



UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

NOV 5 1984

MEMORANDUM FOR: Colleen Ostrowski
Office of Nuclear Regulatory Research

FROM: J. M. Felton, Director
Division of Rules and Records
Office of Administration

SUBJECT: REVIEW OF FINAL RULE AMENDING 10 CFR PART 60

The Division of Rules and Records has reviewed the final rule and concurs subject to the modifications contained in the enclosed marked copy.

Specifically, note that throughout the Supplementary Information section, reference is made to other Federal Register (FR) publications. The full FR cite, which includes the FR page number and date of the publication, is needed in several places for these references.

A statement concerning environmental impact is inserted to reflect the Commission's recent revisions to 10 CFR Part 51. You should check with ELD or OGC to ensure that this statement is appropriate for this final rule.

We forwarded a copy of this rule to Steve Scott of TIDC for review of reporting and recordkeeping requirements. That Office will contact you regarding the paperwork statement.

Additionally, the Regulatory Flexibility Act Certification and amendatory instruction number three are slightly revised.

If you have any questions about our comments, please contact John Philips, Chief, Rules and Procedures Branch, on extension 27086.

A handwritten signature in dark ink, appearing to read "J. M. Felton", written over the typed name and title.

J. M. Felton, Director
Division of Rules and Records
Office of Administration

Enclosure: As stated

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NUCLEAR REGULATORY COMMISSION

10 CFR PART 60

Disposal of High-Level Radioactive Wastes
in the Unsaturated Zone

AGENCY: Nuclear Regulatory Commission.

ACTION: Final rule.

Amending its Regulations OK

SUMMARY: The Nuclear Regulatory Commission is ~~publishing amendments~~ ^{amending its Regulations} related to the disposal of high-level radioactive wastes in geologic repositories ~~within the unsaturated zone. These amendments, in addition to the existing provisions, ensure that the rule will apply to geologic media within either the saturated or unsaturated zone.~~ This action is necessary to assure that NRC regulations are applicable to all geologic repositories, whether sited in the saturated or unsaturated zone.

EFFECTIVE DATE:

FOR FURTHER INFORMATION CONTACT: Dr. Colleen Ostrowski, Office of Nuclear Regulatory Research, U.S. Nuclear Regulatory Commission, Washington, DC 20555, telephone (301)427-4580. *OK*

SUPPLEMENTARY INFORMATION:

Background

On February 25, 1981, the Nuclear Regulatory Commission (NRC) promulgated a rule that established procedures for licensing the disposal of high-level radioactive wastes (HLW) in geologic repositories (46 FR 13971). NRC promulgated technical criteria to be used in the evaluation of license applications under those procedures on June 21, 1983 (48 FR 28194). Although the final technical criteria as written

*No. that the technical criteria for
high-level disposal in the saturated zone
may be equally applicable to disposal in*

were generally applicable to disposal in both the saturated and unsaturated hydrogeologic zones, their scope was limited to HLW disposal within saturated geologic media for the reasons discussed at 48 FR 28203 and 49 FR 5934. The Commission recognized that this approach might be considered unduly restrictive and expressed the intent of issuing technical criteria for the unsaturated zone shortly after promulgating the final technical criteria so as to afford further opportunity for public comment on this issue. (48 FR 28203). Proposed amendments which would have the effect of broadening the scope of the technical criteria to include HLW disposal within either the saturated or unsaturated zone were published for comment on February 16, 1984. (49 FR 5934). These proposed amendments contained provisions for new definitions and favorable and potentially adverse siting criteria. In addition to the proposed amendments the Commission specifically requested public input on two questions related to groundwater travel time calculations within the unsaturated zone. (49 FR 5937). In conjunction with the proposed amendments the Commission published for public comment draft NUREG-1046 which contained a discussion of the principal technical issues considered by the Commission during the development of the proposed amendments.

Comments and Changes

A total of fourteen groups and individuals commented on the proposed amendments and draft NUREG-1046. There was general acceptance of the Commission's view that disposal of HLW within the unsaturated zone is a viable alternative to disposal within the saturated zone. The commenters addressed the Commission's specific questions on groundwater travel time

^{OK} Draft NUREG-1046 is currently being revised to reflect changes made in the final amendments to 10 CFR Part 60 related to HLW disposal within the Unsaturated Zone. Upon publication a copy of NUREG-1046 will be placed in the Commission's Public Document Room. Copies of NUREG-1046 may be purchased by calling (301) 492-9530 or by writing to the Publication Services Section, Division of Technical Information and Document Control, U.S. Nuclear Regulatory Commission, Washington, DC 20555, or purchased from the National Technical Information Service, Department of Commerce, 5285 Port Royal Road, Springfield, VA 22161.

