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MEMORANDUM TO: Margaret V. Federline, Chief
Hydrology and Systems Performance Branch, DHLWM

THRU: Norman A. Eisenberg, Section Leader
Repository Performance Assessment Section
Hydrology and Systems Performance Branch, DHLWM

FROM: Robert B. Neel, Systems Performance Analyst
Repository Performance Assessment Section
Hydrology and Systems Performance Branch, DHLWM

SUBJECT: FOREIGN TRIP REPORT: MEETING OF THE REFERENCE BIOSPHERE WORKGROUP OF BIOMOVS II, MADRID, SPAIN

An abstract of my trip and a detailed trip report are enclosed. These documents contain those observations and comments on the meeting that I consider significant. I have also indicated my recommendations as to further participation in BIOMOVS.

/s/

Robert B. Neel, Systems Performance Analyst
Repository Performance Assessment Section
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Enclosure:
As stated

cc: J. M. Taylor, EDO
J. Brady, SEC/ADM
C. R. Stoiber, IP
G. Arlotto, NMSS
J. Youngblood, HLWM

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TRIP REPORT ABSTRACT
DATE OF REPORT
5/14/93

OFFICIAL TRAVELER:
Robert B. Neel

TRAVEL TO: BIOMOVS II
Madrid, Spain

BEGINNING ON: 4/26/93
ENDING: 4/29/93

OFFICE: Nuclear Material Safety & Safeguards
Division of High-Level Waste Management
Hydrology and Systems Performance Branch

MEETING TITLE AND/OR AFFILIATION:

Reference Biospheres Working Group of the
Biospheres Model Validation Studies, Phase II

ORGANIZED BY: Intera Information Technologies Limited, UK

SUMMARY OF MEETING RESULTS:

Dr. R. B. Neel, Systems Performance Analyst, HLHP, DHLWM, NMSS, participated as an observer from the U.S.A. at a workshop convened by the Reference Biospheres workgroup (RBWG), one of four study groups that participate in Biosphere Model Validation Studies, Phase II (BIOMOVS II). The chairman of the RBWG is Fritz van Dorp (Nagra, Switzerland). BIOMOVS is an international cooperative effort to test quantitative biosphere models. These are used to estimate the transfer and accumulation of radionuclides (and other trace substances) between living organisms and their environment.

The members of the RBWG believe that the following assumptions should guide any approach to the modeling of the long-term consequences of releases of radionuclides to the biosphere. They are convinced that this is the best, and the only productive, approach that should be pursued in the further development of current biosphere models. The concept of a reference biosphere appears to rest upon four major assumptions:

o Assumption #1: Although we cannot predict the consequences of a release of radionuclides into the environment with biosphere models for a future time, we can evaluate what the consequences would be if the postulated release occurred today (or in some other hypothetical range of conditions present at any potential site today).

o Assumption #2: Assessments of the long-term consequences of a release of radionuclides into the biosphere should provide an indication of the general levels of dose (or risk) for an assumed set of biosphere conditions rather

than be based on predictions that take into account all the possible evolutions (future states) of the surface environment.

o Assumption #3: Reasonable predictions of the future developments in current technology and agriculture are not feasible.

o Assumption #4: The consequences of a release of radionuclides for comparison to national regulatory guidelines should be estimated for individuals, not for populations.

As a result of these studies, the RBWG claims it may ultimately be able to provide:

--a recommended methodology of biosphere modeling for the assessment of radioactive, solid-waste disposal that is consistent with different disposal concepts and for different types of waste.

--examples of how the methodology might be applied to modeling.

--an international list of features, events and processes that can be used as a basis for the definition of specific biosphere models.

--factors to convert geosphere releases into dose (or risk) (these may be developed for certain types of biospheres, but it is not yet clear if they would apply to Yucca Mountain, NV).

The reference biosphere concept is at a very preliminary stage of development, the work is voluntary, and I therefore expect it to progress at a rather slow pace. The results of the analyses discussed in this paper are scheduled to be reported at the next BIOMOVS meeting to be held in Vienna, Austria, November 1993.

