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FEB 29 1984

Dr. Donald L. Vieth
Director
Waste Management Project Office
Department of Energy
Nevada Operation Office
P.O. Box 14100
Las Vegas, NV 89114

Dear Dr. Vieth:

Enclosed for your information is a copy of the proposed amendment to the technical criteria of 10 CFR Part 60 that would make them applicable to geologic repositories in the unsaturated zone. Also enclosed are ten copies of the draft NRC report entitled, "Disposal of High-Level Radiactive Waste in the unsaturated zone: Technical Considerations," (NUREG-1046) which provides the technical basis for the proposed amendment. If you have any comments on the enclosed documents you may send them to:

Attn: Docketing and Service Branch
Secretary of the Commission
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Sincerely,

"ORIGINAL SIGNED BY"

Seth Coplan
Repository Projects Branch
Division of Waste Management

Enclosures:
1. Proposed Amendment to 10 CFR Part 60 regarding unsaturated zone disposal
2. NUREG-1046

10/22/84/158

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Proposed Rules

Federal Register
Vol. 49, No. 33
Thursday, February 16, 1984

This section of the FEDERAL REGISTER contains notices to the public of the proposed issuance of rules and regulations. The purpose of these notices is to give interested persons an opportunity to participate in the rule making prior to the adoption of the final rules.

NUCLEAR REGULATORY COMMISSION

10 CFR Part 60

Disposal of High-Level Radioactive Wastes in the Unsaturated Zone

AGENCY: Nuclear Regulatory Commission.

ACTION: Proposed rule.

SUMMARY: The Nuclear Regulatory Commission (NRC) is considering amending its rules on the disposal of high-level radioactive wastes (HLW) in geologic repositories so that the technical criteria for geologic disposal in the saturated zone may be equally applicable to disposal within the unsaturated zone. The amendments are being proposed in response to public comments on the proposed technical criteria for geologic disposal in the saturated zone. Final technical criteria adopted by the Commission for disposal of HLW in the saturated zone were published in the Federal Register on June 21, 1983.

DATES: Comment period expires April 16, 1984. Comments received after this date will be considered if it is practical to do so, but assurance of consideration cannot be given except as to comments received on or before this date.

ADDRESSES: Send comments or suggestions to the Secretary of the Commission, U.S. Nuclear Regulatory Commission, Washington, DC 20555, Attention: Docketing and Service Branch. Copies of comments received may be examined at the NRC Public Document Room, 1717 H Street NW., Washington, DC 20555.

FOR FURTHER INFORMATION CONTACT: Dr. Colleen Ostrowski, Office of Nuclear Regulatory Research, U.S. Nuclear Regulatory Commission, Washington, DC, 20555, telephone (301) 427–4343.

SUPPLEMENTARY INFORMATION:

Background

On February 25, 1981 the Nuclear Regulatory Commission (NRC) published a rule that established procedures for licensing the disposal of HLW in geologic repositories (46 FR 13971). NRC published proposed technical criteria to be used in the evaluation of license applications under those procedures on July 8, 1981 (46 FR 35280). In response to solicitation for public comments on the proposed technical criteria NRC received 93 comment letters. The Commission considered all public comments in developing the final technical criteria which were published on June 21, 1983 (48 FR 28194).

Several commenters on the proposed rule, including the U.S. Department of Energy (DOE), the U.S. Department of the Interior, and separately the U.S. Geological Survey (USGS), took issue with a statement made by the Commission at 46 FR 35281 which explained that the proposed technical criteria were developed specifically for disposal in saturated geologic media because DOE plans at that time called for HLW disposal at sufficient depth to be situated in the hydrogeologic region termed the saturated zone. The commenters considered disposal in the unsaturated zone [1] to be a viable alternative, and noted that since the technical criteria were generally applicable without regard to the possibility of saturation, their scope and applicability should not be unduly restricted. DOE, in its comments on this issue, suggested that since opportunities may arise for exploratory studies in unsaturated geologic media, the Commission should reexamine the rule and make whatever changes are necessary to ensure that the rule will apply to all geologic media. The U.S. Department of the Interior urged that the rule be modified because, under appropriate conditions, the unsaturated zone could provide one more natural barrier to the movement of radionuclides from the geologic repository to the water table.