When this revision is completed,

within the unsaturated zone and provided additional comments suggesting word changes to improve the technical accuracy and clarity of the proposed amendments. The principal comments received on the questions and proposed amendments and the Commission's corresponding responses are discussed below. Changes and clarifications made in the rule as a result of the Commission's consideration of these comments are also explained in this section. Copies of the individual comment letters and a detailed analysis of these letters by the NRC staff are available in the NRC Public Document Room, 1717 H Street NW., Washington, DC 20555.

(a) Groundwater Travel Time Calculations.

Technical criteria governing the post-emplacement performance of the particular barriers of the geologic repository system (i.e. engineered barriers and geologic setting) are set forth at §60.113 (48 FR 28224). The post-closure performance criterion for the geologic setting set forth at §60.113(a)(2) requires that the geologic repository be located so that pre-waste-emplacement groundwater travel time along the fastest path of likely radionuclide travel from the disturbed zone to the accessible environment be at least 1,000 years or such other travel time as may be approved or specified by the Commission. Although no change was made explicitly to the provisions of §60.113(a)(2) in the proposed amendments for the unsaturated zone, the proposed definition of the term "groundwater" set forth at §60.2 ^{OK} (49 FR 5937) would make the scope of §60.113(a)(2) applicable to geologic repositories within 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 hydrogeologic zone. Previously, these two provisions applied only to HLW disposal in the saturated zone since, as mentioned above, the scope of the final technical criteria was specifically limited to geologic disposal in saturated geologic media.

In the statement of considerations which accompanied the proposed amendments, the Commission discussed possible limitations that might be

add full cite then include same as 48 FR 28224 in p2

placed upon the pre-waste-emplacement groundwater travel time performance objective of §60.113 when applied to the unsaturated zone, ~~(49 FR 5936)~~. ^{OK}

However, the Commission stated that if DOE could 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). The Commission also acknowledged that it may be more appropriate to specify another parameter upon which performance may be evaluated for a geologic setting in the unsaturated zone, or to ~~utilize~~ ^{use}

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 satisfied. Further, the Commission observed that calculations of

pre-waste-emplacement groundwater travel time along the fastest path of likely radionuclide travel through the unsaturated zone could involve considerable uncertainty, and thus requested public comment on questions related to the applicability of the existing 10 CFR Part 60 performance objective for the geologic setting to sites located in unsaturated

geologic media. ^{OK} ~~(49 FR 5937)~~. ^{comment or input} In response to this solicitation of public input, seven of the fourteen commenters specifically addressed the questions on groundwater travel time calculations. These questions and the views expressed by the seven commenters will be reviewed here before turning to other considerations.

The notice of proposed rulemaking first requested comment on how groundwater travel time in the unsaturated zone could be determined with reasonable assurance. Comments received in response to this question were divided nearly equally into two categories. The first group of commenters argued that presently it would be difficult to calculate groundwater travel time in the unsaturated zone with reasonable assurance because of the lack of generally acceptable methodology and the limited scope of research efforts currently devoted to this question. A second group of commenters, comprised predominantly of representatives of other Federal agencies, endorsed the opinion that groundwater travel time could be determined with reasonable assurance. One of these commenters indicated that groundwater travel time calculations could be made by

measuring the amount of natural tritium in the groundwater samples from a vertical profile in unsaturated geologic formations. Two other commenters stated that groundwater travel time could be derived from groundwater flux using measurements of ambient water content, degree of saturation, matric potential and hydraulic conductivities, and then ^{to determine moisture - hydrologic conditions} ~~it~~ ^{these commenters OK} could be used to predict constitutive relationships over a wide range of conditions. From these relationships ~~it was~~ ^{then} argued that groundwater velocities and travel times could then be estimated. One of these two commenters further stated that reasonable assurance may be gained in estimating groundwater travel time using results of laboratory testing, state-of-the-art direct determinations in the field or laboratory, and bounding estimates developed by indirect methods, while both commenters indicated that reasonable assurance may also be gained by incorporating uncertainty analyses into predictive models.

