NRC REGULATIONS FOR DISPOSAL OF HIGH-LEVEL RADIOACTIVE WASTES IN GEOLOGIC REPOSITORIES: TECHNICAL CRITERIA

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ABSTRACT

The Nuclear Regulatory Commission is promulgating regulations specifying the technical criteria for disposal of high-level radioactive wastes in geologic repositories. The proposed rule was published for public comment in July 1981. Public comments have been received and considered by the Commission staff. The Commission will soon approve and publish a revised final rule. While the final rule being considered by the Commission is fundamentally the same as the proposed rule, provisions have been added to permit flexibility in the application of numerical criteria, some detailed design requirements have been deleted, and other changes have been made in response to comments. The rule is consistent with the recently enacted Nuclear Waste Policy Act of 1982.

Introduction

Three Federal agencies have major roles in the national program for disposal of high-level radioactive wastes. The EPA is responsible for developing a generally applicable enviornmental standard which will serve as the overall performance objective for releases from normal operations involved in high-level waste disposal. The NRC is responsible for developing and issuing regulations which cover all aspects of high-level waste disposal, and which will implement the EPA standard. The NRC will then consider license applications for HLW disposal. DOE is responsible for siting, designing, constructing and operating a waste disposal facility.

The NRC is currently promulgating a regulation for geologic disposal of high-level waste (HLW). The regulation has been developed in two sections, licensing procedures and technical criteria. NRC published the final version of the licensing procedures in February, 1981. The licensing procedures specify a multi-step licensing procedure consisting of: (1) site characterization, (2) construction authorization, (3) license to receive waste, (4) permanent closure, and (5) termination of license.

On July 8, 1981, the Commission published the proposed technical portion of the rule for public comment. The staff has considered the comments received and has prepared a revised final rule which is under consideration by the Commission. Two events have occurred recently which are relevant to the rule. First, Congress has enacted the Nuclear Waste Policy Act of 1982 which provides legislative direction for the program for disposing of radioactive wastes. Second, the EPA has issued their proposed rule on waste management. Among other things, the act requires that NRC's technical rule be promulgated by January 1, 1984. It also expressly allows NRC to promulgate its rule prior to the issuance of EPA's rule. We will meet this schedule requirement as the Commission is in the final stages of review and approval for issuance of the regulation.

This paper will discuss several significant issues which the staff addressed in preparing the final rule. These issues are: (1) a single overall performance standard vs. minimum performance standards for each of the major elements of the geologic repository; (2) the need for, and appropriate duration of, a waste retrievability period; (3) the level of detail to be used in the criteria, particularly with respect to design and construction requirements; (4) the desirability of population-related siting criteria; (5) the application of an ALARA (as low as reasonably achievable) principle to the performance requirements dealing with containment and control of releases; (6) inclusion of transuranic waste (TRU) criteria; (7) criteria for disposal in the unsaturated zone; and (8) the definition of the accessible environment. Comments will be made concerning the effects of the Waste Policy Act and the proposed EPA regulation.

Single vs. Multiple Performance Standards

The final rule being considered by the Commission specifies numerical performance standards for three major elements of a repository. It requires that the containment of HLW within the waste packages be substantially complete for a period to be determined by the Commission which shall be between 300 and 1,000 years. It requires that the release rate of any radionuclide from the engineered barrier system following the containment period shall not exceed one part in 100,000 per year of the inventory of that radionuclide calculated to be present at 1,000 years following permanent closure, or such other fraction of the inventory as may be approved or specified by the Commission. It also requires that the groundwater travel time from the disturbed zone to the accessible environment shall be at least 1,000 years or such other travel time as may be approved or specified by the Commission.

Initially the Commission identified two potential approaches to keeping releases of radioactive material to the general environment at sufficiently low levels. One was to prescribe minimum performance standards for each of the major elements of the geologic repository, in addition to prescribing the EPA standard as a single overall performance standard. As an alternative, we considered an approach that would specify the EPA standard as the sole measure of isolation performance.

There was general acceptance of the multiple barrier approach. However, the establishment of fixed

numerical values for performance was extensively criticized. The criticism took two forms. First, numerous commenters argued that until such time as an EPA standard is established, no logical connection can be demonstrated between the performance of the particular barriers and the overall system performance objective. The values specified by NRC, it was argued, had not been shown to be either necessary or sufficient to meet any particular standard. The second criticism was that the performance appropriate to a particular barrier is highly dependent upon design features and site characteristics and that values such as those proposed by the Commission could unduly restrict the applicant's flexibility - possibly imposing great additional expense without compensating protection of public health and safety.

These are both reasonably arguments. But, if we were simply to adopt the EPA standard as the sole measure of performance, the degree of confidence (depth in defense) necessary to deal with the inevitable uncertainties and to make the required licensing decisions would not be specified. To that end, it is appropriate to include reasonable generic requirements that, if satisfied, will contribute to meeting the standards even though exceptions may need to be made for some designs and locations.

