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ENVIRONMENTAL RADIATION PROTECTION STANDARDS FOR YUCCA MOUNTAIN, NEVADA

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ABSTRACT

The Environmental Protection Agency (EPA) has issued radiation protection standards for the potential spent nuclear fuel and high-level radioactive waste disposal system in Yucca Mountain, Nevada. These standards are found in Part 197 of Title 40 of the Code of Federal Regulations (40 CFR Part 197). The Energy Policy Act of 1992 directed, and gave the authority to, EPA to take this action based upon input from the National Academy of Sciences (NAS). The final standards were published in the *Federal Register* (66 FR 32073) on 13 June 2001.

The 40 CFR Part 197 standards have four major parts: (1) individual-protection during storage activities; (2) individual-protection following closure of the repository; (3) human-intrusion; and (4) ground-water protection. The storage standard is 150 microsieverts (μSv) annual committed effective dose equivalent (CEDE) to any member of the general public. The disposal standards are: (1) 150 μSv annual CEDE for the reasonably maximally exposed individual (RMEI) for 10,000 years after disposal; (2) 150 μSv received by the RMEI within 10,000 years after disposal as a result of human intrusion; and (3) the levels of radionuclides in the ground water cannot exceed 40 μSv from beta and gamma emitters, 5 picocuries per liter (pCi/L) of radium-226 and -228, and 15 pCi/L of gross alpha activity. There are also requirements related to the post-10,000-year period, the basis of compliance judgments, and performance assessments.

The Agency has published its responses to the comments received, its technical background document, and its economic impact analysis. In addition to printed form, the documents are available on the World Wide Web at <http://www.epa.gov/radiation/yucca/index.html>.

INTRODUCTION

The U.S. Environmental Protection Agency (EPA) issued radiation protection standards for the potential spent nuclear fuel and high-level radioactive waste disposal system in Yucca Mountain, Nevada on 13 June 2001 (1). (The term "repository" is used in this paper to refer to the mined facility, while the term "disposal system" is used to refer to the entirety of the mined facility, the engineered barriers, and the geologic barrier.) The Energy Policy Act of 1992 (EnPA) directed EPA "to set generally applicable standards for the Yucca Mountain site...for protection of the public from releases from radioactive materials stored or disposed of in the repository at the Yucca Mountain site" (2). It also directed EPA to set the standards "based upon and consistent with" the results of a contract with the National Academy of Sciences (NAS) to "conduct a study to provide [to EPA]...findings and recommendations on reasonable standards for protection of the public health and safety..." (the NAS Report, 2). The standards are in Part 197 of Title 40 of the Code of Federal Regulations (40 CFR Part 197).

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In previous papers, EPA has reported upon the findings and recommendations in the NAS Report, public comments received from the review of the NAS Report, and the range of the EPA's considerations while establishing standards based upon the NAS Report's findings and recommendations. This paper reviews the provisions of the final standards.

STORAGE STANDARD

Subpart A of 40 CFR Part 197 contains the storage standard. It limits the doses, received by members of the public, coming from management and storage which occurs prior to closure of the repository. The standard is 150 microsieverts (μSv) annual committed effective dose equivalent (CEDE). "Annual committed effective dose equivalent" is the CEDE resulting from one year's intake of radionuclides plus the annual dose received from external radionuclides released from the storage area. It applies to any member of the public in the general environment. The general environment is anywhere outside the Yucca Mountain site, the Nellis Air Force Range, and the Nevada Test Site. Storage was not addressed by NAS.

The standard covers management and storage occurring within the repository combined with the activities on the surface and defines the interaction between 40 CFR Part 197 and Subpart A of 40 CFR Part 191, *Environmental Radiation Protection Standards for Spent Nuclear Fuel, High-Level and Transuranic Radioactive Wastes* (3). The interaction between 40 CFR Parts 191 and 197 is necessary because 40 CFR Part 191 is based upon the older critical-organ dose system, whereas 40 CFR Part 197 is based upon effective dose equivalent. The Agency considered setting an overall dose limit using only annual CEDE, but decided that the bifurcation is necessary (largely because the EnPA specifies that the standards cover storage in the repository) despite the fact that it is advantageous to have a single methodology.