The Commission recognizes that prior to the commencement of HLW disposal studies most groundwater investigations in unsaturated geologic media were generally limited in scope to issues related to near-surface, highly porous soils and unconsolidated rock types. Efforts to predict groundwater movement through potentially suitable geologic repository sites within the unsaturated zone often entail the application of hydrogeologic theories, models and methodologies governing near-surface, porous media to much deeper hydrogeologic environments and different rock properties than they originally were designed for. The Commission realizes that given the current state of groundwater investigations there may be difficulties associated with groundwater travel time calculations in both the saturated and unsaturated zones, as one commenter observed. However, the Commission concludes that groundwater travel time calculations can be determined in the unsaturated zone provided that the proper level of site characterization analyses is conducted by the applicant. Following a detailed study of the comments received on this question, the Commission believes it is currently feasible for DOE to demonstrate the implementability of the groundwater travel time provisions using existing standard field and laboratory experiments. Further, as several commenters indicated, a substantial effort is currently underway ~~both~~ to develop new methodologies and to improve

existing techniques for measuring the hydrogeologic parameters and flow properties that will provide the necessary input to groundwater travel time calculations. For example, it was noted that in-situ monitoring techniques, including tracer tests are undergoing development and may broaden the range of rock types and conditions for which it is feasible to estimate groundwater velocity and hence, groundwater travel time.

The second part of the first question on which the Commission sought comment centered on whether or not the existing groundwater travel time performance objective in §60.113(a)(2) should be limited to groundwater movement within the saturated zone. The general consensus among commenters on this issue was that there is no reason to strictly limit the groundwater travel time performance objective to water movement in the saturated zone. Following a review of the discussions presented in these comments the Commission has determined that the groundwater travel time provision (§60.113(a)(2)) can be applied to a geologic setting located in either the saturated or unsaturated zone. The Commission could discern no obvious advantage for developing a parallel provision for the unsaturated zone as one commenter suggested. With respect to another commenter's concern that if the Commission decided to retain the groundwater travel time provision^{OK} then travel time along any segment of the flow path, including the unsaturated zone, should be creditable^{OK} provided that reasonable assurance has been demonstrated, ^{OK} The Commission has concluded^{OK} that the definition of the term "groundwater" set forth at §60.2 will allow travel time along subsurface flowpaths to be credited regardless of the hydrogeologic regime through which the water is moving. The Commission believes that the concerns of one commenter that it would be inappropriate to limit groundwater travel time to the saturated zone because such an action would not accurately indicate the actual radionuclide transport time from the original location of the waste to the accessible environment will be largely accommodated by the definition of the term "groundwater". With respect to the view expressed that the approach set forth in §60.113(b) may be particularly appropriate in the case of HLW disposal in the unsaturated zone^{OK} it should be noted that in those instances when groundwater travel time calculations cannot be

determined with reasonable assurance, the Commission may prefer to specify variations in performance objectives pursuant to §60.113(b).

In its second question related to groundwater travel time the Commission sought public comment on whether groundwater travel time represented an appropriate measure of performance for a site within the unsaturated zone, or whether an alternative performance objective for the geologic setting would be more appropriate. The views expressed by the commenters were nearly equally divided on this issue. Some of the commenters asserted that, although not ideal, the groundwater travel time provision may, under certain circumstances, represent an appropriate measure of performance for a geologic setting in the unsaturated zone. Other commenters argued that groundwater travel time was not an appropriate performance objective for HLW disposal within the unsaturated zone, and suggested several alternative performance objectives, as discussed below.

With respect to alternative performance requirements, one commenter considered it unacceptable to establish an alternative performance measure for unsaturated geologic media while using a different measure for a saturated salt site. The Commission anticipates that the decision to apply the groundwater travel time provision to all geologic settings regardless of the hydrogeologic zone in which the site is located should alleviate this commenter's concern. Another commenter stated that although groundwater travel time substantially exceeding 1,000 years is a favorable condition it is not appropriate as a totally definitive performance objective for disposal in either the saturated or unsaturated zone. The same commenter considered release criteria as the absolute measure of total performance, and further argued that realistic estimates of release criteria for the unsaturated zone might not be possible until observations are actually made in shafts and drifts. One commenter indicated that if NRC chose to retain the groundwater travel time performance objective, ^{that OK} this provision should only be applied if the travel time calculations include combined travel times in the unsaturated and saturated zones so as to better approximate radionuclide transport. The Commission considers the concerns of this commenter to be accommodated by the definition of the term "groundwater" adopted in the final amendments.