Our approach has been to examine the values for particular barriers that would assist in arriving at the conclusion that the working draft EPA standard has been satisfied. The numerical criteria in the draft EPA standard have remained about the same for several years and have now been issued for public comment. In this way, we have demonstrated the logical connection between the overall system performance objective for anticipated processes and events and the performance of specific barriers.

While use of an assumed EPA standard provides a basis for specifying performance requirements for individual barriers, it does not deal with the concern about undue restrictions on the applicant's flexibility. Our response to this has not been to abandon the values altogether, but rather to allow them to be modified as the particular case warrants. Thus the applicant is required to comply with the specified values or such other values as the Commission "may approve or specify." Also, the waste package containment time is now specified as a to-be-determined period between 300 and 1,000 years instead of being specified as 1,000 years. Among the factors that the Commission might take into account in exercising this discretion are the radiation and heat generation rate of the waste, the characteristics of the host rock, and particular sources of uncertainty in predicting the performance of the geologic repository. Any variance between an actual EPA standard and that assumed could also be a basis for approving or specifying other values for radionuclide release rate, designed containment period, or pre-waste-emplacement groundwater travel time.

Our approach is consistent with the recent Nuclear Waste Policy Act of 1982 (hereafter referred to as the recent Act). This law requires that NRC's technical criteria provide for the use of a system of multiple barriers in the design of the repository.

Retrievability

A retrievability requirement is necessary because the decision to permanently close the repository will come some time after emplacement of the wastes. The only way to be able to consider information developed by testing during the lengthy emplacement period in a decision to close the repository is to require that retrievability be incorporated into the design of the repository.

The Commission solicited comment on the provisions of the proposed rule which would have required that the repository design permit retrieval of waste packages for a period of up to 110 years (30 years for emplacement, 50 years to confirm performance, 30 years to retrieve).

While the benefits of retaining the option of retrieval were recognized, the length of the proposed requirement, in the opinion of several commenters, was excessive. In their view, the Commission had given inadequate consideration to the additional costs of design, construction, and operations implied in the original proposal.

In the final rule being considered by the Commission, the requirement has been rephrased in functional terms, rather than in the inflexible way it was originally presented. The final rule specifies that the design shall keep open the option of waste retrieval throughout the period during which the wastes are being emplaced and, thereafter, until the completion of a performance confirmation program and Commission review of the information obtained from such a program. While we have provisionally specified that the design should allow retrieval to be undertaken at any time within 50 years after commencement of emplacement operations, this feature is explicitly subject to modification in the light of the planned emplacement schedule and confirmation program for the particular repository.

We have also clarified our prior intention that retrievability does not preclude earlier backfilling or permanent closure. A definition of "retrieval" has been added which indicates that the requirement of retrievability does not imply ready access to emplaced wastes at all times prior to permanent closure.

These requirements are consistent with those provisions of the recent Act which state that NRC's technical criteria shall include such restrictions on retrievability as the Commission deems appropriate.

Level of Detail

The proposed rule contained both general and detailed requirements, derived from the Commission's experience and practice in licensing other facilities, with respect to the design and construction of a repository.

The public response included arguments addressed both to the level of detail generally and to specific criteria which were deemed to be unduly restrictive.

It is appropriate to describe in functional terms, the principal features which should be incorporated into repository design - such as protection against dynamic effects of equipment failure, protection against fire and explosions, emergency capability, etc. Certain of these proposed criteria, however, such as those dealing with subsurface ventilation and shaft and borehole seals were too detailed and, in some cases, inappropriate. At this stage of development, emphasis should be placed on the objectives that must be met and not on the detailed ways that may be used in doing so. Thus,

the majority of the more detailed design requirements have been deleted from the final rule now under consideration by the Commission.

Population-Related Siting Criteria

The proposed rule did not include any siting requirements which dealt directly with population density or proximity of population centers to a repository. The issue was addressed indirectly through consideration of resources in the geologic setting.

The commenters on this issue fell generally into two categories - those who endorsed the proposed approach and those who believed that population factors were important. The latter group addressed not only the repository's long-term isolation capability, but also the relevance of population considerations during the period when wastes are being received and emplaced. Population factors for the period when wastes are being received and emplaced will be considered on a case-by-case basis in the licensing process through evaluation of the adequacy of DOE's emergency plans.

Population distribution over the long term is immaterial if the geologic repository operates as anticipated. Population distribution could be of concern to the extent that it could increase the probability or the consequences of releases associated with unanticipated processes or events. It is difficult to relate the likelihood of releases to population factors. It is more realistic to reduce the probability of release by avoiding sites with significant resource potential and by using records and monuments to caution future generations against intrusion. Consequences of unanticipated releases would be greater if they should occur in densely populated areas. Nevertheless, it makes little sense to attempt to limit such consequences by means of a population-related siting criterion, since long-range demographic forecasts are inherently speculative.