DISPOSAL STANDARDS

Subpart B of 40 CFR Part 197 contains the disposal standards for: (1) protection of individuals; (2) human intrusion; and (3) ground-water protection. The disposal phase is considered to start when the repository is closed. Disposal was the subject of the findings and recommendations of the NAS Report (4).

Role of the NAS Report

The question was raised following the release of the NAS Report as to whether EPA believed itself to be bound to the NAS' findings and recommendations. Many of the NAS' findings and recommendations are written in a non-binding manner because NAS recognized that many of the issues are not scientific or technical but rather societal policy issues to be determined through an EPA public rulemaking process. Therefore, it is clear that these are non-binding. But what about those findings and recommendations which are stated in relatively definite terms?

The EPA does not believe that Congress intended for public rulemaking to be bypassed since the EnPA stipulated that the standards be "promulgated by rule." Also, the Conference Report accompanying the EnPA stated, "The provisions of section 801 [of the EnPA] are not intended to limit the Administrator's [of EPA] discretion in the exercise of his authority related to public health and safety issues" (5). In summary, EPA does not believe that it is bound to adopt the NAS' findings and

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recommendations. However, the NAS' findings and recommendations played a dominant role in the Agency's deliberations.

Reasonable Expectation

All of 40 CFR Part 197's disposal standards are based upon the concept of "reasonable expectation." Reasonable expectation means that the Nuclear Regulatory Commission (NRC) is satisfied that compliance will be achieved based upon the full record before it. Reasonable expectation is used by EPA to recognize that absolute proof is neither necessary nor possible to obtain since performance of the disposal system must be projected for at least 10,000 years. "Reasonable expectation" is distinct from the concept of "reasonable assurance" as it has developed over the years in nuclear power reactor licensing. The difference between projecting the performance of an engineered system with a cumulative experience of hundreds of years of operation versus projection of the performance of a new type of combined engineered and natural system with no operational experience to date is clear. The EPA is trying to recognize that the uncertainty involved in projecting the performance of the disposal system is much greater than for a reactor. Further, "reasonable expectation" is intended to be cautiously realistic in that it does not exclude important parameters simply because they cannot be quantified to a high degree of confidence, whether they contribute to, or detract from, disposal system performance. That is not to say that parameter values can be arbitrary, but rather, that ignoring effects of parameters (the values of which are reasonable based upon research or expert judgment) or using only their extreme values can lead to assessments of performance which have a high probability of being unrealistic or have such a low probability of occurring that they would not be representative of the range of likely performance.

Individual-protection Standard

Form. There was disagreement between the EnPA and the NAS recommendation as to whether this standard should be stated in terms of risk or dose. The NAS recommended risk, whereas the EnPA stated that the standard was to be a dose limit. The EPA decided to use dose. First, advisory bodies such as the International Council on Radiation Protection and the National Council on Radiation Protection have recommended that standards be stated in dose. Second, most existing national and international radiation standards are stated in dose. Third, dose and risk are closely related mathematically. In addition, the dose standard is based upon the lifetime risk of an individual developing a fatal cancer (using the linear, non-threshold, dose-response relationship). Therefore, risk is the basis for the limit anyway. Fourth, the EnPA called for a dose limit. And, finally, most commenters on the NAS Report favored dose.

