No. 95-74 FOR IMMEDIATE RELEASE
Tel. 301/415-8200 (Thursday, June 1, 1995)

NOTE TO EDITORS:

The Nuclear Regulatory Commission has received the attached report from its Advisory Committee on Nuclear Waste. The report, in the form of a letter, provides comments on issues related to regulatory guidance on groundwater travel time for a high-level waste repository.

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Attachment:
As stated

May 25, 1995

The Honorable Ivan Selin
Chairman
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Dear Chairman Selin:

SUBJECT: ISSUES RELATED TO GUIDANCE ON 10 CFR 60 GROUNDWATER TRAVEL TIME REGULATIONS.

In accordance with its program plan, the Advisory Committee on Nuclear Waste has reviewed the basis of the groundwater travel time (GWTT) requirement in 10 CFR Part 60. It also has reviewed the ongoing activities of the NRC staff and the U. S. Department of Energy (DOE) on this topic. The purpose of this letter is to convey our observations on the regulatory aspects of GWTT and our recommendations on the pending guidance by the NRC staff to DOE in this important area. Our conclusions are derived from two working group meetings, one in December 1993 on the status and methodology for study of groundwater flow in the unsaturated zone at the proposed repository at Yucca Mountain, Nevada, and another in October 1994 on the use of groundwater dating techniques in determining GWTT. In addition, we heard presentations from the NRC staff, and representatives from DOE and the State of Nevada at our 71st, 72nd, and 73rd meetings.

In 10 CFR 60.113, the NRC establishes the performance objectives for specific barriers after permanent closure of the repository. These objectives implement the Commission's defense-in-depth philosophy. The subsystem requirement in 10 CFR 60.113(a)(2) specifies a quantitative measure related to the inherent capability of the geologic environment of the emplaced waste to contain radionuclides released to the accessible environment in case of failure of the engineered barrier. This part of the regulations states, "The geologic repository shall be located so that the pre-waste-emplacement groundwater travel time along the fastest path of likely radionuclide travel from the disturbed zone to the accessible environment shall be at least 1000 years or such other travel time as may be approved or specified by the Commission."

The systematic regulatory analysis of the NRC high-level waste regulations identified two key technical uncertainties (KTUs) in the GWTT subsystem requirement. Potential ambiguities have been identified in the terms "fastest path

of likely radionuclide travel" and "disturbed zone." As a result, the NRC staff is drafting guidance to clarify these and other potential uncertainties in 10 CFR 60.113(a)(2) and related sections of Part 60. Further, the wording of the GWTT regulation in Part 60 is similar to the GWTT disqualifying condition in 10 CFR Part 960 that DOE will use to determine the technical site suitability (TSS) of Yucca Mountain. Thus, the guidance being prepared by the NRC staff not only will have a major impact on the evaluation of the repository license application but also will be applicable to the Commission's comments on the TSS of Yucca Mountain.

Our review of the basis of the GWTT regulation resulted in the following observations and related recommendations.

1. **Role of GWTT**

The GWTT requirement is designed to be a numeric measure of the geologic system's ability to contain radionuclides; the geologic system serves as one of the redundant barriers. Thus, GWTT is one element of the triad that makes up the Commission's defense-in-depth approach. However, this subsystem regulation alone is not intended to satisfy the entire performance requirement of the current Environmental Protection Agency high-level waste repository standard. Thus, the NRC staff should clarify in its guidance that the intent of the GWTT requirement is to provide reasonable assurance that the geologic barrier will be effective. The NRC guidance should stress that, because of the overall emphasis on the performance of the repository and the uncertainties in estimating GWTT, adherence to the 1000-year requirement should be interpreted liberally.

2. **Need for timely guidance**

Because of the rapid progress of the geohydrology studies at Yucca Mountain, early, comprehensive guidance is needed on the KTUs and other technical issues concerning GWTT.