The Commission has determined that disposal of HLW within the unsaturated zone is a realistic alternative to disposal within the saturated zone, provided that the site and the geologic repository design are carefully selected, and are capable of meeting the performance objectives of 10 CFR Part 60. In reaching this determination, the Commission has examined the arguments presented by the public commenters as well as the analysis of the principal issues associated with unsaturated zone disposal described in the NRC staff technical support document (draft NREG–1046) prepared in conjunction with the proposed amendments. This document identifies the positive aspects and possible concerns associated with disposal in the unsaturated zone and explains why the Commission has developed the following proposed amendments. Other issues which were discussed by public commenters but which did not result in proposed changes to the final rule are also addressed in the technical support document. Upon publication, a copy of draft NUREG–1046 entitled "Disposal of High-Level Radioactive Wastes in the Unsaturated Zone: Technical Considerations" will be placed in the Public Document Room, 1717 H Street NW., Washington, DC 20555. Since this document is available to the general public,[2] only a summary discussion of these issues is presented below.

Issues Examined by the Commission

The depth to the regional water table varies throughout the United States. Potential geologic repository sites within unsaturated geologic media may be identified in arid to semi-arid geographic regions of the country because such regions generally are characterized by a deep regional water table and hence, a relatively thick unsaturated zone. The unsaturated zone in certain arid regions of the United States has been documented as extending to depths of approximately 600 meters below the ground surface. In contrast, the unsaturated zone in humid regions is often only a few meters thick, or entirely non-existent.

Perhaps the most positive aspect associated with disposal of HLW within the unsaturated zone is that the HLW would be emplaced in a relatively dry (i.e., low moisture content) geologic

[1] The definition of the term "unsaturated zone" is derived from U.S. Geological Survey Water Supply Paper 1988 (Washington, DC, 1972).

[2] Free single copies of Draft NUREG–1046 may be requested for public comment by writing to the Publication Services Section, Division of Technical Information and Document Control, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555.

medium. The Commission considers the relatively low moisture content of unsaturated sediment and rock as a positive aspect of HLW disposal in the unsaturated zone because the lack of available moisture could reduce leaching of the waste packages and thus, significantly reduce the likelihood of radionuclide transport by groundwater [8] migration. Further, it is generally recognized that vertical groundwater flux in the unsaturated zone is very small. A credible pathway for the migration of water soluble contaminants from a geologic repository located in the unsaturated zone to the accessible environment would probably be vertically downward to the underlying regional water table, and subsequently through the saturated groundwater units to the regional discharge points.

The Commission has reviewed several other issues that are of general concern to disposal of HLW in geologic repositories, regardless of the hydrogeologic zone involved. Such issues include the effects of climatic changes on the regional hydrologic systems, the potential for human intrusion into the geologic repository, and the effects of geologic processes (e.g., tectonism) on the structural stability of the geologic repository. The Commission does not believe that any of these issues would negate the generic concept of HLW disposal within the unsaturated zone. However, since the relative importance of these issues will depend upon natural conditions existing at a particular site, each must be evaluated on a site-by-site basis.

Vapor transport of contaminants has been identified by the Commission's staff as a potential concern associated with HLW disposal in the unsaturated zone. In unsaturated geologic media, water is transported in both liquid and vapor phases. The relative contribution of transport via liquid and vapor phases, and their direction of movement with respect to a geologic repository will have a direct influence on the containment of contaminants. Vapor transport, particularly when a thermal gradient is imposed may provide a possible mechanism for radionuclide migration from a geologic repository. However, positive aspects associated with vapor transport in the unsaturated zone may also be discerned since water vapor formed near the geologic repository may flow through air-filled openings and partially drained fractures, resulting in a drying of the surrounding host rock. This drying zone may extend hundreds of meters from the geologic repository, and thus may inhibit the movement of soluble contaminants. Therefore, the Commission views vapor transport as another issue which must be evaluated on a case-by-case basis to determine its effects (whether favorable or potentially adverse) on a particular site.

