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U.S. Nuclear Regulatory Commission
ATTN: Mrs. Deborah A. DeMarco
Office of Nuclear Material Safety and Safeguards
Program Management, Policy Development, and Staff
Office of the Director
Mail Stop 8D–37
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 10th International High-Level Radioactive Waste Management Conference to be held March 30–April 3, 2003, in Las Vegas, Nevada. The title of the abstract is:

> "Edge-Cooling Effect on the Potential Thermohydrologic Conditions at Yucca Mountain" by C. Manepally and R. Fedors

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

Sincerely,

for Budhi Sagar
Technical Director

/ph
Enclosures Abstract
NRC Form 390A

cc: J Linehan (w/o encl), D Riffle, B. Meehan, J Greeves, W. Reamer, J Pohle, L. Campbell, J. Bradbury, D Brooks, K Stablein, J Schlueter, B. Leslie, T. McCartin, P. Justus, C. Trottier, M Nataraja, W. Patrick, CNWRA Directors, CNWRA Element Mgrs, P Maldonado, T. Nagy (SwRI Contracts), C. Manepally, R Fedors, R Green, S Painter

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~~A Study of Edge-Cooling Effect on the Thermohydrologic Conditions at Yucca Mountain~~ WLF 8/14/2002

Edge-Cooling Effect on the Potential Thermohydrologic Conditions at Yucca Mountain

2 AUTHOR(s)

C. Manepally and R. Fedors

3 NAME OF CONFERENCE, LOCATION, AND DATE(s)

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Edge-Cooling Effect on the Potential Thermohydrologic Conditions at Yucca Mountain

Authors: Chandrika Manepally and Randall W. Fedors
Center for Nuclear Waste Regulatory Analyses
Southwest Research Institute, San Antonio, TX.

The heat load magnitude and distribution produced by the decay of high-level radioactive waste are important parameters for evaluating performance of the proposed repository at Yucca Mountain, Nevada. Temperature variations across the proposed repository will affect seepage water into drifts, moisture redistribution driven by thermal gradients along drifts, and the patterns of natural water flow in the unsaturated rock layers surrounding the in-drift environment. Waste package corrosion rates are influenced by temperature and the presence of water. The return of water to the drifts is related to temperature decreases after the thermal peak. Identifying the distribution and magnitude of water contacting waste packages is not only important for estimating the corrosion potential of waste packages, but also for estimating transport rates of radionuclides into the natural system below the repository. The thermal conditions at any location will be influenced by its proximity to the edge of the potential repository because cooling will occur rapidly there, relative to the center. This phenomenon is called the edge-cooling effect and has been identified as one of the key factors that affect the thermohydrologic conditions in the drift and in the near field host rock.

The focus of this paper is to examine the spatial distribution of the edge-cooling effect at the repository scale as a function of time. Because of scale issues and the need for three-dimensional models, direct modeling at the mountain scale with sufficient thermohydrologic detail at the drift scale would require impractical levels of computational effort. To deal with this problem, sub-models at different scales, different dimensions, and representing different processes are developed and coupled together. In this study, a three-dimensional mountain scale model is coupled with a two-dimensional drift scale model. The mountain scale model is an analytical conduction-only model for mountain scale heat transfer and is used to determine the evolution of the local effective heat load and the time-varying influence of edge cooling. This model is based on line thermal sources representing drifts, separated by specified drift spacing, and residing in a semi-infinite medium. This conduction model will be able to distinguish variation of heat output *between* the drifts, but not *along* the drift due to assumption of linear thermal sources. The linear thermal load is based on the thermal data obtained from the Total-System Performance Assessment code (2). The two-dimensional drift scale coupled thermohydrologic model will be developed using the two-phase mass and energy transport (METRA) component of Multiflo v1.5 (1). In the drift-scale model, the dual-permeability approach is used to characterize the flow of heat and moisture through the rock of the potential repository. The flow of heat and moisture are modeled as flowing through two interacting continua, with each continuum being assigned its own spatially variable hydrologic properties, such as permeability and porosity. Fracture-matrix interaction is represented with an active-fracture model, in which only a portion of the fractures are actively flowing under unsaturated conditions. The drift scale model also uses the linear thermal load assumption; however, the values are adjusted based on the thermal response obtained from the mountain-scale model to account for the edge-cooling effect, and the effect of thermal loading of neighboring drifts. Multiple two-dimensional models will be run at specific locations in the repository to examine the effects of edge-cooling, host rock characteristics, repository overburden and infiltration flux. The drift scale model will take into account the location-specific thermal and hydrologic properties, boundary conditions, and percolation flux. It will compute temperature, relative humidity, liquid saturation, liquid flow rate or flux, and liquid evaporation rate at several locations within and near the drift. This information can be used in other process level models such as coupled thermohydrologic-chemical or thermohydrologic-mechanical models, or in performance assessments codes.

Preliminary results of the mountain-scale conduction model indicate that edge-cooling effects significantly affect the repository-scale temperature distribution. There is more than 100 °C (180 °F) difference in waste package temperature between the center and the edge of the repository at 100 years after emplacement. This difference between center and edge reduces to about 20 °C (36 °F) at 10000 years. This suggests that the thermohydrologic conditions at the edge locations are quite different from the center locations and need to be analyzed in detail to account for the edge-cooling effect. Enhanced understanding of the edge-cooling effect can decrease uncertainties associated with prediction of thermohydrologic behavior of the drift and the host rock. It can also play an important role in heat management if knowledge gained is used in the strategic placement of waste packages based on their decay characteristics.

This abstract is an independent product of the CNWRA and does not necessarily reflect the views or regulatory position of the NRC.

References

1. Lichtner, P.C., M.S. Seth, and S. Painter. *MULTIFLO User's Manual MULTIFLO Version 1.5—Two-Phase Nonisothermal Coupled Thermal-Hydrologic-Chemical Flow Simulator.* San Antonio, TX: Center for Nuclear Waste Regulatory Analyses. 2000.

2. Mohanty, S., T.J. McCartin, and D.W. Esh. *Total-System Performance Assessment (TPA) Version 4.0 Code: Module Descriptions and User's Guide,* San Antonio, TX: Center for Nuclear Waste Regulatory Analyses, 2000.

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