DOE currently plans to complete the acquisition of data and analyses for its technical basis report on geohydrology in its TSS program in early 1997. Although DOE will evaluate the Yucca Mountain site against the requirements in 10 CFR Part 960, the GWTT disqualifying condition of 10 CFR 960 closely parallels the subsystem regulation in 10 CFR Part 60. Further, the Commission is required to comment on the Yucca Mountain site suitability determination that is scheduled to be sent to the President in the year 2000. Thus, it is urgent that uncertainties in the GWTT regulation be reduced through a carefully developed technical position.

Where applicable, the guidance should be specific and quantitative and based on physical or statistical justification.

3. **Scope and content of GWTT guidance**

Our recommendations for the scope and content of the NRC staff guidance on the GWTT requirement of 10 CFR Part 60 are as follows:

a. **Determining GWTT along the fastest path of likely radionuclide travel.**

The NRC staff's technical position on defining and determining GWTT along the fastest path of likely radionuclide travel as specified in 10 CFR 60.113(a)(2) is required to eliminate the regulatory uncertainty. The complex, interactive pathways possible in the matrix, fracture, and fault flow conduits in the proposed unsaturated zone repository at Yucca Mountain result in a variety of GWTTs between the disturbed zone of the repository and the accessible environment. Determining the groundwater paths and their travel time is likely achievable with acceptable uncertainties but may require probabilistic calculations to define the distribution of GWTTs. We believe the use of a measure of the central tendency may be acceptable but urge that the technical guidance by the NRC staff indicate the need for justifying any such selected attribute of the GWTT distribution.

We also believe that the NRC staff's position on GWTT should address the possible incorporation of the volumetric flux of water from the disturbed zone to the accessible environment, in that GWTT is not necessarily related to flux. Consideration of the volumetric flux is predicated on the reasonable assumption that higher volumes of water will carry larger quantities of dissolved radionuclides and hence constitute a greater risk. The NRC staff should be urged to point its guidance toward the desirability of modulating the measure of GWTT with water flux.

b. **Uncertainties in GWTT**

A recognized issue in the determination of GWTT is the ability of geohydrologists to predict the groundwater paths and associated uncertainties in travel time values. We believe that after completion of adequate site characterization of Yucca Mountain and quantification of the sources of uncertainty, these predictions will be possible. DOE must gain an understanding of the saturated and unsaturated zone groundwater flow systems sufficient to

bound, for example, the role of fracture flow, the location and behavior of faults as flow conduits, and the potential role of perched water conditions in the flow system in estimating GWTT. Emphasis on the flow system through rock units underlying the repository horizon is also required. This information, together with definition of geohydrologic units, their relevant properties, and lateral and vertical variability, needs to be available to develop conceptual models of the geohydrologic system at Yucca Mountain.

To address uncertainties in conceptual models, guidance is needed on evaluating the results from multiple conceptual models and the use of information such as groundwater tracers, isotopic dating of *in situ* water, and related geoscience input to constrain and temper the models. All require careful application, integration, and interpretation, but in particular, the NRC staff should, in its guidance, caution against excessive reliance on the results from one method of isotopic dating of water that are not supported by results from other isotopic dating methods or other methodologies.

Further, the NRC staff guidance should encourage DOE to delimit the uncertainties associated with the proximity of the repository to fault zones. Potentially, fault zones provide pathways for rapid groundwater flow.

c. **Definition of disturbed zone**

The functional definition of the disturbed zone referred to in 10 CFR 60.113(a)(2) remains a KTU. The NRC staff in presentations to the Committee and at technical exchanges between NRC and DOE has proposed a method of defining and demarcating the disturbed zone that is based on a two-step process. The steps are to evaluate the effects of changes in physical and chemical properties of the rock volume of the site resulting from construction and the emplaced waste on pre-waste-emplacement GWTT and determine if the effect on pre-waste-emplacement GWTT is significant. The disturbed zone is the outer limit of the volume in which the GWTT has been "significantly" affected by the repository and its wastes. The staff’s definition takes into consideration the rock volume that may affect the capability of the geologic barrier to contain waste, but does not allow credit to be taken if the effect of the repository is to lengthen GWTTs. This approach has been well received by DOE, and we believe it is appropriate. We urge the staff to proceed with it in developing its guidance, but we caution that the term "significant" when referring to the effect of the repository on pre-waste-emplacement GWTT will need further consideration. A suggested course of action is to define the

term "significant" quantitatively in such a way that takes into account the uncertainty and resulting effects of the possible changes of the physical and chemical properties on GWTT in the disturbed zone.