[8] The Commission recognizes that the term "groundwater" is generally applied by the technical community to water which occurs beneath the water table (i.e., phreatic water) while the term "vadose water" is more accurately applied to the soil water, gravitational water and capillary water which occur in the unsaturated zone (zone of aeration, vadose zone). However, for the sake of simplicity, groundwater is defined in the proposed amendments as all water which occurs below the Earth's surface.

Other Comments Considered by NRC

The Commission has reviewed the following six issues related to HLW disposal within the unsaturated zone which were addressed in the public comments on the proposed rule, as well as in a recent USGS publication,[4] and has determined that the final rule (48 FR 28194) accommodates these concerns. More detailed discussion of these issues is presented in draft NUREG–1046.

Minimum 300-Meters Depth for Waste Emplacement

One commenter on the proposed 10 CFR Part 60 technical criteria who advocated applying the rule equally to the saturated and unsaturated zones considered it necessary to change the siting criterion which sets a minimum depth of 300 meters for waste emplacement. However, the commenter incorrectly identified this provision (see § 60.122(b)) as a requirement, rather than as a favorable condition. The Commission notes that favorable conditions are those which may enhance waste isolation potential. Hence, a minimum depth of 300 meters for waste emplacement is considered a favorable condition because the deeper the HLW is emplaced, the less likely it is to be disturbed. Viewed in that light this depth is a favorable condition, irrespective of hydrogeologic zone. Since the unsaturated zone may extend to depths of up to 600 meters, the Commission considers this favorable condition to be a realistic one for both the saturated and unsaturated zones. Therefore, this provision of the rule has not been modified.

Requirements for Sealing Shafts and Boreholes

In USGS Circular 903 the view was expressed that, with respect to a geologic repository within the unsaturated zone, sealing shafts and boreholes tightly to inhibit water movement may be undesirable. The reasoning behind this view is that although shafts and boreholes need to be carefully sealed in the saturated zone so that they do not become future conduits for radionuclide migration, they may have an entirely different relation to an unsaturated zone repository. Shafts and boreholes would increase the amount of water moving through a geologic repository located within the unsaturated zone only if they diverted a significant amount of runoff to the subsurface.

The Commission has reviewed both the arguments of the USGS and the provisions of the final rule relating to the design of seals for shafts and boreholes (§ 60.134). The provisions of § 60.134 appear to be generally applicable to seals of shafts and boreholes in both hydrogeologic zones. Therefore, the Commission does not consider it necessary to modify § 60.134 at this time.

Backfill Requirements

Another issue which has been identified both in public comments on the proposed technical criteria and in USGS Circular 903 pertains to the necessity of backfill in a geologic repository located within the unsaturated zone. The USGS expressed the view that the role of backfill in the unsaturated zone would be the opposite of that in the saturated zone. Backfill material that would inhibit the flow of water to, and radionuclide migration from, the waste packages may be highly desirable in the saturated zone. In the unsaturated zone, however, the designers of a geologic repository may wish to promote drainage. The opinion has been expressed that within the unsaturated zone backfill should allow groundwater to drain readily, rather than serve as a barrier to drainage. It was suggested in USGS Circular 903 that if backfill is necessary to perserve structural or waste package integrity, a relatively permeable material (e.g., cobble-sized rock) could be used to permit continued drainage.