Most commenters who argued against the application of the groundwater travel time performance objective to unsaturated geologic media generally suggested alternatives based either on the hydrogeologic concept of flux or upon the case-by-case approach of §60.113(b).

As derived from U.S. Geological Survey Water Supply Paper 1988 the term "flux" can be defined as the rate of discharge of groundwater per unit area of porous or fractured geologic media measured at right angles to the direction of flow. In comparison, the term "groundwater travel time" used in 10 CFR Part 60 can be interpreted as the length of time required for a unit volume of groundwater to travel between two locations. Alternatives suggested by the commenters which were based upon the concept of flux included a maximum groundwater flux requirement and a dual "either/or" criterion which would allow the applicant the option of demonstrating compliance with either a minimum groundwater travel time requirement or a maximum groundwater flux requirement. After considering the possibility of an alternative performance objective based upon the maximum groundwater flux, the Commission has decided to retain the groundwater travel time requirement for geologic settings regardless of the hydrogeologic zone in which they are located. This decision was based on the Commission's belief that the groundwater travel time requirement represents an independent measure of the overall hydrogeologic system performance which may encompass a variety of hydrogeologic parameters including groundwater flux. However, the Commission expects that groundwater flux will remain an important factor in the technical evaluation of radionuclide releases in the unsaturated zone, *as it is in the saturated zone.*

The Commission does not consider it necessary to specify a dual "either/or" groundwater criterion suggested by another commenter since under the provisions of §60.113(b), the Commission already has the flexibility to approve or specify some other radionuclide release rate, designed containment period, or pre-waste-emplacement groundwater travel time on a case-by-case basis. Further, the Commission *believes there is* no obvious advantage to incorporating a concept of areally integrated or averaged groundwater flow velocity into the dual "either/or" criterion proposed by this commenter since the Commission considers the fastest pathway

is this correct?

wording changed during concourse process

spelling? or technical term. it appears to me below

criterion to be more conservative than averaged flow criteria. The primary interest of the Commission is not the quantity of groundwater moving towards the accessible environment per se, but rather the radionuclides contained within the groundwater. The fastest pathway concept is preferred because it will allow estimates to be made concerning when radionuclides may first reach the accessible environment. ⁰¹⁴
~~Such~~ ^{These} estimates would not be apparent if an areal or temporal averaging of groundwater flow were introduced. The Commission anticipates that temporal and areal variations in the hydrologic regime will be addressed in the evaluation of uncertainties inherent to groundwater travel time calculations.

In contrast to the commenters who supported a performance criterion based upon groundwater flux, DOE concluded that it would be impractical to define a performance objective for the geologic setting based on flux through a geologic repository located in the unsaturated zone. Instead, DOE took the position that an alternative performance objective developed upon the concept of a minimum time for release of radionuclides to the accessible environment based on four separate physical events would be more appropriate for the unsaturated zone. The four physical events contained in the suggested DOE alternative performance objective were: (1) the creation of a drying zone around the emplaced wastes, (2) the subsequent return of moisture to the rock surrounding the waste canisters, (3) the transport of radionuclides through the unsaturated zone and finally, (4) the transport of radionuclides to the accessible environment by groundwater movement through the saturated zone.

The Commission has reviewed the suggested DOE alternative performance objective and has concluded that it offers no obvious advantages to the performance objectives set forth in §60.113. The Commission notes that DOE has selected four of many possible physical events that can be anticipated to occur within the geologic repository environment, but has not provided a clear basis for why those four events were preferred among others. Further research and verification of both the underlying theory and the data collection techniques and methods are deemed necessary by the Commission before specific events and their sequences for groundwater flux and subsequent radionuclide transport in a

deep, low-saturated, hydrogeologic environment could be identified and modeled with confidence. However, it should be recognized that the likelihood of specific physical events occurring at a geologic repository is dependent upon a number of factors such as the specific hydrogeologic and thermal characteristics of a particular site, thermal loading, canister design and complex interactions and couplings among the thermal, mechanical, hydrogeologic and chemical properties of the geologic setting. Although DOE indicated that related studies are both currently underway and planned as future site characterization activities, the Commission is not familiar with any scientific basis currently in the published literature to support the assertion that these four physical events will, in fact, occur in the manner and sequence DOE anticipated by b1c ✓

