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U.S. Nuclear Regulatory Commission
ATTN: Mrs. Deborah A. DeMarco
Two White Flint North
11545 Rockville Pike
Mail Stop T8 A 23
Washington, DC 20555

Subject: Programmatic Review of Abstract

Dear Mrs. DeMarco:

The enclosed abstract is being submitted for programmatic review. This abstract will be submitted for presentation at the 2003 International Conference on Coupled T–H–M–C Processes in Geosystems, to be held October 13–15, 2003 in Stockholm, Sweden. The title of the abstract is

> "Thermal-Mechanical Modeling of a Large-Scale Heater Test" by S.M. Hsiung, A.H. Chowdhury, and M.S. Nataraja.

Please advise me of the result of your programmatic review. Your cooperation in this matter is appreciated.

Sincerely yours,

Budhi Sagar
Technical Director

BS/cp

cc:

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Thermal-Mechanical Modeling of a Large-Scale Heater Test

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A.H. Chowdhury, Center for Nuclear Waste Regulatory Analyses, U.S.A.
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ABSTRACT

DECOVALEX (acronym for the **DE**velopment of **CO**upled models and their **VAL**idation against **EX**periments in nuclear waste isolation) is an international cooperative project to support the development of mathematical models for coupled processes in the geosphere and their applications and validation against experiments in the field of nuclear waste isolation. The DECOVALEX project has been designed to increase understanding of coupled thermal-hydrological-mechanical processes as they affect rock-mass responses and radionuclide release and transport from a repository to the biosphere and also to assess how these processes can be described by mathematical models. In the Phase III of the program, modeling of the drift-scale heater test at the Exploratory Studies Facility at Yucca Mountain, Nevada, U.S.A. was designated as one of the tasks. This task involved modeling the thermal-hydrological-mechanical-chemical behavior of the drift-scale heater test. The results presented in this paper will focus on predicting (i) temperature-induced mechanical deformation surrounding the heated drift, and (ii) thermal-mechanical effects on rock mass permeability.

The thermal-mechanical modeling was conducted using a continuum approach. Three litho-stratigraphic units were modeled in the simulations: Upper Lithophysal, Middle Nonlithophysal, and Lower Lithophysal litho-stratigraphic units with a circular drift, 5 m in diameter, in the middle of the Middle Nonlithophysal litho-stratigraphic unit. Rock-mass propertied were used for the simulation. Sensitivity analyses were also conducted to examine the potential effects of rock-mass quality on the rock responses, including deformation and permeability. The temperature data set provided by the DECOVALEX program was used in the simulation.

This paper will present the modeling results of thermally induced mechanical responses in terms of principal stresses, extent of yielding, rock deformation, and roof and wall convergences. The effects of temperature will be examined at thermal times of 3 months, 1 year, and 4 years. Discussions will include a comparison of the predicted displacements at specified locations surrounding the heater drift with the field displacement data obtained from the multiple-position extensometer measurements.

To assess the thermal-mechanical effects on rock mass permeability, a continuum model representing a deformation-permeability relationship was developed to predict thermal-mechanically induced permeability variations. This paper will present the development of this continuum model. Using this model, the effects of excavations and temperature variations at the three thermal times mentioned in the previous paragraph will be discussed in detail. Also, the predicted variations of permeability at specific locations will be compared with the measured data from field. Furthermore, study results on sensitivity of strength and deformation properties to rock-mass thermal-mechanical response and permeability changes will be reported.