The final rule published by the Commission on June 21, 1983 contained only the general functional statement that the engineered barrier system (including backfill) be designed to assist the geologic setting in meeting the performance objectives for the period following permanent closure (§ 60.133(h), 48 FR 28227). This provision, as promulgated, should be

[4] Roseboom, E. H. Jr., 1983. Disposal of High-Level Nuclear Waste Above the Water Table in Arid Regions. U.S. Geological Survey Circular 903, Washington, DC, p. 21.

responsive to the concerns discussed above.

Waste Package Design Criteria

As defined at § 60.2, the term "waste package" means "the waste form and any containers, shielding, packing and other absorbent materials immediately surrounding an individual waste container" (48 FR 28219). The point has been raised that because of the different nature of the emplacement environment designs of waste package components for the saturated and unsaturated zones may be quite different. The Commission recognizes that several characteristics of the emplacement environment (e.g., oxidation conditions, lithostatic pressure, geochemistry, contact with groundwater, etc.) may vary significantly between the two hydrogeologic zones. This variation of emplacement environment may necessitate that DOE consider alternative designs for waste packages (including waste form, canisters, overpack, etc.) for geologic disposal in the unsaturated zone. The Commission has reviewed the performance objectives which pertain to the waste package (§ 60.111 and § 60.113), and believes that the provisions, as currently written, are equally applicable to waste packages emplaced within either the saturated or unsaturated zone. Similarly, the specific design criteria for the waste package and its components (§ 60.135, 48 FR 28227) have been determined to be generally applicable to both zones. Therefore, no changes have been made to the provisions of §§ 60.111, 60.113, or 60.135.

Ventilation

The issue of restricting the number of ventilation shafts associated with a geologic repository was addressed in USGS Circular 903. In the case of the saturated zone, the number of ventilation shafts may be kept at a minimum since the shafts could constitute potential pathways to the accessible environment. In USGS Circular 903 it is stated that in the case of the unsaturated zone additional shafts for ventilation would not compromise the geologic repository's performance because sealing shafts in the unsaturated zone is much simpler and of less consequence than in the saturated zone. Several potential benefits were cited by the USGS to support this view—e.g., reducing the problem of thermal load in the early phases of the geologic repository, removal of any water vapor during the operational period, drawing large amounts of desert air through the geologic repository to promote even drier conditions and increasing worker safety by providing alternative sources of ventilation and escape routes.

The number of ventilation shafts included in any geologic repository will be decided by the designer—DOE. No provision of 10 CFR Part 60 expressly limits the number of ventilation shafts that a geologic repository may contain. What is important is that the surface facility ventilation systems comply with the design critera in § 60.132(b) (48 FR 28226) and that the underground facility ventilation system be designed in accordance with § 60.133(g) (48 FR 28227). The Commission considers the design requirements for the ventilation systems set forth in §§ 60.132 and 60.133 to be applicable to both the saturated and unsaturated zones. As long as the ventilation system complies with provisions of §§ 60.111(a), 60.132, and 60.133 and does not compromise the integrity of the site to host a geologic repository, DOE will have broad flexibility in designing the system.

Exploratory Boreholes

Provisions relating to site characterization are set forth in the final rule at § 60.10 (48 FR 28219). Section 60.10(d)(2) requires that the number of exploratory boreholes and shafts be limited to the extent practical, consistent with obtaining the information needed for site characterization. The view was expressed in USGS Circular 903 that in the unsaturated zone, if the host rock already has a high vertical permeability, there is no reason to limit the number of drill holes. Thus, the USGS noted that if necessary, a proposed geologic repository could be explored like an ore body or coal bed, with drill holes every few hundred feet on a rectangular grid.

The Commission's view on the importance of not compromising the integrity of a site during the site characterization program of testing and exploration has been clearly stated at 44 FR 70409. However, if DOE should opt for a site exploration and characterization program which includes plans for drilling numerous boreholes then DOE would have the burden of showing the Commission that the ability of the site to isolate HLW has not been compromised during these activities.