DETAILED TRIP REPORT OF:
Robert B. Neel, Systems Analyst
Hydrology and Systems Performance Branch
Division of High Level Waste Management
Office of Nuclear Material Safety and Safeguards

SUBJECT: Trip report on a meeting of the Reference Biosphere Working Group of BIOMOVS II, in Madrid, Spain, April 26-29, 1993

Dr. R. B. Neel participated as an observer from the U.S.A. at a workshop convened by the Reference Biospheres workgroup, one of four study groups that participate in Biosphere Model Validation Studies, Phase II (BIOMOVS II). BIOMOVS is an international cooperative effort to test models designed to quantify the transfer and bioaccumulation of radionuclides and other trace substances in various media in the surface environment. BIOMOVS, which was established at the specific request of the Nuclear Energy Agency-Performance Assessment Group (PAAG), is administered by a Steering Committee composed of representatives from funding organizations in three countries: Spain, Canada and Sweden. In the past meetings, representatives from the following countries have also participated in the various BIOMOVS exercises: Austria, Belgium, Hungary, Japan, Romania, Slovenia, Switzerland, Netherlands, and Finland.

The meeting took place at the CIEMAT research complex in Madrid, Spain. A variety of technical disciplines were represented (radioecology, agronomy, soil chemistry, etc.). Most participants had used one or more computer models for dose assessment in their respective countries. Representatives from the following countries attended: Spain, Canada, Sweden, United Kingdom, Netherlands, Russia, France, Belgium, and Switzerland. K. Higley, currently a Ph.D. candidate at Colorado State University, but who has worked in the past as a consultant for the Department of Energy, also attended. (Only 2 or 3 persons from the Department of Energy were listed as participants in this study in the Progress Report No.3 for last BIOMOVS general meeting in late 1992).

REPORT ON THE REFERENCE BIOSPHERES WORK GROUP (RBWG):

The chairman of RBWG is Fritz van Dorp (Nagra, Switzerland). The primary objective of the RBWG is to establish a consensus on the development and application of the reference biosphere approach in the evaluation of the long-term consequences of solid waste disposal systems. A secondary objective of the RBWG is to define and categorize methods to demonstrate that the consequences (usually expressed as dose or risk) of a release will comply with the national regulatory criteria for solid waste disposal.

The members of the RBWG believe that the following assumptions should guide any approach to the modeling of the long-term consequences of releases of radionuclides to the biosphere. They consider this as the only productive

approach that should be pursued for the further development of current biosphere models. The concept of a reference biosphere appears to rest upon four major assumptions:

o Assumption #1: Although we cannot predict the consequences of a release of radionuclides into the environment with biosphere models for a future time, we can evaluate what the consequences would be if the postulated release occurred today (or under some hypothetical range of conditions present at any potential site today, e.g., a tropical climate in the artic tundra).

o Assumption #2: Assessments of the long-term consequences of a release of radionuclides in the biosphere should provide an indication of the general levels of dose (or risk) for an assumed set of biosphere conditions rather than be based on predictions that take into account all the possible evolutions (future states) of the surface environment.

o Assumption #3: Reasonable predictions of the future developments in current technology and agriculture are not feasible.

o Assumption #4: The consequences of a release of radionuclides for comparison to national regulatory guidelines should be estimated for individuals, not populations.

It may be possible to define a set of environmental conditions that can be combined into a single universal conceptual model of the biosphere, i.e., to define a single "reference biosphere." On the other hand, the consequences of a release due to the range of variations in the surface environment that can be found on the planet at this time may be so broad as to require many conceptual models, i.e., a number of reference biospheres may need to be defined.

The RBGW adopted the following approach in order to determine the "assumed set of biosphere conditions" that might be used to prepare the conceptual model for a reference biosphere. The chairman, Van Dorp, prepared a comprehensive list of those features, events and processes (FEPs) that might be expected to have an impact on the conditions for transfer or accumulation of radionuclides in any current biosphere. Eight of the RBWG participants volunteered to perform a test calculation in order to rank the FEPs in Van Dorp's list in terms of their importance. The criterion for importance of an FEP is the relative magnitude of its consequence as calculated by the computer code used by the participant to model their particular biosphere.