Level. The individual-protection standard is 150 μSv annual CEDE. The NAS recognized that the appropriate level is a question of both science and public policy. There were several bases for the proposed level. First, it is within the range that the NAS recommended. The NAS stated that a starting point for the rulemaking should be within an annual risk of 10^{-6} to 10^{-5} -- about 20 to 200 μSv per year. Second, it represents a 50-year lifetime risk of about 4×10^{-4} . This is about the upper value of the range of the risk that EPA generally uses to judge the acceptability of non-radiation-related activities. The EPA generally considers a range of about 10^{-6} to 10^{-4} lifetime risk as an acceptable risk range for regulation. And, finally, it is consistent with the individual-dose limit in 40 CFR Part 191 that is the basis for the certification of the Waste Isolation Pilot Plant (WIPP) and the decision on the Greater Confinement Disposal system.

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The representative of the exposed population. The NAS recommended that EPA use the average risk within a critical group to determine compliance with the individual-protection standard. They cited two examples of critical groups that might be used. One was a group of subsistence farmers, while the other was a statistical/probabilistic representation of the doses received by the population in the region surrounding Yucca Mountain (4).

The Agency chose to use a reasonably maximally exposed individual (RMEI). The concept is similar to the critical group concept in that its purpose is to project doses that are within a reasonably expected range rather than the highest theoretical dose. This is accomplished by using cautious, but reasonable, parameter values and is to be based upon what EPA believes is a common lifestyle in Amargosa Valley, Nevada. Ground water is to be assumed to be consumed at a rate of two liters per day per person and a portion of the diet is to be from locally grown food that was grown using the ground water.

Location. The location of the RMEI must be assumed to be in the accessible environment above the point of highest concentration of radionuclides in the aquifer. The accessible environment can be no farther downgradient than the southern edge of the Nevada Test Site (NTS), or about 18 kilometers south of the repository (see the Point of Compliance discussion in the Ground-water Protection Standards section below for more details). Overall, it appears that an individual could reside anywhere downgradient from about five kilometers to 30 or more kilometers from the repository. However, the ability of an individual to reside at any particular point is dependent upon that person's purpose and resources since the ground water is deeper near the proposed repository (about 300 meters in depth) and decreases in depth with distance from the repository until there are surface discharges 30 to 40 kilometers away. The EPA believes that the rougher terrain and expense of recovering water significantly north of Lathrop Wells would discourage settlement by individuals, particularly since water is more easily accessed just a few kilometers farther south. Similarly, EPA found that commercial agriculture is unlikely north of Lathrop Wells because of the cost of water recovery, but that it would be reasonable to assume that an RMEI could live near Lathrop Wells and recover some water for domestic purposes. The EPA also believes that an individual living in this location would be among the most highly exposed individuals even though water closer to the repository would likely contain higher concentrations of radionuclides. This is counterintuitive until you remember that EPA believes that individuals would not live closer because of the cost and physical/technical difficulty of recovering that water.

Ground-water Protection Standards

Level of protection. Water which flows under Yucca Mountain is being used for drinking water by members of the public starting as close as 20 kilometers south of the proposed repository. Since ground water is particularly valuable in this desert setting and is the sole source of water south of Yucca Mountain, EPA believes that it should be separately protected. The overall goal is to prevent adverse effects upon human health and the environment by preventing contamination rather than relying upon later mitigation. The level of protection is provided in Table I. This approach provides the same protection regarding Yucca Mountain that exists elsewhere in the country for other waste disposal projects. The time frame for these standards is 10,000 years of undisturbed performance, i.e., the repository is not affected by human intrusion or unlikely features, events, or processes (FEPs).

Table I. Limits on Radionuclides in the Representative Volume

Radionuclide or type of radiation emitted	Limit	Is natural background included?
Combined radium-226 and radium-228	5 picocuries per liter	Yes
Gross alpha activity (including radium-226 but excluding radon and uranium)	15 picocuries per liter	Yes
Combined beta and photon emitting radionuclides	40 microsieverts (4 millirem) per year to the whole body or any organ	No

Representative volume. The EPA also proposed the concept of a representative volume of ground water. This is the volume of ground water in which the concentrations of radionuclides will be calculated. The intent is to provide a basis that is conservative, but reasonably implementable. In other words, EPA believed that it is unreasonable to require projections of concentrations in small volumes, for example, a few gallons of water in a fracture. On the other extreme, it is neither reasonable nor conservative to assume that all of the water in an entire hydrologic sub-basin would be involved.

