JUL 29 1988

WM88086/88/07/28

MEMORANDUM FOR: Robert E. Browning, Director
Division of High-Level Waste Management

FROM: Ronald L. Ballard, Chief
Technical Review Branch
Division of High-Level Waste Management

SUBJECT: REGULATORY IMPLICATIONS OF HYDROCOIN RESULTS (WM ACTION #88086)

This memorandum is in response to your inquiry concerning the HYDROCOIN Level One project and how this work will affect DOE and NRC work. HYDROCOIN, the international cooperation project for studying groundwater flow modelling in the context of radioactive waste disposal was initiated in 1984. Thirteen organizations from ten countries and two international organizations are participating in the project, which is managed by the Swedish Nuclear Power Inspectorate. Seven groups from the USA participated in the project:

(1) DOE Nevada Nuclear Waste Storage Investigations
(2) DOE Office of Crystalline Repository Development
(3) DOE Office of Nuclear Waste Isolation
(4) DOE Salt Repository Project
(5) DOE Basalt Waste Isolation Project
(6) Sandia National Laboratories
(7) The Nuclear Regulatory Commission

The purpose of the project is to improve knowledge of the influence of various strategies for groundwater flow modelling on the safety assessment of nuclear waste repositories. To this end, calculations are made with different mathematical models. The study comprises:

(1) The impact of different solution algorithms on groundwater flow calculations;
(2) the ability of different models to describe field and laboratory experiments; and
(3) the impact of incorporating various physical phenomena on groundwater flow calculations.

The HYDROCOIN project is divided into three levels; Level One - code verification, Level Two - model validation, and Level Three - uncertainty and sensitivity analyses. To date only Level One has been completed and Levels Two and Three are still being pursued. Therefore, this memo only addresses the Level One results.

The most significant finding from HYDROCOIN Level One was that there were difficulties in modelling nonlinear problems, such as unsaturated ground water flow conditions (more details are provided in the attachment). For the

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unsaturated case, no team managed to get a satisfactory answer. Therefore, the development of numerical solution techniques to solve highly nonlinear equations is important for unsaturated flow modelling at Yucca Mountain.

Since the DOE actively participates in HYDROCOIN they should already be aware of this finding, so that if need be they can incorporate it into their ground water modelling program. Sections that describe unsaturated zone ground water modelling in the Consultative Draft Site Characterization Plan do not get into this level of detail, but a general commitment is made on page 8.3.1.2-274 that existing codes will be modified or new codes developed to meet specific requirements peculiar to the site for which available codes may be inadequate or unsuitable. To date the NRC staff has not reviewed a numerical model of this complexity developed by the DOE for Yucca Mountain. However, the staff will be incorporating this information into the review of modelling efforts described in the Site Characterization Plan and Study Plans.

Should you have any questions concerning this memo please contact William Ford (X20506).

/s/ Mysore Nataraja

Ronald L. Ballard, Chief
Technical Review Branch
Division of High-Level Waste Management

Attachment:
Comments

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ATTACHMENT TO WM ACTION #88086

The most significant conclusion drawn from HYDROCOIN that will affect the Yucca Mountain High Level Waste Site required modeling of unsaturated flow in layered sedimentary rock with different layers having highly contrasting hydraulic conductivities. The significance of this case was that no team managed to solve this problem and obtain a converged solution. This is because the initial permeability contrasts, which caused the moisture content to be discontinuous in the domain, proved too difficult to solve. Groundwater modeling at Yucca Mountain may require modeling to this level of complexity or greater. The development of numerical solution techniques to solve highly nonlinear equations is important for unsaturated flow modeling at Yucca Mountain, because without such development, cases of this complexity cannot be modeled.

Other conclusions that were significant to modeling Yucca Mountain were:

1. Particle-tracking algorithms used as post processors to analyze the simulation results proved to be very useful in achieving convergence with respect to velocities in saturated groundwater flow modeling cases. However, it was also learned that differences in particle-tracking routines contributed to the uncertainty of the calculated path lines in addition to discritization effects. A test case was formulated to compare and evaluate different strategies for particle tracking in the Level 3 effort.

2. During the workshop deliberations, it was determined that simulation and comparison of only scalar values such as groundwater levels were not sufficient to determine the accuracy of a code. Simulation and comparison of velocity and flux values were more sensitive tests of the codes.

3. It is easier to accurately model a domain with a complex geometry using finite elements, while finite-difference codes are less expensive to run than finite-element. However, for the types of problems simulated, the finite-difference codes were just as capable as the finite-element codes in simulating groundwater flow, even when the simulations involved complex geometry such as intersecting fractures.