In order to facilitate intercomparison of the results of these ranking studies, the Complementary Studies Work Group (CSWG) provided each participant with a set of fixed parameters to be used in their calculation ( the data correspond to a synthetic biosphere based on a valley in central Switzerland). To facilitate the evaluation of the data, each participant was asked to provide the following information to the CSWG along with the results of their

calculations: a written and mathematical description for each FEP and for those conceptual models used in the test calculation, how the parameters supplied for the synthetic biosphere were used in the calculations, and any values for default parameters that had to be substituted for the synthetic parameters in order to complete the calculations. This information will be compiled into a FEP data base to be stored electronically on a file in DBASE IV. The members of the RBWG and the SCWG expect that this study could result in a valid intercomparison of the various conceptual models now used by members of the work group for consequence assessment, and that, based on these intercomparisons, the relative ranking of the FEPs for the different models may be shown to be similar. After screening out unimportant FEPS, the remaining FEPs will be used to prepare a universal list of FEPs to be considered in any comprehensive model of the biosphere.

The RBWG plans to develop a procedure to combine the important FEPs into reference scenarios that could be used to update the conceptual models currently used for these scenarios. The RBWG also intends to use these reference scenarios to compare different solid waste disposal systems, and perhaps as a basis for the definition of one or more reference biospheres. These comparisons will use concentrations in the various environmental media as end points. Any uncertainties in the results of assessments due to uncertainties in values for the dose conversion factors or risk factors are not considered a part of the charter for the RBWG.

REPORT ON THE MODEL COMPLEXITY WORK GROUP (MCWG):

The chairman of the MCWG work group is Mark Elert, (Kemakta Konsult AB), Sweden.

Assessment models used to describe transport of radionuclides in the biosphere are often based on simplification of more complex physical and chemical models. This may introduce biases and uncertainties into the assessments of the long-term consequences of a release into the biosphere. The MCWG initially plans to study a very simple model of the downward migration of radionuclides into soil after their deposition on the soil surface.

Eight members of this work group were given a fixed set of soil parameters (conductivity, porosity, density...and the uncertainties of these values), meteorological data, and a simple conceptual model of the soil. They were asked to use this standardized soil model to calculate the concentration profiles and travel times for three nuclides (Cs-137, Sr-90 and I-129) to selected depths of the soil column at various times post deposition. They intend to include additional model complexities (such as fractures, correlation of parameters...) in future studies. Intercomparisons of results of these calculations for models of varying complexity are expected to help define the magnitude of the uncertainties that can result when simpler models are used for consequence calculations.

SIGNIFICANT OBSERVATIONS:

o At some point in the near future the RBWG claims it may be able to provide:

--a recommended methodology of biosphere modelling for the assessment of radioactive solid waste disposal that is consistent for different disposal concepts and for different types of waste.

--examples of how the methodology might be applied to modelling.
--an international list of FEPs that can be used as a basis for specific biosphere models.

--factors to convert geosphere releases into dose (or risk) (these may be developed for certain types of biospheres, but it is not yet clear if they would apply to Yucca Mountain, NV).

o The RBWG and CSWG do not plan to address the consequences of releases of special nuclides (such as C-14, I-129,...) until after 1993.

o The consequences of releases on a growing global population will not be a part of these studies of the reference biosphere. Only the consequences to individuals will be estimated.

o Data collected by radio-ecologists in Europe as a result of the Chernobyl accident are expected to help refine the models and parameters currently used for biosphere modelling.

o The reference biosphere concept is at a very preliminary stage of development, the work is voluntary, and I therefore expect it to progress at a rather slow pace. The results of the analyses discussed in this paper are scheduled to be reported at the next BIOMOVS meeting to be held in Vienna, Austria, November 1993.

RECOMMENDATIONS AS TO FURTHER PARTICIPATION:

o It is not clear, at the present time, how limitations on staff availability might impact NRC participation in BIOMOVS and the associated computer modelling exercises. However, I recommend that the NRC staff should continue to follow the BIOMOVS studies for the following reasons:

--the reference biospheres methodology might be useful to determine if further development of biosphere models for Yucca Mountain (or other potential disposal sites) will be necessary.

--the licensing activities for a geologic repository to dispose of high-level radioactive waste might be greatly accelerated if a reference biosphere could be developed and agreed upon by all interested parties in the pre-licensing period.

--the biosphere modelling approaches of the NRC may be more easily justified and may be more acceptable to members of the public if they follow a methodology developed by international cooperation.

o The development of a reference biosphere may be of interest to the National Academy of Sciences as it attempts to formulate recommendations to the Environmental Protection Agency on the proper regulatory requirements to be included in Subpart B of 40 CFR 191.