UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON NUCLEAR WASTE
WASHINGTON, DC 20555 - 0001

ACNW R-0236

January 23, 2006

The Honorable Nils J. Diaz
Chairman
U. S. Nuclear Regulatory Commission
Washington, DC 20555-0001

SUBJECT: TITLE 10 OF THE CODE OF FEDERAL REGULATIONS PART 63 PROPOSED RULE

Dear Chairman Diaz:

On September 8, 2005, the NRC proposed a revision to Title 10 of the Code of Federal Regulations Part 63 (10 CFR Part 63) to comply with the Environmental Protection Agency's (EPA's) proposed revision of the Yucca Mountain standards. The Advisory Committee on Nuclear Waste offers the following observations and recommendations on these proposed revisions that the NRC may wish to consider in developing its final rule.

The Committee observations were developed during deliberations supported by technical presentations to the Committee during its 163rd, 165th, and 166th meetings on the proposed revisions to the standard and regulation for a repository at Yucca Mountain. Presentations by Professor Matt Huber, Purdue University, and Dr. Matthew Kozak, Electric Power Research Institute, evaluated future climate variations. Dr. Dade Moeller, Dade Moeller and Associates, Inc., and Dr. Thomas Tenforde, National Council on Radiation Protection and Measurements (NCRP), discussed health physics topics associated with the revised standard. Professor Chen Zhu, Indiana University, and Dr. Ward Sanford, U.S. Geological Survey, presented their informed opinions on the problems of estimating deep percolation at Yucca Mountain. The Committee also heard from other stakeholders and individuals at these meetings on the proposed standard and regulation. Additional insights into the NRC's proposed revision to the Yucca Mountain regulations were provided by the NRC staff supported by specialists from the Center for Nuclear Waste Regulatory Analyses at the Committee's 165th and 166th meetings.

NRC's Proposed Rule

The EPA proposes to retain the existing standards for the first 10,000 years of the potential repository. Accordingly, the NRC regulation addressing this time period is unaffected by the proposed rule except for the adoption of up-to-date dosimetry specified by the EPA for dose calculations. To comply with the proposed revisions to the EPA's Yucca Mountain standard in the post-10,000 year period, the NRC proposes the following revisions to 10 CFR Part 63:

(1) Peak dose limit after 10,000 years

The NRC proposes to incorporate into its regulation the requirement in the proposed EPA revised standard that the Department of Energy (DOE) compare the median value of the projected dose after 10,000 years through the period of geologic stability to an annual dose limit

of 3.5 mSv/yr for both individual protection and human intrusion. The period of geologic stability is defined as 1 million years. Stability refers to consistency in the mean rate of geologic processes that will affect the environment.

(2) Criteria for performance assessments used to estimate peak dose after 10,000 years

The NRC proposes to incorporate into its regulation the EPA proposal that performance assessment for the first 10,000 years of the repository is an adequate basis for projecting the repository performance in the post-10,000 year period. The EPA proposes, and the NRC accepts in its proposed rule, that inherent uncertainties in evaluating features, events, and processes over 1 million years should be constrained to limit speculation. The proposed rule also incorporates changes to 10 CFR Part 63 that (1) limit the analysis of seismic activity to the effects caused by damage to the waste package and drifts, (2) limit consideration of igneous activity to effects on the waste package that result in release of radionuclides to the atmosphere or ground water, (3) limit consideration of the effects of climate change to the effects of those resulting in change in the water flowing through the unsaturated zone to the repository, and (4) require DOE to include general corrosion in the analysis of engineered barrier performance.

The performance assessment for the first 10,000 years will provide a basis for projecting repository performance to 1 million years. However, performance assessment for the post-10,000 year period will consider the decreasing inventory of radionuclides in the waste, the physical and chemical characteristics of the waste form, the effect of the near-field environment on the waste packages and waste form, and the release of radionuclides from waste packages as a result of unlikely geological events such as volcanic activity and major earthquakes. The Committee understands that the staff is considering these factors, their importance to risk, and the source and magnitude of uncertainties in the time and magnitude of the peak dose from the repository after 10,000 years.

(3) Individual and worker dose calculations

The NRC supports the EPA proposal to use specific dose-weighting factors (based on recommendations and guidance from International Commission on Radiological Protection Publications 60 through 72) that are specified in Federal Guidance Reports No. 11 and No. 13 (FGR 11 & FGR 13). Consistent with the revised EPA standard, the NRC proposes to use the same methods for calculating dose to workers during the operational period as those required for calculating dose to the public.

