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FROM: B. John Garrick, ACNW

DUE: 06/07/04

EDO CONTROL: G20040321
DOC DT: 05/03/04
FINAL REPLY:

TO:

Chairman Diaz

FOR SIGNATURE OF : ** GRN **

CRC NO: 04-0291

Travers, EDO

DESC:

Working Group Session on Biosphere Dose Calculations

DATE: 05/07/04

ASSIGNED TO: NMSS

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Date Printed: May 06, 2004 16:18

PAPER NUMBER:	LTR-04-0291	**LOGGING DATE:**	05/05/2004
ACTION OFFICE:	EDO		
AUTHOR:	B. Garrick		
AFFILIATION:	ACNW		
ADDRESSEE:	Nils Diaz		
SUBJECT:	Working group session on biosphere dose calculations		
ACTION:	Appropriate		
DISTRIBUTION:	RF		
LETTER DATE:	05/03/2004		
ACKNOWLEDGED	No		
SPECIAL HANDLING:			
NOTES:			
FILE LOCATION:	ADAMS		
DATE DUE:		**DATE SIGNED:**	

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON NUCLEAR WASTE
WASHINGTON, D.C. 20555-0001

CHAIRMAN REC'D
04 MAY -5 AM 10:48

May 3, 2004

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

SUBJECT: WORKING GROUP SESSION ON BIOSPHERE DOSE CALCULATIONS

Dear Chairman Diaz:

During its 148th meeting on February 24-26, 2003, the Advisory Committee on Nuclear Waste (ACNW) had a working group session (WGS) on biosphere dose calculations for the potential Yucca Mountain high-level waste repository. The session included an expert panel of six distinguished scientists from academia, research institutions, and private enterprise renowned in the fields of radiological assessment, the fate and transport of radioactive materials in the environment, and related subjects in earth sciences. The Department of Energy (DOE), the Nuclear Regulatory Commission (NRC) staff, and representatives of the State of Nevada made presentations. Stakeholders and members of the public were given opportunities to comment on the discussions that took place during the technical sessions.

The purposes of the WGS were to (1) increase ACNW's technical knowledge of NRC staff plans to develop and conduct biosphere dose assessment work for the potential Yucca Mountain repository, (2) understand NRC staff expectations for biosphere dose assessments, (3) review examples of biosphere dose assessment work being planned by both NRC and DOE, (4) identify aspects of biosphere dose assessments that may warrant further study, and (5) complement previous and planned WGSs.

In addition, there were discussions regarding (1) the technical bases (measurements, analyses, and interpretations) necessary to conduct biosphere dose assessments, (2) the role of risk insights in the development of technical bases, and (3) the impact of outstanding technical issues on the resolution of agreements.

The expert panel offered a number of suggestions and observations regarding assessments and evaluations that will underpin the biosphere dose calculations that are required in a DOE license application.

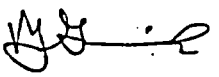
This letter provides a summary of the WGS expert panel's suggestions and observations. These suggestions and observations should help the NRC staff prepare for the review of the biosphere dose calculations that must be included in a license application.

Recommendation

The Committee recommends that the NRC staff consider the suggestions and observations of the biosphere WGS. The suggestions and observations were directed toward DOE but, to the extent they are adopted, may affect an NRC review of the biosphere dose calculation.

The suggestions and recommendations are provided as an enclosure to this letter.

Sincerely,



B. John Garrick
Chairman

Enclosure: As stated

ENCLOSURE

Observations and Background Information

The major comments of the expert panel[1] focused on several issues related to specific models and parameter values used by the U.S. Department of Energy (DOE) during their pre-licensing work on dose calculations for the proposed Yucca Mountain high-level waste repository. The principal topics are discussed below.

1. *Excessive conservatism in the estimates of the uptake by cows of radionuclides from local alfalfa farms.* The basis for questioning the uptake values used was the degree to which locally produced alfalfa and other hay (produced on about 90 percent of about 2000 acres that are being commercially farmed in the area) could meet the needs of a commercial dairy operation having a reported total of more than 5000 Holstein dairy cows. Experience of one expert panel member indicates that about 2000 acres of alfalfa would provide only a very small percentage of the total feed needs of about 5000 cows.

2. *Failure to consider the Carbon-14 pathway through roots that could contaminate foodstuffs.* Apparently, the analysts did not consider this pathway.

