Environmental Views on the Geologic Disposal of Nuclear Materials

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United States efforts to geologically isolate high-level nuclear waste began more than 40 years ago. The National Academy of Sciences in 1957 reported that a number of geologic disposal alternatives were possible, but indicated a preference for disposal in salt. In 1967 the Atomic Energy Commission ("AEC") proposed Project Salt Vault, a plan to develop a geologic repository in the Cary salt mine at Lyons, Kansas. This plan was abandoned by the AEC in the early-1970s after the Kansas Geological Survey mounted a strong campaign against the site, pointing out that the area had been subjected to extensive exploratory drilling for oil and gas deposits, and noting that an adjacent salt mine could not account for the loss of a large volume of water used during solution mining of the salt.

In 1974 the Energy Research and Development Agency ("ERDA"), formed out of the AEC and the predecessor to the Department of Energy ("DOE"), retreated from geological disposal by proposing a Retrievable Surface Storage Facility ("RSSF") for interim storage of high-level waste while pursuing geologic disposal at a more leisurely pace. This idea was rejected by environmentalists and the Environmental Protection Agency ("EPA") on the grounds that it would delay permanent disposal.

In the mid-1970s it also became clear that commercial spent fuel reprocessing was uneconomical, environmentally unsound and represented a serious proliferation risk. President Gerald Ford refused to subsidize the completion of the Barnwell reprocessing plant, and then President Jimmy Carter pulled the plug on reprocessing. This gave a new urgency to finding a site suitable for geologic disposal of both spent fuel and high-level nuclear waste. In the late 1970s President Carter initiated an Interagency Review Group ("IRG") process to solve once and for all the nuclear waste problem in the United States. The IRG process involved numerous scientists, extensive public involvement, and a consultation and concurrence role for the states. The outcome of the IRG effort was a two track program. The DOE was tasked with the responsibility for identifying the best repository site in the country, and the EPA and the NRC were tasked to develop nuclear waste disposal criteria against which the selection and development of the final repository site would be judged.

In 1982, Congress enacted the Nuclear Waste Policy Act ("NWPA of 1982"), which embodied in law the principal recommendations that grew out of the IRG process, including a commitment to geologic disposal, two repositories, and characterization of three sites before final selection of the first repository. At that time the U.S. Government enjoyed fairly widespread support from within the Congress, the environmental community and state governments for the site selection and development process proposed by the IRG. Now, twenty years later the U.S. Government has no support from the State of Nevada, very little Congressional support and virtually no public support for the Yucca Mountain project. What went wrong?

First, DOE and then the Congress corrupted the site selection process. The original strategy contemplated DOE first choosing the best four or five geologic media, then selecting a best candidate site in each media alternative, then narrowing the choices to the best three alternatives, and then picking a preferred site for the first of two repositories.

Site selection guidelines were suppose to take six months to develop, but took two years. The ranking criteria were strongly criticized. DOE was accused of selecting sites that they had previously planned to pick. In May of 1986 DOE announced that it was abandoning a search for a second repository, and it had narrowed the candidate sites from nine to three, leaving in the mix Hanford, Deaf Smith Co., Texas (in bedded salt) and Yucca Mountain (in unsaturated volcanic tuff).

The fact that DOE had corrupted the site selection process is evidenced by the fact that one of three final candidate sites was on the Hanford Reservation in a much larger basalt formation. The Hanford Reservation, of course, was selected in 1943 by the Corps of Engineers for reasons that had nothing to do with geologic attributes favorable for disposal of spent fuel and high-level waste. DOE had abandoned crystalline granite in the face of political opposition from east coast politicians. This alienated the Western states politicians, particularly those from Nevada.

All equity in the site selection process was lost in 1987, when the Congress, confronted with a potentially huge cost of characterizing three sites, amended the NWPA of 1982, directing DOE to abandon the two-repository strategy and to develop only the Yucca Mountain site. At the time, Yucca Mountain was DOE's preferred site.

