Sandia National Laboratories
Albuquerque, New Mexico 87185

A1165
PM
MJS
DDR
LPDR (B/H)

February 14, 1983

Mr. Matthew J. Gordon
High-Level Waste Licensing
Management Branch
U.S. Nuclear Regulatory Commission
7915 Eastern Avenue
Silver Spring, MD 20910

Dear Mr. Gordon:

Enclosed is the summary of activities during January 1983 for the following tasks (A-1165): (1) Coordination of NRC Research and Technical Assistance Programs; (2) Monitor and Review Aspects of DOE . . . ; (3) Technical Support for Comments on the EPA Standard; (4) Short-term Technical Assistance.

Sincerely,

Nestor R. Ortiz, Supervisor
Fuel Cycle Risk Analysis
Division 9413

NRO:9413:fmp
Enclosures

Copy to:
Office of the Director, NMSS
Attn: Program Support
Robert Browning, Acting Director
Division of Waste Management
Malcolm R. Knapp
Division of Waste Management
Cal Belote
Division of Risk Analysis
Jared J. Davis, Chief
Health Siting & Waste Management Div.
3151 W. L. Garner (Form 426)
9413 N. R. Ortiz
9413 N. C. Finley

PROGRAM: Coordination of NRC Research and Technical Assistance Programs Pertaining to Performance Assessment

FIN#: A-1165 Task I

CONTRACTOR: Sandia National Laboratories

NMSS PROGRAM MANAGER: M. J. Gordon

CONTRACT PROGRAM MANAGER: N. R. Ortiz FTS PHONE: 844-5644

PRINCIPAL INVESTIGATORS: A. B. Muller FTS PHONE: 844-7391
M. D. Siegel FTS PHONE: 846-5448

PROJECT OBJECTIVES

To provide a basis for coordination of NRC research and technical assistance programs pertaining to performance assessment (cf. 189 No. A-1165).

SUMMARY OF ACTIVITIES FOR JANUARY 1983

An effort was started to set up a matrix summarizing the NRC's HLW projects in the areas of waste package and performance assessment. This matrix will contain the following information:

1. Title and short description of the project.
2. FIN number.
3. Name and telephone number of the NRC's program manager.
4. Name and telephone number of the contractor's program manager.
5. Beginning and ending dates of the project.

The above information should be useful to NRC for coordination of and integration of the HLW program, and to prevent duplication of efforts. We will meet with NRC after the first draft to update the matrix.

PROGRAM: Monitor and Review Aspects of DOE, other National and International Waste Management Programs

FIN#: A-1165 Task II

CONTRACTOR: Sandia National Laboratories

NMSS PROGRAM MANAGER: M. J. Gordon

CONTRACT PROGRAM MANAGER: N. R. Ortiz FTS PHONE: 844-5644

PRINCIPAL INVESTIGATOR: N. C. Finley FTS PHONE: 844-6059

PROJECT OBJECTIVES

To monitor and review the performance assessment aspects of DOE and other national and international waste management programs.

ACTIVITIES DURING JANUARY 1983

During this month, some progress was made on the document reviews referred to in the December monthly. We hope that these may be completed for inclusion in the February monthly report. Copies of several reviews completed during January are attached.

In addition, the report "Engineered Components for Radioactive Waste Isolation Systems--Are They Technically Justified?" (ONWI-286) was reviewed. Comments were sent to NRC on January 21, 1983. ONWI-286 concludes that engineered barriers are not needed in repositories because "even relatively poor sites [are] more than adequate to isolate the waste without the use of any engineered components." The conclusion is not well-supported by ONWI-286. Not all the assumptions and arguments used in arriving at the conclusions of ONWI-286 are convincing. The demonstration of the non-usefulness of the engineered barriers is based on non-conservative parameter value selection and use of relatively narrow ranges of retardation factors which are poorly understood (but highly significant). In spite of repeated claims of being conservative, we feel that in many instances the assumption or input value selections were not conservative at all. No provision seems to have been made for the large uncertainties in characterizing the subsystems. NRC, in its rationale for the Rule (10CFR60), has used considerably more conservatism and determined consequences in terms of the EPA draft standard.

We feel that significantly different conclusions regarding the engineered barriers might result if an appropriate degree of conservatism went into the analysis and if the consequences were expressed in terms of the EPA release limits.

PROGRAM: Technical Support for Comments on The EPA Standard — FIN#: A-1165 Task III

CONTRACTOR: Sandia National Laboratories

NMSS PROGRAM MANAGER: M. J. Gordon

CONTRACT PROGRAM MANAGER: N. R. Ortiz — FTS PHONE: 844-5644

PRINCIPAL INVESTIGATORS: M. S. Y. Chu — FTS PHONE: 844-9931
M. D. Siegel — FTS PHONE: 846-5448

PROJECT OBJECTIVES

This program seeks to provide information to be used in commenting on the draft standard on geologic disposal of radioactive wastes (40CFR191, draft) to be issued by the Environmental Protection Agency (EPA). This information is to be derived from insights gained by performing several calculations similar to those which provide the basis for the EPA Standard. All calculations will be performed with the Sandia Pathways-to-Man, Dosimetry and Health Effects, and SWIFT/NWFT/DVM models and will use data available from the sites currently under investigation for possible geologic repositories. Media of interest are: bedded salt, basalt, welded tuff, and granite.