3. *The need to quantify better all of the dose pathways that significantly contribute to the total dose.* An example, which might contribute to the inhalation dose, is the use of evaporative coolers in the Amargosa Valley region.

4. *Overestimation of ingestion dose from fish from the local fish farm.* In this case, the "solution" to the lack of quantified values for various input parameters was to make overly conservative dose estimates. The now inoperative local fish farm used fish feed purchased from outside of the Amargosa Valley. It was noted by several panel members that improved realism would certainly add to the credibility of the dose calculations performed by DOE.

5. *The use of Federal Guidance Reports (FGRs) in performing dose calculations.* DOE is using FGR No. 11 to estimate the doses from internal exposures and FGR No. 12 for external exposures. Dose estimates included time-weighted exposure for five environments by various population groups residing within the Amargosa Valley. The five environments applied to people who were (a) active outdoors, (b) inactive outdoors, (c) active indoors, (d) asleep indoors, and (e) away. DOE has not used FGR No. 13, a compilation of updated dose conversion factors. The panel expressed the opinion that using FGR No. 13 would enhance the credibility of the dose calculations.

Opportunities for Improving Dose Calculations

The expert panel drew a distinction between dose calculations for the purpose of complying with regulations and calculations not linked to the prescriptive requirements of the regulations. With respect to compliance, the expert panel identified a number of opportunities for improving the

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[1]The chair of the expert panel was Dr. Dade W. Moeller (Dade Moeller and Associates). The other members were Drs. Keith Eckerman (Oak Ridge National Laboratory) David Kocher (SENES Oak Ridge, Inc.) John Till (Risk Assessment Corporation) Jeffrey Daniels (Lawrence Livermore National Laboratory) and Michael Thorne (Mike Thorne and Associates, Ltd., England).

quality of the DOE dose calculations on which the panel was briefed. An overarching issue in this regard is to address the major sources of uncertainty. The enhancements recommended include the following:

1. Dose estimates based on different dose coefficients, including the FGR No. 11 and FGR No. 13 coefficients.

2. Dose estimates for different age groups within the general population, most notably those for infants and teenagers rather than just the required adult. Such analyses might also include a report explaining the nature of the Biosphere Dose Conversion Factors (BDCFs), with emphasis on the various factors conversion into setting the BDCFs, the values currently being assigned to the BDCFs, and their associated uncertainties. It should be recognized, however, that the reasonably maximally exposed individual (RMEI) is an adult.

3. Several members of the expert panel recommended a data update, i.e., a revision of the DOE technical baseline report (DOE, 1997) to include data, on existing conditions related to biosphere parameters. This included the collection and tabulation of information on (a) the relative amounts of water from local ground water sources and the amounts of specific locally produced types of foods being consumed, (b) details on the types of housing in which the people live, and (c) the average residence time of the population and the frequency of population turnover. The expert panel suggested that much more needs to be known about possible site-specific effects, particularly with respect to additional details of the ongoing agricultural activities (the characteristics of each of the crops being grown, including small grains, pistachio nuts, grapes, orchard produce, garlic, and onions). Better documentation of existing conditions in the Yucca Mountain region could serve as an improved reference for modeling parameters. The expert panel recognized that preparation of such a report would undoubtedly require the acquisition of additional site-specific information, including existing concentrations of radionuclides generated by earlier activities at the Nevada Test Site, as well as radionuclides of natural origin.

The uncertainties in the dose assessments should be quantified and possibly separated into two types, those that are prescribed by the regulations and those that are not. Examples of the first type are as follows:

1. Section 63.312 (e) of Title 10 of the Code of Federal Regulations (10 CFR 63.312 (e)) specifies that the RMEI is an adult.

2. The RMEI is assumed to consume 2 liters of water per day from potentially contaminated sources.

3. The estimated concentration of radionuclides in the ground water is based on a withdrawal rate of 3000 acre-feet per year.

Examples of the second type of assessment are:

1. Those associated with the dynamics of the uptake of radionuclides by plants that are irrigated with the ground water.

2. The biokinetics (metabolism) of the radionuclides within the human body, two major factors being the uptake through the gastrointestinal tract and the deposition of the radionuclides in various body organs.