The second thing that went wrong was that EPA failed to develop the disposal criteria before development of the Yucca Mountain site was well under way. Section 121 of the NWPA of 1982 directed EPA to establish generally applicable standards to protect the general environment from offsite releases from radioactive materials in repositories and directed the NRC to issue technical requirements and criteria for such repositories. Some 17 years have past and EPA still has not issued its final version of the waste disposal criteria.

EPA has a history of being extremely slow at promulgating radiation protection standards. With respect to promulgating standards for the proposed high-level radioactive waste repository, others also have contributed to the delay. As a consequence of a suit brought by the Natural Resources Defense Council ("NRDC"), EPA was forced to reissue its first set of proposed standards because they were inconsistent with EPA's drinking water protection standards. In 1992 the Congress directed the EPA to retain the National Academy of Sciences ("NAS") to recommend geologic disposal standards, and directed EPA to establish Yucca Mountain standards consistent with the NAS findings and recommendations. The NAS findings and recommendations were issued in 1995. The EPA also has been forced to battle DOE, NRC and the Office of Management and Budget in the interagency process to get any proposed regulations published for public comment. This has been a major cause of delay.

There is little integrity in the licensing process given that DOE, the applicant in the Yucca Mountain licensing process, through closed-door interagency meetings is able to influence the proposed licensing regulations before they are published for public comment and again before the final rule is published.

A substantial segment of the environmental community believes the process for setting radiation protection standards is rigged to ensure the licensability of Yucca Mountain. When it began to look like the geologic repository might not meet an acceptable collective dose standard because of the potential release of long-lived radioisotopes such as carbon-14, the EPA discarded any limits on collective dose.

More recently, the Nuclear Information and Resources Service, Public Citizen and more than 200 other NGO groups petitioned DOE to disqualify Yucca Mountain for failure to meet the DOE repository siting regulation [10 CFR §960.4-2-1(d)]:

> A site shall be disqualified if the pre-waste-emplacement ground-water travel time from the disturbed zone to the accessible environment is expected to be less than 1,000 years along any pathway of likely and significant radionuclide travel.

Part of the supporting evidence cited in their petition is the fact that researchers using chlorine-36 as a tracer, detected residues from rainwater less than 50 years old at the level of the proposed repository. This discovery contradicts earlier models of rainwater flow (travel time to the water table). DOE rejected the petition on the grounds that DOE did not have sufficient information to disqualify the site. DOE officials argue that although the flow rate in some cases is larger than anticipated, the volumes of water in these cases may be small—not enough to move the quantities of waste necessary to disqualify the site based on dose calculations.

DOE models used to estimate groundwater dose assume that the waste will not leak from the canisters for the first 1,000 years. The models predict that some radionuclides reach wells 20 km (12 miles) from the repository about 500 years later. The DOE apparently does not consider the amounts to be significant. At 2,000 years post-closure—1,000 years after the canisters begin to leak—the dose rate at wells 20 km from the repository reaches 0.01 percent of the dose rate at 10,000 year post-closure. Some have argued that these data also demonstrate that the radionuclide travel time from the repository to the well is less than 1,000 years and therefore the site should be disqualified.

On August 19, 1999, EPA released for public comment its latest draft environmental protection standards for the proposed high-level radioactive waste repository at Yucca mountain. The proposed EPA standards set a limit for leakage-related doses at 15 mrem (150 μSv) per year committed effective dose equivalent (CEDE), and for exposure from groundwater the limit is 4 mrem (40 μSv) per year. I have no quarrel with these limits, however, EPA has left unresolved whether the point of compliance is 5 km, 20 km , or 30 km from the repository.

Previous EPA draft standards, contained a time limit of 10,000 years for the purpose of assessing compliance with the above limits. The National Research Council's Committee on Technical Bases for Yucca Mountain Standards criticized this time limit noting that "there is no scientific basis for limiting the time period of an individual-risk standard in this way." (NRC, "Technical Basis for Yucca Mountain Standards," 1995, p.