In summary, we have found no health or safety reasons for a numerical population related siting criteria and thus have not included one in the regulation. We note, however, that considerations related to future human activities, particularly uses of groundwater, are an important source of uncertainty in assessing future performance of a geologic repository. We consider it a favorable condition, if these sources of uncertainty, which would be affected by a large nearby population, are not present at a particular site. Therefore, we have included in the final rule as a favorable condition, a low population density within the geologic setting and a controlled area that is remote from population centers.

ALARA

Another issue considered was whether an ALARA (as low as reasonably achievable) principle should be applied to the performance requirements dealing with containment and control of releases. Some commenters felt that ALARA should be applied to all licensed activities, and that no exception should be made for geologic repositories. Other commenters argued against incorporating ALARA, since the allowable releases under the EPA standard would already be so low as to eliminate any significant risk to public health and safety.

The EPA standard is expected to establish the permissible amounts of radioactivity in the general environment at such a low level that efforts to reduce releases further would have little, if any, demonstrable value. Thus, the ability of a repository to perform at levels superior to the EPA standard should not be at issue in licensing proceedings. The central issue with respect to the EPA standard is whether DOE's proposal, and the data presented in its support, will enable the Commission to determine with reasonable assurance that the established EPA standard will be met. A variety of design features, tests, or other measures may be required to be able to conclude with confidence that the EPA standard is met. The result may be the same as imposing similar requirements in the name of keeping releases as low as reasonably achievable.

The same kinds of balancing that would be undertaken in a ALARA determination may be appropriate. That is, if confidence in the performance of the repository is sensitive to a particular source of uncertainty, it will be necessary for the Commission to take into account both the significance of the factor involved and the costs of reducing or eliminating it.

In short, the long-term performance requirements should not be tied to an ALARA principle, and the rule remains as it was when proposed. The factors considered by an ALARA approach will be accommodated in connection with the treatment of uncertainties in the licensing process. We consider that our approach accomodates EPA's underlying concerns as articulated in its proposed standard, that appropriate measures are taken to assure confidence in complying with its numerical release limits.

Transuranic Waste (TRU)

The proposed rule included a definition of transuranic waste and performance objectives that would apply to the disposal of TRU in a licensed geologic repository. This was widely construed as a requirement that TRU must be disposed of in a repository. This was not the intention of the rule. The Commission was merely indicating what performance objectives would apply if TRU were disposed of in a repository.

If a facility is licensed, the Commission must consider the radiological hazards associated with whatever wastes may be emplaced. We attempted, in the proposed rule, to address the requirements for one such kind of waste - TRU. But we were too restrictive, in that our definition of TRU was too limited for present purposes and in that wastes other than HLW and TRU were not covered at all. For the final rule being considered by the Commission, we have concluded that the matter is best handled by eliminating all references to TRU and treating wastes other than HLW that might be placed in a geologic repository on a case-by-case basis.

Unsaturated Zone

The proposed rule addressed only disposal in saturated media with the possibility that additional or alternative criteria might need to be developed for regulating disposal in the unsaturated zone.

This approach was criticized on the basis that disposal in the unsaturated zone was a practical alternative, and that since the criteria were

generally applicable without regard to the possibility of saturation, their scope and applicability should not be overly restricted. We reviewed the criteria in the light of the comments and found that only minor revisions would be required to make the regulation applicable to the saturated zone. The Commission is planning to publish proposed amendments to the criteria that will apply to disposal in the unsaturated zone during the course of this year. For disposal in the saturated zone we will require both the partial and complete filling of available void spaces in the underground facility with groundwater be considered and analyzed in designing the engineered barrier system.

Accessible Environment/Controlled Area

The isolation capability of a geologic repository is evaluated at a boundary which we have referred to as the "accessible environment." Under the proposed rule, this was defined as "portions of the environment directly in contact with or readily available for use by human beings." Several commenters criticized this definition as being too vague; further, the definition failed to assure that the isolation capability of the rock surrounding the underground facility would be given appropriate weight in licensing reviews.

We agree with this criticism and have revised the definition in several respects - most importantly, by excluding from the accessible environment that portion of the lithosphere that is inside what we are calling, in the final rule, a "controlled area." This is an area marked with monuments designed to caution future generations against subsurface penetrations. The size and shape of the controlled area will depend upon the characteristics of the particular facility, but it must be small enough to justify confidence that the monuments will effectively discourage subsurface disturbances. Therefore, we have limited the size of the controlled area so that it extends no more than 10 kilometers from the emplaced waste. This is consistent with EPA's proposed standard.

In summary, we expect the Commission to act shortly to approve publication of the final technical criteria. When published, we consider that the criteria will fully satisfy the requirements of the Nuclear Waste Policy Act for NRC to promulgate technical criteria for disposal of high level wastes by January 1, 1984.