3. The factors involved in the dosimetry of the radionuclides once they have been deposited in various body tissues.

The expert panel suggested that DOE prepare reports in which they identify and quantify the conservatisms and uncertainties associated with various input factors. For example:

1. The expert panel indicated the need to justify the assumed lung solubility of radionuclides, such as plutonium-239.

2. The expert panel noted that values for the soil adsorption coefficients probably encompass the largest uncertainties of any of the input parameters in the overall dose assessments. Estimates on the resuspension of dust deposits on the ground also involve large uncertainties.

3. The expert panel recommended that DOE consider preparing a report that clarifies the circumstances, particularly regarding dose calculations, of each of the three basic requirements of 10 CFR Part 63: (a) individual protection, (b) ground water protection, and (c) human intrusion.

Other issues addressed by the expert panel included the igneous event, coupling of models, radium-226 (^{226}Ra), the RMEI concept, future climate projections, and risk insights.

Igneous Activity Disruptive Event

Information presented to the working group indicated that the igneous activity disruptive event scenario is a postulated event that contributes to dose during the compliance period. This being the case, the expert panel recommended emphasizing the ongoing efforts to reduce the uncertainties in the values of the key model input parameters for analyzing this scenario. Of particular importance are factors such as the density, particle size distribution, and solubility (within the lungs) of the ash that would be produced and subsequently resuspended and inhaled. Also important is the partitioning of radionuclides among particles of a specific size range. The expert panel was encouraged that natural analogs are being vigorously studied and evaluated. While the impacts of the initial release are important, the values of the parameters related to chronic exposure scenarios need careful evaluation. These include the mechanisms of deposition of the airborne ash, its potential for resuspension once deposited, and the rate of aging of the deposited ash, especially the determination of a realistic estimate of its half-time for availability for resuspension.

Coupling of Various Models

Several expert panel members noted that there is interplay, as well as correlation, between the input parameters used in modeling biosphere transport and those used in assessing the impacts of various engineered barriers. For example, if the adsorption coefficient for a specific radionuclide is high, then its uptake by plants should be reduced accordingly. There are also extensive data from detailed analyses of the soil in the Amargosa Valley; these data should be reviewed and evaluated in terms of the potential impacts on the input parameters for the biosphere models. They also cited a need for decoupling different elements of the BDCFs within the total system performance assessment.

Radium-226 as a Radionuclide Source

The importance of ^{226}Ra and its relevance to the biosphere dose calculations needs to be further assessed. From the standpoint of the individual protection standard, ^{226}Ra is important only if it is released from the repository.

Acceptability of the Reasonably Maximally Exposed Individual Concept

The NRC regulations (10 CFR 63.312) specify that the dose limits apply to the RMEI, who is an adult with "a diet and living style representative of the people who now reside in the Town of Amargosa Valley, Nevada."

Several members of the expert panel pointed out that the International Commission on Radiological Protection (ICRP) recommends that compliance with the applicable regulations be based on the annual dose and/or dose rate to the average member of what they describe as the "critical group." The expert panel suggested that the NRC consider having DOE perform some auxiliary dose estimates to compare the values based on the RMEI and the ICRP critical group concepts. This is another example of a calculation outside the compliance requirements that could build confidence in the dose calculations.

Risk Insights Initiatives

The NRC and the Center for Nuclear Waste Regulatory Analyses (CNWRA) have been conducting studies since the early 1990s on both the ground water exposure scenario and the postulated igneous activity release. In terms of the former, the analyses indicate that about 50 percent of the dose will occur as a result of direct ingestion and about 40 percent through the consumption of irrigated crops. The NRC and CNWRA concluded that the uncertainties of these estimates are "low relative to other abstractions." As a result, they do not plan any additional technical work in this area.

For a potential igneous event, the analyses show that the inhalation pathway dominates, the key parameters being the mass loading and exposure duration. Mass loading, in particular, is a sensitive and uncertain parameter. The NRC and CNWRA will continue to investigate these parameters. They are also developing new dose assessment models. One observation relative to the key input parameters is that it appears that radionuclides will not be readily leached from the ash. Items needing special attention are the size distribution of the airborne particles and the processes involved in the remobilization of the volcanic ash. The NRC and CNWRA identified two areas that need to receive priority attention: (a) documentation of the basis for the assumed particle size concentrations of the airborne particles and (b) the basis for bounding the redistribution of ash.

Reference:

U.S. Department of Energy, "The 1997 'Biosphere' Food Consumption Survey: Summary Findings and Technical Documentation," Las Vegas, Office of Civilian Radioactive Waste Management, 1997. [Prepared by TRW Environmental Systems, Inc.]