The EPA considered four different volumes (the metric volumes listed are approximate) before choosing 3,714,000,000 liters (3,000 acre-feet). The smallest volume was 12,380,000 liters (10 acre-feet). This is the estimated annual volume of water used by a community of 25 people for domestic purposes or a non-farming family of four with a garden. It is also the lower bound for the amount of water which would be used in a public water supply (which is defined as a system serving at least 25 people). The next largest volume considered was 148,560,000 liters (120 acre-feet). The basis of this volume is a community of 150 people. This population was intended to reflect the estimated population increase over the next 20 years around Lathrop Wells. It was also assumed that this community would likely use water for more than just domestic purposes, such as light industrial or tourist use. The third volume considered was 1,591,023,000 liters (1,285 acre-feet). This volume is based upon the average size of an alfalfa farm in Amargosa Valley, Nevada, i.e., about 103 hectares (255 acres). The estimated annual irrigation rate is about 6,190,000 liters (5 acre-feet) per acre. Multiplying the two values yields 1,578,450,000 liters (1,275 acre-feet) per year. An extra 12,380,000 liters (10 acre-feet) per year is added for domestic use of 25 people in the community. And, finally, the Agency considered 4,952,000,000 liters (4,000 acre-feet) per year. This is representative of the estimated perennial yield of the Jackass Flats hydrologic sub-basin, i.e., the amount of water that could be removed from the sub-basin without significantly decreasing the yield and quality of water in the future.

The Agency chose 3,714,000,000 liters (3,000 acre-feet) per year because it was deemed to be a cautious, but reasonable, value which represents the current and currently projected types of water use at Lathrop Wells/Amargosa Valley. It is based upon the estimated annual volume of water used by two average-size (for southern Amargosa Valley) alfalfa farms (3,160,000,000 liters or 2,550 acre feet per year), the planned commercial/industrial use near Lathrop Wells (124,000,000 liters or 100 acre-feet per year), and individual/municipal water use for a small community consistent with the near-future growth projections in the area (149,000,000 liters or 120 acre-feet per year). This sums to an annual use of 3,430,000,000 liters (2,770 acre-feet). To account for uncertainty in these projections, another 285,000,000 liters (230 acre-feet) per year were added to arrive at 3,714,000,000 liters (3,000 acre-feet).

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To calculate the concentrations of radionuclides in the representative volume, EPA proposed two approaches, either of which may be used for compliance determination. The first approach is termed the "well-capture zone." In this approach, the dimensions of the representative volume are based upon a well that is pumping an annual volume equal to the representative volume. The dimensions of the well-capture zone are determined by the pumping rate in combination with aquifer characteristics such as hydraulic conductivity and gradient, and the length of the screened interval of the well. The Department of Energy (DOE) must assume that the well has characteristics consistent with public water supply wells in Amargosa Valley and that the screened interval of the well is centered in the highest concentration in the contamination plume. The second approach is termed the "slice of the plume." This approach is based upon a cross-section of the plume of contamination with sufficient thickness parallel to the prevalent flow of the plume of contamination that it contains the representative volume. The DOE and NRC must determine where the edge of the plume of contamination is, for example, where the concentration falls to 0.1% of the highest concentration. Finally, the "slice" must be perpendicular to the prevalent flow of the aquifer.

