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5 February 1986

David Tiktinsky - SS623
U.S. Nuclear Regulatory Commission
Division of Waste Management
Washington, D.C. 20555

"NRC Technical Assistance
for Design Reviews"
Contract No. NRC-02-85-002
FIN D1016

Dear David:

Enclosed is the trip report for Charles Fairhurst's and my at-
tendance at the NRC Workshop on Validation of Mathematical Models
for Waste Repository Performance (27-30 January 1986) and my
meetings with NRC staff.

Sincerely,

Roger D. Hart
Roger D. Hart
Program Manager

cc: J. Greeves, Engineering Branch
Office of the Director, NMSS
E. Wiggins, Division of Contracts
DWM Document Control Room

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ITASCA TRIP REPORT



DATES: 27-30 January 1986

LOCATION: Holiday Inn Hotel
8120 Wisconsin Avenue
Bethesda, Maryland

and

Nuclear Regulatory Commission
Silver Spring, Maryland

PURPOSE: NRC Workshop on Validation of Mathematical Models for
Waste Repository Performance Assessment — Confidence
Building Through Synthesis of Experiments and Calcula-
tions

ITASCA ATTENDEES: Charles Fairhurst
Roger Hart

Summary - This workshop is described as the first of a "series of workshops to address the validation of models and their assumptions for high-level (HLW) repository performance and assessment". The meeting was attended by between 75-100 persons (attendance fluctuated over the three days). A copy of the workshop program is attached.

Although billed as a meeting to examine the question of model validation for all aspects of high-level waste isolation, participation was heavily biased toward geochemistry and geochemists. Much of the discussion centered on the complexities and difficulties inherent in predicting the retardation of radio-nuclide transport with respect to that of groundwater. It has been traditional to select a single retardation coefficient (K_d) for each nuclide, but research suggests that the value (K_d) can effectively range over several orders of magnitude—but all greater than zero. From the discussion, it seemed very clear to many in the audience that:

- (1) There is no accepted procedure for prescribing radionuclide retardation. It would take a lot of research (of the order of 10 years or more) to approach consensus on retardation of specific nuclides in specific rocks at specific sites.

- (2) The only logical course to follow, if DOE is to have any chance of maintaining the legislated time-scale for development of a high-level waste repository, is to assume $K_d = 0$ (i.e., no retardation) for all significant radionuclides and to base the case of isolation entirely on groundwater travel times. This appears to be the course that DOE will pursue. This should make all NRC research on retardation geochemistry at best a second-order concern—yet NRC research staff appear keenly interested in geochemistry.

Dr. Langmuir, of the Department of Chemistry and Geochemistry, Colorado School of Mines, has a much broader appreciation of geochemistry and its practical applications. His presentation on the geochemical approach to sealing recognizes the application of geochemistry to fully utilize this engineered barrier.

Groundwater travel modeling was discussed primarily by Dr. Lynn Gelhar (MIT) and Dr. Neuman (University of Arizona, Tucson). Both were concerned with the modeling of dispersion and its effect in calculating groundwater travel time. The apparent general acceptance of the need to use stochastic approaches to groundwater flow was remarkable. (Note, however, that there were just 2 main speakers and that Dr. Neuman was not as committed to a stochastic approach as Dr. Gelhar but, rather, he felt that flow was complicated and very difficult to predict—dispersion was a big problem and, hence, he seemed to agree to a stochastic approach.)

Dr. Fairhurst noted that the distinct element method used by the UDEC and FRIP codes could be used to help understand groundwater flow in crystalline rock. The Camborne geothermal reservoir experiment demonstrated clearly that the stress field dominates the direction of fluid flow. Also, aperture fracture appears to follow a log-normal distribution—i.e., a lot of (short) fractures with small aperture, very few (long?) fractures with large aperture. It would seem that UDEC, used together with these controls, could provide insights to at least some of the groundwater problems. Thus, it would seem probable that most of the flow in a fracture flow-controlled rock mass would be primarily through those (relatively few) joints that are normal to (or nearly so) the minimum in-situ normal stress. A discussion with structural geologists on joint systems, and the influence of present (or previous) stress fields on jointing, aperture, etc. could be valuable.

Geomechanics modeling presentations were given by Dr. Tsang (LBL) and Dr. Fairhurst. Dr. Tsang filled in at the last minute for Dr. Noorishad and thus talked in generalities. He presented a need for more code development and the use of large mainframe computers (i.e., linking CRAY's together). I would take exception to these remarks and think that Dr. Fairhurst's presentation showed that much can be learned without resorting to extremely complicated and time-consuming analyses.