Observation 1

The Committee strongly supports the use of dose-weighting factors for the public and workers based on the best available dosimetry information and dose conversion factors.

(4) Climate variation after 10,000 years

An important uncertainty in projecting the performance of the proposed Yucca Mountain repository over a period of one million years is predicting future climate variation. Geological and paleobiological evidence show that significant changes in the climate of the earth and the Yucca Mountain region have occurred in the past. Changes in the Yucca Mountain region have generally followed the global pattern of climate change, with some differences in timing of

events (Winograd et al., 1992). Projections of climate variations from changes in the orbital parameters of the earth, energy interactions between the ocean and the land, and effects of anthropogenic atmospheric gases indicate that continuing changes in climate are likely to occur. However, the science of predicting climate variation either on the basis of past climates or on the basis of climate modeling is not mature enough to predict the future climate without significant uncertainties.

In the face of the uncertainties in climate and the likely significant impact of climate variation on risk from the repository, the EPA has proposed, as stated in (2) above, that consideration of the effect of climate change after 10,000 years be limited to the impact from increased water flowing through the repository. EPA specifies that the NRC establish in regulation the steady-state (constant-in-time) value that DOE should use to project the impact of climate change after 10,000 years. The guidance to the NRC in the proposed EPA standard removes the need to consider varying climatic conditions over one million years and focuses instead on the need to specify the average climate.

Having considered various proxies for average climate over the next million years, the NRC proposes to use deep percolation flowing to the repository horizon, which is a measure of the average amount of water reaching the repository per unit area per unit time.

Observation 2

Deep percolation is appropriate as the proxy for the average climate at Yucca Mountain over the next million years because it is the climate-controlled parameter that most directly influences the performance of the repository and the potential risk to the public.

The NRC proposes an average deep percolation rate based on estimates of (1) the average precipitation rate and (2) the proportion of precipitation reaching the repository over the next million years. There are large uncertainties in both of these parameters.

The NRC has used precipitation values interpreted from preserved plant macrofossil assemblages over several time periods from southern Nevada dating from ~40 to 12 ka (Thompson et al., 1999). Thompson et al.'s results indicate the average precipitation in the Yucca Mountain region was greater in the past than in the present (roughly 125 mm/yr), reaching a peak during the last glacial maximum (21 to 18 ka) of from 266 to 321 mm/yr. The NRC has assigned this range of precipitation as the average annual precipitation over the next million years at Yucca Mountain. The climate record over the past 500,000 years suggests that the higher precipitation levels of the last glacial maximum conditions prevailed for only about half of this period as interpreted from data presented by Forester et al. (1999). In addition, the NRC's analysis has not considered the possible effects of climate change due to anthropogenic atmospheric gases (AGU, 2003), which may delay the onset of the next glacial maximum (Archer et al., 1997). Climate modeling indicates that the next glacial maximum may be at least 40,000 years in the future and may be delayed as long as several hundred thousand years even without the mitigating effects of anthropogenic gases.

Observation 3

The NRC estimate of average precipitation over the next million years may lead to calculated deep percolation rates that are not consistent with the data discussed above.

The other parameter needed to calculate the deep percolation rate is the percentage of precipitation that reaches the repository horizon, which is currently estimated at 4% at Yucca Mountain. The NRC has determined that between 5% and 20% of precipitation would reach the repository depth for the higher-precipitation climatic conditions. The NRC proposes that DOE use a time-independent deep percolation rate after 10,000 years, based on a log uniformly distributed range of deep percolation rates from 13 to 64 mm/yr. The technical basis would be strengthened by more detailed discussion of this deep percolation rate. The upper limit of the NRC's estimated range may not conform to the data of Zhu et al. (2003).

Observation 4

The technical basis for the NRC estimate of the percentage range of precipitation that reaches the repository horizon could be better explained and supported.

Recommendations

(1) The Committee recommends the use of dose-weighting factors for the public and workers that are based on the best available dosimetry information and dose conversion factors.

(2) The Committee recommends the use of deep percolation at the repository horizon as the appropriate proxy for the average climate over the next million years at Yucca Mountain because it is the climate-controlled parameter that most directly influences the performance of the repository and potential risk to the public.

(3) Regarding deep percolation, the Committee recommends the NRC staff:

   a. Better document the technical basis for its approach to calculating average precipitation rates over the post-10,000 year period.
   b. Evaluate the impact on deep percolation of potential anthropogenic climate change and its effect on the timing of the next glacial maximum.
   c. Better document the technical basis for the selection of the range of percent of precipitation that reaches the repository horizon during both interglacial and glacial periods, considering information presented or referenced in this letter.