Point of compliance. The EPA proposed four potential points of compliance. They ranged in a downgradient limit on distance from five kilometers to about 30 kilometers from the repository. There were two concepts for the points of compliance. First was the controlled area. This concept is used in 40 CFR Part 191. A controlled area is an area, and its underlying geology, in which the ground water standards would not apply. This means that the standards must be met anywhere outside of the area. Compliance is generally determined at the boundary of the controlled area. The second approach is to name a specific point based upon the understanding of the ground water flow and economic and land use factors in the area. This approach necessitates a contingency provision in case the ground water flow or other factors are found not to meet the underlying understanding, with the result that the highest concentration is found somewhere besides the specified point.

The first alternative was a controlled area. It would be defined the same as in 40 CFR Part 191, i.e., the boundary of the area could be no farther than five kilometers from the waste and the area could not exceed 100 square kilometers. This is the same requirement under which the WIPP disposal system was certified.

The second alternative was a point location. That point would be at Lathrop Wells (about 20 kilometers from the waste). The depth to ground water in this location is about 110 meters.

The third alternative was, again, a point that would be determined by DOE and NRC within a specified area about 30 kilometers south of the emplaced waste. This area encompasses a large part of the agricultural area in southern Amargosa Valley. The depth to ground water in this area is roughly 20 to 40 meters.

In case the ground water does not flow in the direction which is now thought, for the second and third alternatives, a new point of compliance must be established at the same distance from the emplaced waste as the original point but centered over the highest concentration of radionuclides in the aquifer.

The fourth and final alternative was a controlled area. This could be considered a combination of two controlled areas. The first would be limited to a distance of five kilometers from the emplaced waste. The second would be the current boundary of the Nevada Test Site. Where these two areas overlap, the Nevada Test Site boundary would be the boundary to be used. If the ground water flows southward from

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the waste (as currently thought) and DOE and NRC used the southern boundary of the Nevada Test Site as the southern limit of the controlled area, the downgradient edge of the controlled area would be about 18 kilometers from the emplaced waste.

The Agency decided to use a controlled area that is similar to the fourth alternative. The controlled area must: (1) be identified by passive institutional controls; (2) encompass no more than 300 square kilometers and (2) extend no farther south than 36° 40' 22.391" north latitude (the southernmost edge of the Nevada Test Site), in the predominant direction of ground water flow. The compliance point is then the point in the accessible environment (anywhere outside of the controlled area) where the highest radionuclide concentration is projected to occur during the compliance period (10,000 years).

As mentioned above, the size of the controlled area may not exceed 300 km². That limit was derived by combining the concept of the controlled area as used in 40 CFR Part 191 and the requirement for a site-specific standard for Yucca Mountain. If fully employed by DOE, and based upon current repository design, the controlled area could extend approximately 18 km in the direction of ground water flow (presently believed to be in a southerly direction) and extend no more than five km from the repository footprint in any other direction. Allowing for a nominal repository footprint of a few square kilometers, this results in a rectangle with approximate dimensions of 12 km in an east-west direction and 25 km in a north-south direction, or approximately 300 km². The DOE may define the size and shape of the controlled area, but the boundaries cannot extend farther south than latitude 36° 40' 22.391"North in the direction of ground water flow and five km in any other direction.

Human-intrusion Standard

There were two alternatives proposed for the human-intrusion standard. They both limit the annual CEDE to 150 μ Sv. However, the first alternative limits the consideration to the first 10,000 years after disposal. The second alternative recognized that an intrusion might not be able to occur prior to 10,000 years. Therefore, in addition to the dose limit for the first 10,000 years, there is a requirement that the results of the analysis and its bases be placed in the Yucca Mountain environmental impact statement as an indicator of long-term performance following the intrusion.

The Agency decided to establish two different ways for DOE to proceed depending upon the projected time of the intrusion. If waste package penetration is projected to occur 10,000 years or sooner after disposal, DOE must demonstrate that there is a reasonable expectation that the dose limit will be met and, if exposures of the RMEI will occur beyond 10,000 years after disposal, the results of the analyses and their bases must be placed into the Yucca Mountain environmental impact statement. However, if the intrusion is projected to occur after 10,000 years, there is no quantitative dose limit, but the results of the analyses and their bases must be placed into the Yucca Mountain environmental impact statement.

