository program and to obscure the dangers and risks faced by thousands of communities in 43 states directly impacted by spent fuel and high-level waste shipments. A national information campaign targeted at states and cities at risk of significant transportation impacts will energize opposition to the project in other states.

Ideally, such an effort should attempt to encourage other states, through legislative and gubernatorial organizations, to join Nevada's likely litigation on the final Yucca Mountain EIS. The campaign would make other states and communities aware of the fact that, if DOE is legally allowed to ignore route identification and assessment of potential impacts and risks along highway and rail routes in other states in the final EIS, DOE will never be forced to deal with these issues.

The campaign will require adequate resources to be effective. The Commission has long believed that such an effort is essential to a successful strategy for opposing the Yucca Mountain project, and we urge the governor and legislature to support funding for a national information initiative.

(6) The Commission advises the governor and the legislature that, in addition to the legal services afforded by the Attorney General's staff, the State of Nevada will likely need to retain a law firm with proven and extensive experience dealing with the Nuclear Regulatory Commission's licensing process and attendant case law to represent Nevada's interests in any potential licensing proceeding before the NRC.

Discussion: As discussed earlier in this report, the U.S. Nuclear Regulatory Commission's laws, regulations, and procedures governing licensing of nuclear facilities are extremely complicated and fraught with legal and procedural mine fields. NRC licensing has become a highly specialized field of law unto itself, one that requires legal services with expertise and experience beyond what a state like Nevada is able to provide using in-house legal staff. In order to assure that Nevada's interests are adequately protected in the event NRC initiates a licensing proceeding for the Yucca Mountain project, the State must be represented by legal counsel intimately knowledgeable with the intricacies of the licensing process and with a track record of successful interventions in such proceedings.

While there is uncertainty about how much money may be needed and the time when these funds would be required, it is clear that such an initiative will be necessary. Estimates of the amount of funds required range from $2 to $3 million per year. By comparison, the Department of Energy has already retained such a firm at a cost of approximately $20 million. Given the amount of funds that may be required, the Commission recommends that consideration be given to the impact a request for this amount of money may have on the State's Contingency Fund and that contingency plans be initiated, in the event the need to move ahead with securing such legal expertise should arise between legislative sessions.

(7) The Commission strongly recommends that the 71st Session of the Nevada Legislature formally adopt a joint resolution of the Nevada State Assembly and the Nevada State

Senate stipulating that the Legislature strongly opposes the development of a high-level nuclear waste repository at Yucca Mountain and, further, that the Legislature adopt a joint resolution that can serve as the Legislature's notice of disapproval in the event that such notice is required during the biennium between sessions.

Discussion: The Nuclear Waste Policy Act contains potentially conflicting provisions related to the notice of disapproval the State of Nevada is entitled to submit to Congress in the event the President decides to recommend Yucca Mountain for development as a repository. In Section 115 (a), the Act indicates that "the designation of a site as suitable for a construction authorization for a repository shall be effective at the end of the 60-day period beginning on the date that the President recommends the site to Congress ... unless the *Governor and legislature* of the State in which such site is located ... has submitted to Congress a notice of disapproval under Section 116 ... "(emphasis added).

Section 116 (b) contains the following language: "Upon submission by the President to the Congress of a recommendation of a site for a repository, the *Governor or legislature* of the State in which such site is located may disapprove the site designation and submit to the Congress a notice of disapproval"(emphasis added).

The ambiguity in the statute as to whether it is the governor *and* the legislature or the governor *or* the legislature who is responsible for submitting the notice of disapproval is something DOE or the Congress could potentially use to thwart Nevada's notice. To assure that such an eventuality does not arise, the Commission is recommending that the 2001 Nevada Legislature act proactively to make its intentions clear with regard to the notice of disapproval. This could be done by means of a joint resolution stipulating the legislature's notice of disapproval to any decision the President might make recommending Yucca Mountain as a high-level waste repository.