ACTIVITIES DURING JANUARY 1983

Tasks A, B, C, D

No activity.

PROGRAM: Short-Term Technical Assistance FIN#: A-1165 Task IV

CONTRACTOR: Sandia National Laboratories BUDGET PERIOD: 10/82-9/83

NMSS PROGRAM MANAGER: M. J. Gordon BUDGET AMOUNT: $100,000

CONTRACT PROGRAM MANAGER: N. R. Ortiz FTS PHONE: 844-5644

PRINCIPAL INVESTIGATORS: M. S. Y. Chu FTS PHONE: 844-9931
M. D. Siegel FTS PHONE: 846-5448

PROJECT OBJECTIVES

General technical assistance on waste management matters relating to Tasks I-III will be provided by Sandia upon receipt of written requests from NRC. The assistance under this task generally will be to respond on relatively short notice to requests for information not to be provided in the normal course of work outlined under Tasks I-III. Scope, duration, reporting requirements, funding limits and priorities for individual tasks will be set forth by NRC in writing. This task shall not exceed $100K of effort per year.

ACTIVITIES DURING JANUARY 1983

Task 4

Work continues in the write-up of the waste package reliability appendix for the Site Characterization Analysis report. The appendix will include qualitative discussions in the following areas:

1. Essential processes of water ingress, waste form dissolution or leaching, and radionuclide transport out of the waste package.

2. Origins of the uncertainties in the degradation processes of each of the waste package components.

3. Relationship of component performance to waste package performance estimates.

4. Propagation of uncertainties in the waste package reliability estimate.

5. Information needs to estimate degradation of each of the waste package components, initial defective fractions and random failures of waste packages.

6. Methods of acquisition of the necessary data through laboratory and field testing, accelerated testing, etc.

7. Importance of model development and verification in the construction of a waste package performance model and the use of such a model in reliability estimates.

The report will be completed by February 28, 1983.

AUTHOR: Cloninger, M.O., Cole, C.R. and Washburn, J.F.

TITLE: An Analysis of the Use of Engineered Barriers for Geologic Isolation of Spent Fuel in a Reference Salt Site Repository

REFERENCE: Battelle Pacific Northwest Laboratory, Report PNL-3356, UC-70, December, 1980.

DOCUMENT SUMMARY:

This report presents the results of a sensitivity analysis performed on an idealized salt repository using computer programs GETOUT and PABLM. The sensitivity study considers effects of variations in release rate, delay prior to release, and groundwater travel time (groundwater path length/velocity). The performance index is the maximum 70-year dose to an individual, with no consideration for the time when the dose occurs.

The models used are not discussed in detail. GETOUT is a one dimensional geosphere transport model. Geosphere transport processes included are:

- radionuclide release from repository by groundwater contact and leaching
- groundwater transport with advection, reversible sorption and mineralization, and radioactive chain decay
- release to surface water or intrusion (well) water.

The biosphere model, PABLM, predicts the radiation dose to humans via the following pathways:

- direct ingestion of water
- ingestion of aquatic or irrigated foods, including reconcentration and accumulation effects

AUTHOR: Gupta, S.K., Cole, C.R. and Bond, F.W.

TITLE: Assessment of Effectiveness of Geologic Isolation Systems: Finite Element Three-Dimensional Groundwater (FE3DGW) Flow Model - Formulation, Program Listings, and User's Manual

REFERENCE: Battelle Pacific Northwest Laboratory Report PNL-2939, UC-70, December, 1979.

DOCUMENT SUMMARY:

This report presents complete documentation for FE3DGW, a three-dimensional groundwater flow model. The report provides discussion of model theory and computer implementation, verification and illustrative examples, user's manual, and program listings.

FE3DGW is a transient true three dimensional flow model using the Galerkin finite element approach. The program utilizes standard anisotropic, heterogeneous nondeformable porous media flow equations from Jacob (1950). Solution is performed in terms of potential (head) and flow streamlines. Density dependent flow, heat flow and solute transport are not solved. The effects of temperature and salt concentration upon viscosity are included in the hydraulic conductivity term.

Four special features distinguish FE3DGW: 1) user oriented input with graphical data checking; 2) graphical output; 3) core reduction; and 4) computation time control.

Data input is simplified by automatic generation of three dimensional elements from user supplied data. The input sequence is generally as follows:

- Assign nodes to define stratigraphic or structural features
- Assign nodes to define surface water, recharge/discharge areas, wells
- Eliminate clusters of closely spaced nodes
- Prepare a stratigraphic log for each node, input elevation or thickness for each material
- Define straight (linear) or curved (quadratic or cubic) lines between nodes to form isoparametric 2-dimensional elements.