6) In its latest proposed standards, EPA retains the 10,000-year compliance period with quantitative limits on dose; but in a gesture toward the National Academy of Sciences, EPA also requires that performance assessments be made part of the public record when the peak dose occurs after 10,000 years. By refusing to place quantitative limits on post-10,000-year exposures, the EPA, in effect, is leaving to the political process, rather than the licensing process, the decision whether or not a repository site should be rejected if projections of radiation doses to the public in the post-10,000-year period are higher than those deemed acceptable during the first 10,000 years. In the case of Yucca Mountain the projected peak doses occur between 300,000 and 900,000 years, and they are very high.

DOE's Draft Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada, issued in July 1999, estimates the CEDE from groundwater releases during the first 10,000 years are less than 4 mrem/y, even at the 95th percentile uncertainty level. (DOE, Draft EIS for Yucca, p. 5-27) However, these are strongly dependent upon assumptions regarding the failure rate of the waste containers, which in turn depend on assumptions about quality control during the construction of the containers. The environmental community has serious reservations about assumptions related to container integrity.

The mean peak groundwater doses are estimated to be 1.4 rem/y (14 mSv/y) at 5 km and 150 mrem/y (1.5 mSv/y) at 30 km; and the 95th percentile estimates are 9.1 rem/y (91mSv/y) and 0.82 rem/y (8.2mSv/y) at these respective distances. These doses, which occur between 300,000 years and 900,000 years after closure, are 350 to 2,300 times the current ground water protection standards. Many people will argue that since these high groundwater doses are estimated to occur so far into the future, they are not worth worrying about. After all, recorded human history is only about 6,000 years; the last ice age was some 14,000 years ago; Cro-Magnons lived between 35,000 and 10,000 years ago; and the evolution of Homo sapiens commenced approximately 200,000 to 300,000 years ago. Others, including many in the environmental community, will cite these same high groundwater doses projections as proof that the Yucca Mountain site is unsuitable for a geologic repository. Many grass-roots activists are already organizing against Yucca Mountain based on concerns about groundwater contamination, the impacts of earthquakes and potential volcanic activity.

The legislative history of the NWPA of 1982 includes the following admonition:

> The Committee strongly recommends that the focus of the Federal waste management program remain, as it is today, on the development of facilities for disposal of high-level nuclear waste which do not rely on human monitoring and maintenance to keep the waste from entering the biosphere.

From a technical stand point, the current analysis appears to show: a) well designed canisters may be able to safely sequester the waste for a few thousand years; b) there is

not much water flowing through Yucca Mountain, but c) the repository leaks like a sieve. The repository does not keep the waste out of the biosphere.

The NRC regulation 10 CFR §51.51, which went into effect in 1979, requires that every environmental impact report prepared for the construction permit stage of a light-water-cooled power reactor include a table, called "Table S-3," that summarizes the environmental releases associated with the reactor fuel cycle. This Table S-3 asserts that there will be no releases of radioactivity from the high-level radioactive waste repository. While this regulation is largely defunct because there have been no new power plants constructed and a new table has been developed for license extensions, nonetheless, environmentalists have not forgotten that for decades the nuclear electric utilities and the NRC have worked hand-in-hand to license, build and operate nuclear power reactors on the premise that the Federal government would site, design, and construct the Federal geologic repository to achieve essentially zero release of radioactivity. Now that many of these reactors are entering their twilight years, truth be known. The environmental community was right. The nuclear industry and the government does not have a solution to the nuclear waste problem.

If a case is to be made for Yucca Mountain, it may have to be based on the view that starting over looks even more risky, or that Yucca can continue to serve as an R&D and/or interim storage facility while a search is conducted for a better site. These too will be hard sells.