There appeared to be good acceptance of Dr. Fairhurst's talk on geomechanics. Adrian Brown stated to the meeting audience that Dr. Fairhurst's presentation was the only one to actually present a real validation of a code since appropriate values of variables were measured independently [e.g., shear force/deformation behavior of the "joints" (hexagonal interfaces)] and combined in the model to give a predicted result. Others, he suggested, were "knob-twiddling" (calibrating).

An important question for model validation and site characterization concerns the rationale DOE is using to define the field testing program. The question of "How many in-situ tests should DOE be doing?" is a question to be asked only after some background has been established. It should be preceded by questions such as "What is the basis for the design? How will an in-situ test aid the design? How representative of the entire repository will one in-situ test be? Is the design really sensitive to the variables to be measured in the test?, etc. Because most of the repository sites involve rock masses with anisotropic discontinuities and non-hydrostatic stress conditions, for example, it would be difficult to answer several of these questions using the continuum codes (usually involving isotropic cases only) that DOE appears to be using. What NRC needs to do is to get itself into position to look at designs for a variety of (reasonable) assumed rock mass situations, and see what the critical combinations of variables are. Then it could judge intelligently whether the designs and tests (and codes) proposed are adequate.

As a final comment, it appears that NRC Research is directing a significant funding effort to topics, the results of which will not contribute significantly to the licensing deliberations (i.e., licensing will not take credit for any research results which are not proven beyond reasonable doubt—the radionuclide retardation research falls in the category that definitely will be unproven at the time of license application, 5 years from now).

The workshop ended on 29 January, but I was asked to stay one more day to meet with NRC staff at Silver Spring and discuss present

concerns for the rock mechanics and design review effort. The discussions were led by David Tiktinsky and Mysore Nataraja. The preliminary topic was the need for site technical position papers on the in-situ geomechanical testing. Mr. Tiktinsky also provided information on the status of NRC document reviews. A second topic of concern was the NRC modeling strategy for HLW performance assessment. John Greeves provided me with the Modeling Strategy Document (July 1984), which describes NRC staff strategy for using numerical models for review purposes. I was asked for comments on the modeling effort. I suggested that NRC is in a good position to use geomechanical and thermo-mechanical codes on their in-house microcomputer facilities to provide bounding calculations to substantiate review efforts related to site characterization. A general discussion was held on the types of codes which are well suited for this effort.

Respectfully submitted,



Roger D. Hart
Program Manager

4 February 1986

Attach.
mb/ks

COST BREAK-OUT

Labor

R. Hart	30 hrs @ \$ 49.21/hr	\$ 1,476.38
C. Fairhurst	24 hrs @ \$116.80/hr	2,803.20
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	TOTAL LABOR	\$ 4,279.58

Actual Expenses

Travel

Airfare (MSP-WDC-MSP)		
Hart	\$	460.00
Fairhurst		380.00
Miscellaneous Travel Expenses (taxi, buses)		28.50

Motel

Hart (4 nights)	272.80
Fairhurst (3 nights)	204.60

Meals

Hart	27.20
Fairhurst	20.40

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TOTAL EXPENSES	\$	1,393.50

**WORKSHOP ON VALIDATION OF MATHEMATICAL MODELS FOR WASTE
REPOSITORY PERFORMANCE ASSESSMENT - CONFIDENCE
BUILDING THROUGH SYNTHESIS OF EXPERIMENTS AND CALCULATIONS**

January 27 - 29, 1986

**HOLIDAY INN HOTEL
8120 WISCONSIN AVENUE
BETHESDA, MARYLAND**

PROGRAM

**Sponsored by the
U.S. Nuclear Regulatory Commission
Office of Nuclear Regulatory Research**

Organizers:

**E. J. Bonano
Sandia National Laboratories
Tel: 505-844-5303**

**F. A. Kulacki
Colorado State University
Tel: 303-491-6603**

**J. D. Randall
U.S. Nuclear Regulatory Commission
Tel: 301-427-4633**

- PROGRAM -

NATURAL BARRIERS - THERMALLY UNDISTURBED ZONE

Monday, January 27, 1986

<u>Time</u>	
8:30 - 8:45	INTRODUCTORY COMMENTS J. D. Randall, USNRC
8:45 - 9:05	LICENSING PERSPECTIVES ON MODELING S. Coplan, NRC
9:05 - 9:30	OVERVIEW OF WORKSHOP E. J. Bonano, SNLA
9:30 - 10:00	HYDROCOIN PROGRAM P. Davis, SNLA
10:00 - 10:15	INTRODUCTION OF SPEAKERS F. A. Kulacki, CSU
10:15 - 10:30	BREAK
10:30 - 11:00	TRANSPORT PHENOMENA Lynn Gelhar, MIT
11:00 - 11:30	HYDROLOGY S. P. Neuman, UAZ
11:30 - 12:00	GEOCHEMISTRY M. Siegel, SNLA
12:00 - 12:30	DISCUSSION AND QUESTIONS FROM AUDIENCE Moderator: F. A. Kulacki, CSU
12:30 - 2:00	Lunch
2:00 - 3:45	PANEL DISCUSSION AND RESPONSE Moderator: G. Birchard, NRC Panelists: S. P. Neuman, Univ. of Arizona H. Wollenberg, LBL J. Daemen, Univ. of Arizona D. McLaughlin, MIT D. Vogt, CorStar
3:45 - 4:00	BREAK
4:00 - 4:30	INTRAVALE PROGRAM K. Andersson, SKI
4:30 - 6:00	IDENTIFICATION OF NEEDED EXPERIMENTS AND VALIDATION PROCEDURES Moderator: F. A. Kulacki, CSU Participants: Keynote Speakers, Panelists, and Audience

- PROGRAM -

NATURAL BARRIERS - THERMALLY DISTURBED ZONE

Tuesday, January 28, 1986

<u>Time</u>	
8:30 - 8:45	INTRODUCTORY COMMENTS F. A. Kulacki, CSU
8:45 - 9:00	INTRODUCTION OF SPEAKERS E. J. Bonano, SNLA
9:00 - 9:30	HYDROLOGY (SATURATED MEDIA) P. A. Davis, SNLA
9:30 - 10:00	HYDROLOGY (UNSATURATED MEDIA) K. Preuss, LBL
10:00 - 10:15	BREAK
10:15 - 10:45	GEOCHEMISTRY D. Langmuir, Colorado School of Mines
10:45 - 11:15	GEOMECHANICS J. Noorishad, LBL
11:15 - 11:45	GEOMECHANICS C. Fairhurst, University of Minnesota
11:45 - 12:15	DISCUSSION AND QUESTIONS FROM AUDIENCE Moderator: E. J. Bonano, SNLA
12:15 - 1:30	Lunch
1:30 - 3:30	PANEL DISCUSSION AND RESPONSE Moderator: J. D. Randall, NRC Panelists: D. Evans, Univ. of Arizona C.-F. Tsang, LBL F. A. Kulacki, CSU K. Wahi, SNLA T. Nicholson, NRC D. Vogt, CorStar
3:30 - 3:45	BREAK
3:45 - 5:30	IDENTIFICATION OF NEEDED EXPERIMENTS AND VALIDATION PROCEDURES Moderator: E. J. Bonano, SNLA Participants: Keynote Speakers, Panelists, and Audience

- PROGRAM -

ENGINEERED BARRIERS - WASTE PACKAGE

Wednesday, January 29, 1986

<u>Time</u>	
8:30 - 8:45	INTRODUCTION J. D. Randall, NRC
8:45 - 9:00	OVERVIEW OF SESSION & INTRODUCTION OF SPEAKERS. J. D. Randall, NRC
9:00 - 9:30	BACKFILL & PACKING (COUPLED EFFECTS IN TRANSPORT. C. L. Carnahan, LBL
9:30 - 10:00	BACKFILL & PACKING (CHEMISTRY) C. Radke, LBL
10:00 - 10:15	BREAK
10:15 - 10:45	CORROSION A. Markworth, BCL
10:45 - 11:15	LEACHING & DISSOLUTION A. Markworth, BCL
11:15 - 11:45	DISCUSSION AND QUESTIONS FROM AUDIENCE Moderator: E. J. Bonano, SNLA
11:45 - 1:00	Lunch
1:00 - 3:00	PANEL DISCUSSION AND RESPONSE Moderator: K. Kim, NRC Panelists: J. Daemen, Univ. of Arizona M. Molecke, SNLA S. Nicolosi, BCL U. Bertocci, NBS H. Isaacs, Brookhaven M. McNeil, NRC D. Vogt, CorStar
3:00 - 3:15	BREAK
3:15 - 5:00	IDENTIFICATION OF NEEDED EXPERIMENTS AND VALIDATION PROCEDURES Moderator: F. A. Kulacki, CSU Participants: Keynote Speakers, Panelists, and Audience
5:00 - 5:15	CLOSING REMARKS F. A. Costanzi, NRC