The performance objectives of §60.113 are generally applicable to a number of potential physical events while the alternative performance objective suggested by DOE is limited to four, sequential physical events which may or may not occur. Further, the Commission considers that two of these events--the formation of a drying zone and the rewetting phenomenon are not well understood at present, and therefore, should not be included explicitly within performance requirements. The Commission also notes that the existing groundwater travel time provision of §60.113 directly encompasses two of the four physical events--time of travel through the unsaturated zone and time of travel through the saturated zone. Therefore, the Commission has not adopted this DOE alternative performance objective for the unsaturated zone.

The view was also expressed that the development of a new alternative performance objective to existing §60.113 (a)(2) may not be necessary since the Commission's approach set forth at §60.113(b) might be a more appropriate means of specifying alternatives to the groundwater travel time criterion. The Commission notes that it is essentially following this approach in its decision to retain the existing provisions of §60.113(a)(2) and §60.113(b).

Following a review of the various alternative performance objectives suggested by the commenters, the Commission considers groundwater travel time to represent a more appropriate parameter upon which the performance of the geologic setting can be evaluated than any of the suggested alter-

natives because a prescribed groundwater travel time can be generically applied and will provide a conservative estimate of a minimum radionuclide release time to the accessible environment. It should be noted however, that the Commission still retains the option of applying the provisions of §60.113(b) instead of §60.113(a)(2) to a particular geologic setting when such an action is deemed appropriate.

(b) Definition of Groundwater.

Three commenters addressed the Commission's proposed definition of the term "groundwater" as meaning "all water below the Earth's surface". Two of these commenters, citing possible confusion among the public and scientific community stated that the Commission should not define "groundwater" in this manner, but rather should limit the use of the term to water within the saturated zone. In contrast, one commenter commended NRC on this definition, but noted that it may not be consistent with the definition of the term included in the proposed EPA environmental standards -- 40 CFR 191. In its proposed rule EPA defined "groundwater" as "water below the land surface in a zone of saturation" (47 FR 58205). While the Commission recognizes that limiting the use of the term groundwater to water within the saturated zone may currently be a more widely accepted practice, the Commission also notes that numerous members of the scientific community routinely use the term "groundwater" in the same context as the Commission proposed.

The Commission has carefully reviewed the arguments presented by the commenters on this issue and has decided to retain the definition of groundwater with one minor change--the phrase "Earth's surface" has been replaced by "land surface". This change was made for the sake of clarity and internal consistency with wording in the definition of the term "Unsaturated zone". The Commission's decision was based on the fact that, at present, no unique definition of the term "groundwater" appears to be universally accepted in the technical community. Therefore, the Commission has not actually redefined the term "groundwater" as one commenter suggested but rather has adopted one of the commonly used definitions of the term that is most consistent with the Commission's intent concerning the provisions related to groundwater throughout the

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Part 60 regulation. Further, the Commission historically has used the term "groundwater" in referring to subsurface water. With respect to the differences between the definition of the term "groundwater" adopted by the Commission and that proposed by EPA the Commission notes that it does not consider the two definitions to be inconsistent since the scope of the definition adopted in §60.2 will encompass water within the zone of saturation as well as water within the unsaturated zone. As noted above, the Commission considers it necessary to adopt a broader definition of the term "groundwater" in order to maintain internal consistency with previous Commission usage of this term and to effectively apply the provisions of 10 CFR Part 60 to the regulation of HLW disposal within unsaturated as well as saturated geologic media. Further, since EPA has not yet promulgated its final environmental standards, the Commission cannot anticipate whether or how "groundwater" will actually be defined in the final EPA regulation.

(c) Definition of the "Unsaturated zone."