One of the issues that Congress asked NAS to address was whether active institutional controls could effectively stop human intrusion into the repository. The NAS found that it could not. The NAS recommended that EPA assume that an intrusion will occur at Yucca Mountain (rather than using a probabilistic approach) and establish an appropriate scenario for DOE to analyze. They also recommended that EPA establish a standard as a test for the resiliency of the repository and set it at the same level as the individual-protection standard.

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The human-intrusion scenario that EPA chose specifies the basic parameters values for the diameter and other characteristics of the borehole. The DOE is then to assess the dose received by the RMEI as a result of only the releases which travel through the borehole, without consideration of any unlikely FEPs occurring. The scenario is a single intrusion as a result of exploratory drilling for ground water. The DOE must assume that the intruders drill a borehole directly through a degraded waste package into the uppermost aquifer underlying the Yucca Mountain repository using common techniques and practices that are currently employed in exploratory drilling for ground water in the region surrounding Yucca Mountain. Further, it cannot be assumed that careful sealing of the borehole occurs, but rather that natural degradation processes gradually modify the borehole. The standard also requires that the human-intrusion analysis use the same methods and RMEI characteristics as those required for the individual-protection standard, with two exceptions. The first exception is that the human-intrusion analysis would exclude unlikely FEPs. The second exception is that the analysis would address only releases moving through the borehole.

The timing of the intrusion is to be established by NRC based upon the earliest time that current technology and practices could lead to waste package penetration without the drillers noticing it. However, it must not occur sooner than the cessation of active institutional controls. The Agency's information about drilling and experiences of drillers indicates that special efforts, such as changing to a specialized drill bit, likely would be necessary to penetrate intact, non-degraded waste packages of the type DOE plans to use. Further, EPA believes that the time frame for the drilling intrusion should be within the period that a small percentage of the waste packages have failed but before significant migration of radionuclides from the engineered barrier system has occurred because that would be about the earliest time that a driller would not recognize an impact with a waste package.

OTHER CONSIDERATIONS

Lower limit on processes and events to be considered. In 40 CFR Part 191, there is a lower limit on the probability of events and processes that need to be considered in the performance assessment. That provision is that the events and processes which have a probability of less than 1 in 10,000 of occurring within 10,000 years after disposal did not need to be included in the analyses. The Agency decided to apply that same limit to the Yucca Mountain performance analyses.

Underground injection. This issue was first brought to EPA's attention in the lawsuit challenging the original (i.e., 1985) 40 CFR Part 191 (7). In remanding the disposal standards to EPA, the court found that a geologic repository might be a form of underground injection. The EPA later issued amendments to the disposal standards in 40 CFR Part 191 in response to the court's remand (6). In the preamble to the amendments, EPA concluded, based upon a review of the Safe Drinking Water Act (8), its legislative history, and the regulations governing the underground injection control program, that disposal of containerized radioactive waste in geologic repositories does not constitute underground injection. The result for the Yucca Mountain disposal system is the continuation of the previous decision, i.e., the Agency does not believe that the disposal of containerized radioactive waste in geologic repositories is underground injection for the purposes of the SDWA (8).

Assurance requirements. In 40 CFR Part 191, EPA included several qualitative principles which were intended to supplement the protection afforded by the quantitative standards because of the inherent uncertainty in the required long-term projection of disposal system performance. Those requirements covered the need for passive and active institutional controls, monitoring, the use of multiple barriers, the need to be able to locate and remove the waste after disposal, and the need to avoid

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areas with natural resources, unless the advantages of the site outweighed the potential for the increased probability of human intrusion. These provisions were not proposed for Yucca Mountain, however, EPA did request comments on including such requirements.