Groundwater Travel Time in the Unsaturated Zone

The concept of groundwater travel time generally is applied in evaluations of saturated flow systems, where flow is continuous and temporal fluctuations in the potential of the systems are small. In contrast, water movement in the unsaturated zone is generally discontinuous and strongly dependent upon initial conditions (e.g., magnitude and spatial and temporal distribution recharge events) and the conductive properties of the partially saturated geologic media, which vary with moisture content. Reliable calculations and predictions of groundwater travel times and velocities require knowledge of these conditions and properties. Within the unsaturated zone the movement of a given volume of water over a given distance depends very strongly upon the nature of the recharge events. Additionally, the material properties (e.g., moisture characteristic curves, porosity, irreducible saturation, etc.) and the initial conditions (e.g., saturation, capillary pressure, matric potential) may be extremely difficult to measure on a representative scale for unsaturated porous and fractured geologic media.

For these reasons, calculations of pre-waste-emplacement groundwater travel time along the fastest path of likely radionuclide travel through the unsaturated zone may have large associated uncertainities, and may be of questionable value in estimating the capability of the geologic setting to isolate HLW from the accessible environment.

The new definition of the term "groundwater" which the Commission is proposing would have the effect of expanding the scope of the performance objectives set forth in § 60.113 to disposal in either the saturated or unsaturated zone. Similarly, the proposed amendment to the Siting Criteria (§ 60.122(b)(7)) would have the effect of making pre-waste-emplacement groundwater travel time along the fastest path of likely radionuclide travel from the disturbed zone to the accessible environment which substantially exceeds 1,000 years a favorable condition for HLW disposal within either the saturated or unsaturated zone.

The Commission's current thinking on this issue is that if DOE can demonstrate with reasonable assurance that travel time for groundwater movement through the unsaturated zone can be quantified, then DOE should be allowed to include such travel time when demonstrating compliance with § 60.113(a)(2). However, such calculations of groundwater travel times through the unsaturated zone could involve considerable uncertainty. Further, long groundwater travel time possibly may be inconsistent with the proposed amendment which identifies a host rock that provides for free drainage as a

favorable hydrogeologic condition for disposal of HLW within the unsaturated zone. It may be more appropriate for the Commission to specify another parameter upon which performance may be evaluated for a geologic setting in the unsaturated zone, or to utilize the approach set forth in § 60.113(b) which provides the Commission with the flexibility to specify variations in performance objectives on a case-by-case basis, as long as the overall system performance objective is satisifed. Therefore, to solicit input in these matters the Commission is particularly seeking public comment on the following questions:

1. How can groundwater travel time in the unsaturated zone be determined with reasonable assurance? Should the groundwater travel time performance objective be limited to groundwater movement within the saturated zone?

2. Does groundwater travel time represent an appropriate measure of performance for a site within the unsaturated zone, or would an alternative performance objective for the geologic setting, (e.g., maximum likely volumetric flow rate of groundwater through the geologic repository) be more appropriate?

Environmental Impact: Negative Declaration

Pursuant to Section 121(c) of the Nuclear Waste Policy Act of 1982, the promulgation of these criteria shall not require the preparation of an environmental impact statement under Section 102(2)(C) of the National Environmental Policy Act of 1969 or any environmental review under subparagraph (E) or (F) of Section 102(2) of such Act.

Paperwork Reduction Review

The proposed rule contains no new or amended recordkeeping, reporting or application requirements, or any other type of information collection requirements subject to the Paperwork Reduction Act (Pub. L. 96-511).

Regulatory Flexibility Act Certification

In accordance with the Regulatory Flexibility Act of 1980 (5 U.S.C. 605(b)), the Commission certifies that this rule, if adopted, will not have a significant economic impact on a substantial number of small entities. The only entity subject to regulation under this rule is the U.S. Department of Energy.

List of Subjects in 10 CFR Part 60

High-level waste, Nuclear power plants and reactors, Nuclear materials, Penalty, Reporting and recordkeeping requirements, Waste treatment and disposal.