The Commission's proposed definition was derived from U.S. Geological Survey (USGS) Water Supply Paper 1988. Two commenters noted that the phrase "deepest water table" introduced confusion into the definition of the term "Unsaturated zone" (§60.2). The Commission had inferred that the phrase "deepest water table" as used by the USGS referred to the regional water table and hence adopted this same phraseology in the definition of the term "Unsaturated zone" set forth in the proposed amendments to 10 CFR Part 60. However, in light of confusion expressed by commenters which may be due partially to the incorrect inference by some that the phrase "deepest water table" referred to local rather than regional water tables, ^{OK} the definition of term "Unsaturated Zone" has been modified. To clarify the Commission's original intent the phrase "deepest water table" has been replaced by "regional water table" in the final amendments. (A conforming change has also been made to the definition of the term "Saturated zone"). Additionally, the phrase "water in this zone is under less than atmospheric pressure" has been rewritten as "fluid pressure in this zone is less than atmospheric pressure" for the sake of technical clarity. The Commission has attempted to maintain internal consistency with the

definitions of hydrogeologic terms presented in USGS Water Supply Paper 1988 wherever practicable and for this reason has not adopted any of the alternative definitions of the term "Unsaturated zone" suggested by the commenters.

(d) Favorable Siting Conditions.

§60.122(b)(2). The term "low hydraulic potential" has been replaced with "low hydraulic gradient" in §60.122(2)(b)(iii) as suggested by one commenter for the sake of technical accuracy. *comment site* *OK*

§60.122(b)(7). In addition to comments received in response to the Commission's specific request for input on its questions related to groundwater travel time calculations in the unsaturated zone, the subject of groundwater travel time was also addressed by two commenters on proposed §60.122(b)(7). The issues raised by these two commenters merit discussion here although they have resulted in no change to the rule.

The provisions of §60.122(b)(7) would have the effect of identifying pre-waste-emplacement groundwater travel time along the fastest path of likely radionuclide travel from the disturbed zone to the accessible environment that substantially exceeds 1,000 years as a favorable siting criteria for both the saturated and unsaturated zones. Previously these provisions (formerly designated as §60.122(b)(2)(iv)) applied only to sites within the saturated zone.

One commenter on proposed §60.122(b)(7) opposed the application of this provision to the unsaturated zone on the grounds that the determination of groundwater travel time in the unsaturated zone may not be necessary nor always be possible. Under such circumstances, this commenter argued, inability to demonstrate that groundwater travel time substantially exceeds 1,000 years should not amount to the absence of a favorable condition. The issue of groundwater travel time in the unsaturated zone has already been discussed in detail in the above section on Groundwater Travel Time Calculations and will not be repeated here. With respect to the second part of this comment the Commission reiterates its position set forth at 48 FR 28201 that a site is not disqualified as a result of the absence of a favorable siting condition.

A second commenter on §60.122(b)(7) expressed the view that for a HLW repository within the unsaturated zone, minimizing leachate flux would appear to be at least as important as maximizing groundwater travel time. To that end, this commenter felt that it might be more appropriate to specify as a favorable siting condition a dual "either/or" criterion such that groundwater travel time is greater than 1,000 years or groundwater flux through the host rock at a proposed site is less than some average rate. This rate, it was argued, could be based on nuclide solubility, leach rate criteria, and population exposure criteria. The commenter stated that whichever criterion was ultimately selected it should be based upon an areally integrated or averaged calculation, over an area on the order of the cross-sectional area of the repository normal to the direction of expected flux regardless of hydrogeologic zone to help reduce controversy concerning how the "fastest pathway" can be determined. For a discussion of the concept of applying a dual criterion of either groundwater travel time or groundwater flux see the above section entitled Groundwater Travel Time Calculations. ✓

Minor corrections have been made to the provisions of §60.122(b)(8) for the sake of clarity and technical accuracy as a result of the comments received. The phrase "and nearly constant" has been deleted from §60.122(b)(8)(i) and a typographical error in the word "overlying" has been corrected.

(e) Potentially Adverse Conditions.

OK §60.122(c)(9). This provision of the final technical criteria (June, 1983) identified groundwater conditions in the host rock that are not reducing as a potentially adverse condition for the saturated zone. One commenter on the proposed amendments stated that a parallel provision should be provided for the unsaturated zone. The Commission considers this argument to have merit and has modified the final amendments accordingly. Rather than create an additional provision, the Commission has deleted the qualifying phrase "for disposal in the saturated zone" from existing §60.122(c)(9) to ensure that this provision will be applicable equally to groundwater conditions in the saturated and unsaturated zones.