We are concerned that in the absence of a specific thermal loading strategy it will be difficult for DOE to estimate the effects of repository heat and hence difficult to complete the pre-and post-waste-emplacement calculations. Also, DOE has indicated it will not have the results from heater block tests before it performs the post-waste-emplacement GWTT calculations. These deficiencies will result in great reliance on expert judgment in the assessment of post-waste-emplacement effects. The NRC staff should initiate as soon as possible a review of its strategy for evaluating whether DOE has bounded the behavior of groundwater flow in the post-waste-emplacement environment sufficiently to determine compliance with the GWTT regulation and the overall repository performance criteria.

d. **Definition of pre-waste conditions**

The lack of a clear definition for the term "pre-waste-emplacement" in the GWTT regulation requires that NRC staff provide guidance on what is meant by pre-waste-emplacement conditions. The groundwater conditions are part of a dynamic, constantly changing system as a result of local and regional climatologic variations, modifications in geohydrologic parameters, and disruptive effects due to subsurface site characterization. As a result, some geohydrologic data indicative of groundwater residence time reflect groundwater processes over a broad span of time rather than the present conditions. The effects of these factors are likely to be small over the totality of the repository site, but they need to be evaluated in terms of prescribing pre-waste-emplacement conditions and the need for and the method of extrapolating to a specified pre-waste-emplacement state.

e. **Use of transport processes**

DOE has proposed the use of transport processes, including diffusion, in the analyses of GWTT. These effects may significantly impact the GWTT results. The NRC staff technical position should provide clear guidance on the appropriateness of the use of transport processes and the rationale for this decision.

4. **Consistency and integration with other guidance**

The NRC staff needs to ensure that its technical position on the GWTT regulation is consistent and integrated with other NRC guidance including evaluation of the overall performance of the repository, approach to confidence building of models and evaluation of uncertainty in modeling, use of expert judgment, and review of DOE's bounding analyses in support of its program approach. The staff may be able to narrow the scope of the GWTT technical position if the document contains information on how GWTT is related to or incorporates other issues and on where related guidance on these can be found.

5. **Support for GWTT Guidance**

We have observed little direct impact of the Center for Nuclear Waste Regulatory Analyses (CNWRA) in our review of the GWTT regulation. If the staff is not doing so already, we encourage it to take full advantage of the strong technical support available from the CNWRA in formulating the guidance required in the GWTT staff technical position. We look forward to reviewing supporting analyses from the CNWRA when we are briefed on the draft technical position before it is issued for public comment.

6. **NRC/DOE interaction on GWTT**

We have closely followed interactions between DOE and the NRC staff in their technical exchanges regarding GWTT and related issues at Yucca Mountain. We have been impressed with the professional standards of both groups, the increased frequency of these meetings, and their ability to maintain flexibility in their approaches. We commend both the NRC staff and DOE for their actions and encourage broadening of this type of interaction and demonstrated flexibility to other aspects of the high-level waste program.

Summary

We believe there is a need to develop a technical position paper and guidance on various aspects of the GWTT subsystem regulation. We believe that the timing of activities by DOE and the indicated schedules point to a need to complete such guidance in the very near future. Such a technical position paper should address all of the currently identified relevant KTUs or identify where treatment of their subject matter can be found, and provide quantitative guidance to the extent possible. We urge that clarification of the definition of concepts such as the disturbed zone and pre-waste-emplacement conditions be specifically addressed. Further, the technical bases for evaluating adherence to the

numerical regulation for GWTT should be addressed in the guidance in terms that will allow DOE to make early decisions on the need for data and analyses and the strategy for providing the necessary information to the NRC staff. This guidance should also either address data requirements, methodologies, and confidence-building procedures that will minimize the uncertainties in the evaluation of this rule or identify where this information may be found.

Sincerely,

Martin J. Steindler
Chairman, ACNW