Issuance

For the reasons set out in the preamble and under the authority of the Atomic Energy Act of 1954, as amended, the Energy Reorganization Act of 1974, as amended, the Nuclear Waste Policy Act of 1982, and 5 U.S.C. 553, the Nuclear Regulatory Commission is proposing the following amendments to 10 CFR Part 60.

PART 60—DISPOSAL OF HIGH-LEVEL RADIOACTIVE WASTES IN GEOLOGIC REPOSITORIES

Authority: Secs. 51, 53, 62, 63, 65, 81, 161, 182, 183, 68 Stat. 929, 930, 932, 933, 935, 948, 953, 954, as amended (42 U.S.C. 2071, 2073, 2092, 2093, 2095, 2111, 2201, 2232, 2233); secs. 202, 206, 88 Stat. 1244, 1246, (42 U.S.C. 5842, 5846); secs. 10 and 14, Pub. L. 95-601, 92 Stat. 2951 (42 U.S.C. 2021a and 5851); sec. 102, Pub. L. 91-190, 83 Stat. 853 (42 U.S.C. 4332); sec. 121, Pub. L. 97-425, 96 Stat. 2228 (42 U.S.C. 10141).

For the purposes of sec. 223, 68 Stat. 958, as amended (42 U.S.C. 2273), §§ 60.71 to 60.75 are issued under sec. 161o, 68 Stat. 950, as amended (42 U.S.C. 2201(o)).

1. Section 60.2 is amended by adding two new definitions in proper alphabetical sequence:

§ 60.2 Definitions.

* * * * *

"Groundwater" means all water which occurs below the Earth's surface.

"Unsaturated zone" means the zone between the land surface and the deepest water table. Generally, water in this zone is under less than atmospheric pressure, and some of the voids may contain air or other gases at atmospheric pressure. Beneath flooded areas or in perched water bodies the water pressure locally may be greater than atmospheric.

* * * * *

2. Section 60.122 is amended by revising paragraph (b)(2)(iii), designating paragraph (b)(2)(iv) as (b)(7), and adding new paragraphs (b)(8), (c) (22), (23) and (24) to read as follows:

§ 60.122 Siting criteria.

* * * * *

(b) * * *

(2) * * * (iii) Low vertical permeability and low hydraulic potential between the host rock and the surrounding hydrogeologic units.

* * * * *

(7) Pre-waste-emplacement groundwater trave time along the fastest path of likely radionuclide travel from the disturbed zone to the accessible environment that substantially exceeds 1,000 years.

(8) For disposal in the unsaturated zone, hydrogeologic conditions that provide—

(i) Low and nearly constant moisture flux in the host rock and in the overlaying and underlying hydrogeologic units;

(ii) A water table sufficiently below the underground facility such that fully saturated voids continuous with the water table do not encounter the underground facility;

(iii) A laterally extensive low-permeability hydrogeologic unit above the host rock that would inhibit the downward movement of water or divert downward moving water to a location beyond the limits of the underground facility;

(iv) A host rock that provides for free drainage; or

(v) A climatic regime in which the average annual historic precipitation is a small percentage of the average annual potential evapotranspiration.

* * * * *

(c) * * *

(22) Potential for the water table to rise sufficiently so as to cause saturation of an underground facility located in the unsaturated zone.

(23) Potential for existing or future perched water bodies that may have the effect of saturating portions of the underground facility or providing a faster flow path for radionuclide movement from an underground facility located in the unsaturated zone to the accessible environment.

(24) Potential for vapor transport of radionuclides from the underground facility located in the unsaturated zone to the accessible environment.

Dated at Washington, D.C., this 13th day of February 1984.

For the Nuclear Regulatory Commission.

Samuel J. Chilk,

Secretary of the Commission.

[FR Doc. 84-4306 Filed 2-15-84; 8:45 am]

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