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60.122(c)(23). Minor editorial changes have been made as suggested by one commenter, for the sake of clarity.

60.122(c)(24). During the development of the proposed amendments the Commission's staff identified vapor transport of contaminants as a potential concern associated with HLW disposal in the unsaturated zone. The Commission noted at 47 FR 5935 that in unsaturated geologic media water is transported in both liquid and vapor phases. The relative contribution of transport via both these phases and their direction of movement with respect to a geologic repository was deemed ^{to} directly ^{to} influence containment of contaminants. Vapor transport, particularly when a thermal gradient is imposed, may provide a possible mechanism for radionuclide migration from a geologic repository in unsaturated geologic media. This issue was discussed at length by the Commission at 49 FR 5935 and in draft NUREG-1046. The comments received on the discussion of vapor transport at 49 FR 5935 and on the wording of the proposed amendment ~~to~~ ^{to} 60.122(c)(24) indicated a need for the Commission to clarify its intent with respect to vapor transport. ✓

The issue of vapor transport of contaminants is a relatively new waste management issue that has grown out of recent scientific investigations of the feasibility of HLW disposal in unsaturated geologic media. Since most scientific studies related to HLW disposal within the unsaturated zone have been initiated very recently, many of the associated issues have not as yet been examined in any great detail. The Commission recognized that vapor formation may not necessarily be a potentially adverse condition but, given the fact that vapor transport could provide a realistic mechanism for radionuclide transport within the unsaturated zone, ^{it} ^{is} ^{an} opportunity to evaluate whether or not vapor transport could adversely affect a geologic repository system. To that end the Commission identified the potential for vapor transport of radionuclides from the underground facility located in the unsaturated zone to the accessible environment as a potentially adverse condition in the proposed amendments (60.122(c)(24)). The Commission has not reached any conclusions on vapor transport as one commenter incorrectly inferred, but rather is currently sponsoring research on vapor transport in ✓

unsaturated fractured rock in an effort to better understand this subject.

Some confusion was expressed by the commenters with respect to the Commission's use of the term "vapor transport". In particular, one commenter stated that §60.122(c)(24), as written, was ambiguous and meaningless and could, under certain conditions, be applied to any geologic repository site. The term "vapor transport" as used in the proposed amendments referred to both water vapor and the gaseous state of some constituent contaminants. A second commenter on this issue suggested that the Commission add quantitative clarifications to this provision since the proposed wording allowed no potential vapor transport of radionuclides by molecular diffusion (i.e. the process whereby solutes are transported at the microscopic level due to variations in tracer concentrations within the liquid phase) or convective transport (i.e. heat transported along with flowing groundwater). The same commenter noted that while the flux values associated with these two transport processes might be miniscule, they would not be zero at any unsaturated site. The Commission does not consider it appropriate to add quantitative clarifications to §60.122(c)(24) because the movement of radionuclides in the gaseous state is, to a large extent, dependent on site- and design- specific parameters. However, to alleviate the confusion surrounding proposed §60.122(c)(24), the wording of this provision has been extensively modified in the final amendments. Reference to vapor transport has been deleted, and this provision now identifies the potential for the movement of radionuclides in a gaseous state through air-filled pore spaces of an unsaturated geologic medium to the accessible environment as a potentially adverse condition. The Commission believes the revised wording will more accurately convey its original intent and should remove any ambiguity associated with the previous wording, such as one commenter's query of where the vapor transport is occurring and when it is important.

The Commission agrees with the commenter who indicated that vapor transport may occur in geologic repositories sited in the saturated zone until resaturation occurs. A temporary, localized, unsaturated region could form around an underground facility within the saturated zone as a

result of activities related to construction and operation of a geologic repository (e.g. dewatering of shafts and drifts). To date, the issue of vapor transport has not been raised for a geologic repository within the saturated zone primarily because such a phenomenon would be expected to be encompassed within a much larger saturated region, that is, vapor transport might only be expected to occur in that portion of the host rock where the voids are not completely filled or refilled with groundwater. Further, it is anticipated that the time required for waste package integrity (300-1,000 yrs) will generally exceed the post-closure time required for resaturation of a geologic repository within the saturated zone (assumed by the NRC staff to occur within a few hundred years following permanent closure). Therefore, the Commission does not consider it necessary at this time to identify vapor transport as a potentially adverse condition for HLW disposal within the saturated zone. However, if future research in the area of vapor transport challenges these current assumptions, the Commission may decide to broaden the provisions of §60.122(c)(24) to include both the saturated and unsaturated zones.