The Agency decided to not include assurance requirements in 40 CFR Part 197. This decision was based upon public comments which mostly said that it was redundant with NRC's 10 CFR Part 63 and the provisions made for NRC regarding 40 CFR Part 191. Those provisions are that the assurance requirements in 40 CFR Part 191. However, they do not apply to facilities that the NRC regulates, based upon the understanding that NRC would include them in its licensing regulations in 10 CFR Part 60. The NRC is the licensing agency for Yucca Mountain; therefore, at first glance it appears that requiring assurance requirements at Yucca Mountain would be inconsistent with our approach in 40 CFR Part 191 and, therefore, should not even be considered. However, the EnPA mandates that EPA set site-specific standards for Yucca Mountain, so these provisions were once again considered. However, EPA decided that it was unnecessary to include similar requirements in 40 CFR Part 197 since NRC's proposed licensing criteria (see 10 CFR §§ 63.102, 63.111, and 63.113; 64 FR 8640, 8674-8677, February 22, 1999) contained requirements similar to the assurance requirements in 40 CFR Part 191 for multiple barriers, institutional controls, monitoring, and the retrievability of waste from Yucca Mountain,

Expert elicitation. The EPA also considered setting guidelines for the use of expert elicitation, in concert with performance assessments, and solicited comments upon doing so. The provisions considered were: (1) the NRC needs to consider the source and use of the information; (2) to the extent possible, experts with appropriate expertise and independence from the DOE will be chosen for the panel; and (3) DOE should present information to the panel in a public meeting with an opportunity for other qualified experts to present information, also. The EPA would also allow NRC to use the results of expert elicitations which were completed prior to the finalization of 40 CFR Part 197. The Agency decided to leave the specification of the use of expert elicitation to NRC and DOE. The Agency stated that it believes that NRC and DOE "are sufficiently sensitive to public opinion...to avoid the appearance of secrecy or targeted polling of experts to obtain the specific outcome." (1)

PUBLIC PARTICIPATION AND CURRENT STATUS

The EPA published the proposed standards in the 27 August 1999 *Federal Register* (9). A public comment period was open from then until November 26, 1999. Public hearings were held in Washington, D.C. on 13 October 1999; Amargosa Valley, Nevada on 19 October 1999; Las Vegas, Nevada on 20-21 October 1999; and Kansas City, Missouri on 27 October 1999. Approximately 800 comments were received.

On 13 June 2001, the Agency published its final Yucca Mountain standards (1). The Agency has also published its response-to-comments document and the final versions of its background information document, which provides the technical bases for the standards, and its economic impact analysis of the standards upon the disposal system and the program supporting it.

The Yucca Mountain standards and supporting documents may be accessed on the EPA World Wide Web site at <http://www.epa.gov/radiation/yucca>. There is also a toll-free telephone information line at 1-800-331-9477.

REFERENCES

1. *Environmental Radiation Protection Standards for Yucca Mountain, Nevada: Final Rule, Federal Register*, Volume 66, No. 114, pp. 32073-32135, 13 June 2001.
2. *Energy Policy Act of 1992*, Public Law 102-486, 106 Stat. 2921.
3. *Environmental Radiation Protection Standards for the Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Waste*, Part 191, Title 40, Code of Federal Regulations.
4. *Technical Bases for Yucca Mountain Standards*, National Research Council, National Academy Press, Washington, DC, 1995.
5. House of Representatives, Report 1018 at p. 391, 1992.
6. *Amendments to the Environmental Radiation Protection Standards for the Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Waste, Federal Register*, Volume 58, No. 242, pp. 66397-66416, December 20, 1993.
7. NRDC v. EPA, 824.F.2d at 1270-71.
8. *Safe Drinking Water Act*, 42, U.S. Code 300g-1.11, *Federal Register*, Volume 64, No. 166, pp. 46976-47016, August 27, 1999.
9. *Environmental Radiation Protection Standards for Yucca Mountain, Nevada: Proposed Rule, Federal Register*, Volume 64, No. 64, pp. 46975-47016, 27 August 1999.