The Committee recognizes the staff's intensive, high-quality work in this area and looks forward to discussing performance assessment computations and uncertainty analyses regarding major factors controlling the timing and magnitude of the projected peak dose and their relative importance to risk.

Sincerely,

/RA/

Michael T. Ryan
Chairman

References:

AGU (American Geophysical Union), 2003, Human impacts on climate, position state-ment available at http://www.agu.org/sci_soc/policy/positions/climate_change.shtml.

Archer, D., H. Kheshgi, and E. Maier-Reimer, 1997, Multiple timescales for neutralization of fossil fuel CO2, *Geophysical Research Letters*, v. 24, no. 4, 405-408.

Forester, R. M., J. P. Bradbury, C. Carter, A. B. Elvidge-Tuma, M. L. Hemphill, S. C. Lundstrom, S. A. Mahan, B. D. Marshall, L. A. Neymark, J. B. Paces, S. E. Sharpe, J. F. Whelan, and P. E. Wigand, 1999, The climatic and hydrologic history of southern Nevada during the Late Quaternary, U.S. Geological Survey Open-File Report 98-635, 63 pp.

Thompson, R. S., K. H. Anderson, and P. J. Bartlein, 1999, Quantitative paleoclimatic reconstructions from Late Pleistocene plant macrofossils of the Yucca Mountain region, *U.S. Geological Survey Open-File Report 99-338*, USGS, Denver, CO.

Winograd, I. J., T. B. Coplen, J. M. Landwehr, A. C. Riggs, K. R. Ludwig, B. J. Szabo, P. T. Kolesar, and K. M. Revesz, 1992, Continuous 500,000-year climate record from vein calcite in Devils Hole, Nevada, *Science*, v. 258, 255-260.

Zhu, C., J. R. Winterle, and E. I. Love, 2003, Late Pleistocene and Holocene groundwater recharge from the chloride mass balance method and chlorine-36 data, *Water Resources Research*, v. 39, no. 7, doi:10.1029/2003WR001987.

repository depth for the higher-precipitation climatic conditions. The NRC proposes that DOE use a time-independent deep percolation rate after 10,000 years, based on a log uniformly distributed range of deep percolation rates from 13 to 64 mm/yr. The technical basis would be strengthened by more detailed discussion of this deep percolation rate. The upper limit of the NRC's estimated range may not conform to the data of Zhu et al. (2003).

Observation 4

The technical basis for the NRC estimate of the percentage range of precipitation that reaches the repository horizon could be better explained and supported.

Recommendations

(1) The Committee recommends the use of dose-weighting factors for the public and workers that are based on the best available dosimetry information and dose conversion factors.

(2) The Committee recommends the use of deep percolation at the repository horizon as the appropriate proxy for the average climate over the next million years at Yucca Mountain because it is the climate-controlled parameter that most directly influences the performance of the repository and potential risk to the public.

(3) Regarding deep percolation, the Committee recommends the NRC staff:

a. Better document the technical basis for its approach to calculating average precipitation rates over the post-10,000 year period.
b. Evaluate the impact on deep percolation of potential anthropogenic climate change and its effect on the timing of the next glacial maximum.
c. Better document the technical basis for the selection of the range of percent of precipitation that reaches the repository horizon during both interglacial and glacial periods, considering information presented or referenced in this letter.

The Committee recognizes the staff's intensive, high-quality work in this area and looks forward to discussing performance assessment computations and uncertainty analyses regarding major factors controlling the timing and magnitude of the projected peak dose and their relative importance to risk.

Sincerely,

Michael T. Ryan
Chairman

DOCUMENT NAME: **C:\MyFiles\Checkout\PART 63 PROP RULE 1-23-06 - FINAL.wpd**
To receive a copy of this document, indicate in the box: "C" = Copy without attachment/enclosure **"E"** = Copy with attachment/enclosure **"N"** = No copy Accession #:ML060240614

OFFICE	ACRS/ACNW	Y	ACRS/ACNW	Y	ACRS/ACNW	Y	ACRS/ACNW	Y	ACRS/ACNW	Y	ACRS/ACNW	Y
NAME	NColeman		MLee		MScott		AThadani		JLarkins		JTL for MTR	
DATE	01/23/06		01/23/06		01/23/06		01/23/06		01/23/06		01/23/06	

OFFICIAL RECORD COPY