(f) Design Criteria.

Changes were made to provisions of the final technical criteria related to design criteria. The provisions of 60.133(f) have been modified to more closely identify the concept of a preferential pathway for groundwater flow towards the waste package. This change was prompted by a commenter's observation that as originally worded, this provision might not be internally consistent with new §60.122(b)(8)(iv) which identifies a host rock that provides for free drainage as a favorable hydrogeologic condition in the unsaturated zone. Similar word changes have been made to the provisions of §60.134(b) for consistency with §60.122(b)(8)(iv). Additionally, the phrase "radioactive waste migration" has been changed to "radionuclide migration" in both §60.133(f) and §60.134(b) for the sake of technical accuracy. The changes should ensure that these provisions will be applicable to geologic repositories within either the saturated or unsaturated zone, and will more accurately convey the Commission's original intent.

ENVIRONMENTAL IMPACT —

*See insert ISA
ELD says Statute takes precedent over NRC regulatory*

Pursuant to Section 121(c) of the Nuclear Waste Policy Act of 1982, the promulgation of these criteria does 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

This Paperwork Statement should be compiled with TDC

The final rule contains no new or amended recordkeeping, reporting or application requirement, 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 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, which is *not a small entity as defined in the Regulatory Flexibility Act. OK*

LIST OF SUBJECTS IN 10 CFR PART 60

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

and recordkeeping OK

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 adopting the following amendments to 10 CFR Part 60.

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

1. The authority citation for Part 60 continues to read as follows:

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). OK

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. 1610, 68 Stat. 950, as amended (42 U.S.C. 2201(o)). ✓
OK

2. Section 60.2 is amended by adding two new definitions in proper alphabetical sequence and revising an existing definition:

§ 60.2 Definitions.

* * * * *

"Groundwater" means all water which occurs below the land surface.

"Saturated zone" means that part of the earth's crust beneath the regional water table in which all voids, large and small, are ideally filled with water under pressure greater than atmospheric.

"Unsaturated zone" means the zone between the land surface and the regional water table. Generally, fluid pressure in this zone is 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.

* * * * *

3. Section 60.122 is amended by revising paragraph³ (b)(2)(iii), redesignating paragraph (b)(2)(iv) as (b)(7), and adding new paragraphs (b)(8), ~~(b)(9)~~^{OK}, (22), (23) and (24) to read as follows: OK and (C) 12/7

§ 60.122 Siting criteria.

ENVIRONMENTAL IMPACT: CATEGORICAL EXCLUSION

The NRC has determined that this proposed regulation is the type of action described in categorical exclusion 10 CFR 51.22(c)(). Therefore, neither an environmental impact statement nor an environmental assessment has been prepared for this proposed regulation.

ED should provide the particular exclusion

Statute takes precedent over our Regulations

* * * * *

(b) *** ^{line for} separate paragraph (2) ok

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

* * * * *

(7) Pre-waste-emplacement groundwater travel 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 moisture flux in the host rock and in the overlying 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) ***

(9) Groundwater conditions in the host rock that are not reducing.

* * * * *

(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 saturate portions of the underground facility or provide a faster flow path from an underground facility located in the unsaturated zone to the accessible environment.

(24) Potential for the movement of radionuclides in a gaseous state through air-filled pore spaces of an unsaturated geologic medium to the accessible environment.

* * * *

4. Section 60.133 is amended by revising paragraph (f) to read as follows:

§ 60.133 Additional design criteria for the underground facility.

* * * *

(f) Rock excavation. The design of the underground facility shall incorporate excavation methods that will limit the potential for creating a preferential pathway for groundwater flow towards the waste package or radionuclide migration to the accessible environment.

* * * *

5. Section 60.134 is amended by revising paragraph (b)(1) to read as follows:

§ 60.134 Design of seals for shafts and boreholes.

* * * *

(b) ***

(1) The potential for creating a preferential pathway for radio-groundwater flow towards the waste package or (2) radionuclide migration through existing pathways.

Dated at Washington, D.C., this _____ day of _____, 1984.

For the Nuclear Regulatory Commission.

Samuel J. Chilk,
Secretary of the Commission.