AUTHOR: McLaughlin, Dennis B.

TITLE: Hanford Groundwater Modeling - A Numerical Comparison of Bayesian and Fisher Parameter Estimation Techniques

REFERENCE: Resource Management Associates Report RMA 8310, Rockwell Hanford Operations Report RHO-C-24, February 1979.

DOCUMENT SUMMARY:

This report develops and compares two methods for estimating parameters from uncertain data. Both methods require minimization of a performance index which indicates how well the parameter estimates fit available data. The least-squares parameter estimator is simpler to use, but assumes that model inputs are perfectly known and can not include bias effects. The maximum likelihood estimator treats model inputs as random variables with known means and covariances in estimating the unknown parameters. The author makes a distinction between model inputs which are observable variables that are easy to estimate (i.e., pump rates, readily measured initial/boundary conditions) and model parameters which must be indirectly inferred (i.e., hydraulic conductivity, specific storage, porosity, dispersivities, equilibrium distribution coefficients, initial/boundary conditions which are difficult to measure). The statistical methods described in this report solve the inverse problem; that is, they estimate model parameters from available measurements of the model's dependent variable (i.e., hydraulic head). It is assumed that the functional structure of the model is correct so that all uncertainties are related solely to model parameters and inputs.

AUTHOR: Nelson, R.W.

TITLE: Use of Geohydrologic Response Functions in the Assessment of Deep Nuclear Waste Repositories

REFERENCE: Battelle Pacific Northwest Laboratory Report PNL-3817, UC-70, May, 1981.

DOCUMENT SUMMARY:

Response functions are functional representations of the relationships between model parameters and performance indices. This report presents response functions for radionuclide release to the biosphere from an underground waste repository. The paper does not explain how the response functions are developed.

The geohydrologic response functions (GRF's) presented in this paper deal with interrelationships between quantity, arrival time, and outflow location of contaminants. Four hypothetical repository systems are evaluated with respect to these three factors using GRF's, and the most favorable design is selected on the basis of having the longest travel time and lowest release rate to the biosphere.

Within the context of the paper, model parameters are considered fixed and are not included in the response function. Response functions are treated as simple graphs of one performance index against another for a given model. The content of the paper is thus limited to a discussion of how information can be read from graphs. Most of the graphs presented are simple two parameter plots, although some three parameter plots are included.

AUTHOR: Simmons, C.S.

TITLE: Relationships of Dispersive Mass Transport and Stochastic Convective Flow Through Hydrologic Systems

REFERENCE: Battelle Pacific Northwest Laboratory Report PNL-3302, UC-70, August 1980.

DOCUMENT SUMMARY:

The author presents a method for calculating solute transport at the megascopic scale using a stochastic approach. The classical convective-dispersion equations are assumed to hold at the macroscopic scale, which is the scale at which a representative volume can be defined. However, on the megascopic scale uncertainties and actual large-scale variability in the flow velocity field both in space and in time can result in effective dispersivities much higher than either those predicted by the convective-dispersion equation or measured in small-scale laboratory tests.

The report reviews a number of mathematical formulations of solute transport from a stochastic approach. All approaches require an ensemble viewpoint of the groundwater flow. Perturbation methods are effective if the velocity variation is small compared to the mean velocity. A direct velocity ensemble approach is difficult to apply because the complete velocity field probability distribution is seldom known, but this approach can treat arbitrarily large variations in velocity. Geostatistical methods (Kriging), which are suggested but not discussed in this report, can be used to provide a statistical description of spatial variability in the hydraulic properties which cause

AUTHOR: Yeh, G.T. and Ward, D.S.

TITLE: FEMWASTE: A Finite Element Model of Waste Transport Through Saturated-Unsaturated Porous Media

REFERENCE: Oak Ridge National Laboratory Environmental Sciences Division, Publication No. 1462, ORNL-5601, April 1981.

DOCUMENT SUMMARY:

This report presents a 2-dimensional finite element program for solute transport in saturated-unsaturated media. The model is an updated version of a previous ORNL model (Duguid and Reeves, 1976). The report contains complete mathematical development of theoretical and computational approaches, comparison of results using alternative assumptions, program input instructions, sample input, and a program listing.

The solute transport equations used in the model are designed especially for radionuclide transport, and therefore couple porous media flow (advection) with hydrodynamic dispersion, chemical adsorption, and first order decay. Thermal and osmotic effects are not included.

Transport in the unsaturated zone is handled by replacing porosity with moisture content. Transport equations are otherwise identical in the saturated and unsaturated zones. The equilibrium distribution coefficient (K_D) and geochemical retardation (R_D) can both be coupled to saturation. The major difference between this model and Duguid and Reeves (1976) is that the earlier model held R_D constant while this model varies R_D with degree of saturation. This change has a very strong influence on solute concentration results in the unsaturated zone.