March 7, 2001

MEMORANDUM TO: C. William Reamer, Chief
High-Level Waste Branch, DWM, NMSS

THRU: N. King Stablein, Section Leader /RA/
Projects and Engineering Section
High-Level Waste Branch, DWM, NMSS

FROM: Brett W. Neuberger, Materials Engineer Aide /RA/
Projects and Engineering Section
High-Level Waste Branch, DWM, NMSS

SUBJECT: REPORT ON STAFF EXCHANGE TO THE CENTER FOR NUCLEAR WASTE REGULATORY ANALYSIS FROM JANUARY 3, THROUGH JANUARY 18, 2001

Attached, please find a report on my staff exchange to the Center for Nuclear Waste Regulatory Analysis from January 3 through 18, 2001. The topic of this exchange was the Effects of Rockfall on the Titanium Drip Shield. Please contact me at 415-7658, if you have any questions or comments.

Attachment: As stated

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TOPIC: Effects of Rockfall on Titanium Drip Shield

The following tasks were accomplished during my staff exchange Rotation to the CNWRA:

Determine the Effects of a 500 kg Rock Mass Impacting the Titanium Drip Shield at a Velocity of 7 m/s.

Using the software program Hypermesh, the pre-established input deck, as created by Doug Gute, was modified by modeling a 500 kg rock striking the drip shield such that the rock length is just less than the separation distance between the bulkhead supports of the drip shield, compared to previous runs where the rock was modeled on a per meter basis such that the rock extended from bulkhead to bulkhead. The purpose of this was to simulate the effect of a rock block striking the drip shield and then breaking at a bulkhead support. This event was expected to create a higher shear stress at the area adjacent to the support than that obtained with the rock block impacting on the per meter basis. If this simulation showed that the drip shield could withstand this event and not fail, then the model would be considered to be conservatively bounded. If the drip shield could not withstand this impact without failure, the model would have to be more realistically depicted so as to take into account energy losses due to the crushing of the rock.

The Hypermesh program was then used to create the appropriate input deck for use in the Finite Element Method (FEM) modeling program ABAQUS/EXPLICIT.

The model was run for an event time of 50 ms. This was enough time for the rock to cause maximum deflection of the drip shield and then allow recovery of the elastic deformation of the drip shield after rock rebound. Running the model involved both debugging of the program and of the CNWRA's newly acquired computational facilities. It was established that 1 ms of simulation event time corresponded to a computational run time of 1 hour 10 minutes. While this was a high computational resource load, and the time was longer than expected, the machine was available for sole use by the RDTME team. This machine was on loan from another department and was designed for use with extensive graphics. Rather than spending money to upgrade this machine, it may be more worthwhile to purchase / lease a machine that is more suitable for the high amount of mathematical computations necessary during FEM modeling. However, as long as the machine is being used to its full capacity and not causing a delay in needed results, it is adequate for the job.

Preliminary results indicated that the stresses developed in the drip shield were sufficient to cause plastic deformation, but were not great enough to cause failure.

Input Decks for Other Rock Masses and Velocities were Established for Future Work to be Run at the Center.

Input decks involving a total of 15 different permutations with rock masses of 500, 1000, 2000, 4000 and 8000 kg were established with appropriate output requests in accordance with the above conditions. These permutations involved altering the impact velocities of the rock masses in order to obtain specific kinetic energies such that these runs can be compared to previously obtained results for rock falls modeled per meter length of the drip shield. It is also hoped that by using these runs, residual stresses in the drip shield after the rockfall can be identified.

ATTACHMENT

Other Activities

In addition to the FEM modeling conducted, the CNWRA staff provided me with a thorough tour of the laboratory facilities and allowed me to develop a full understanding of the work and experiments that are conducted there.

Products

The work conducted during the rotational assignment and its relevance to KTI's will be discussed during a presentation at the weekly Yucca Mountain Team Meeting. This work is of importance, due to fact that it is necessary in order to form a technical basis which allows proper evaluation of the rockfall model being established by the DOE. Taking into account various rockfall scenarios, such as this one, allows the development of a better understanding of what parameters have important effects on the reliability of the drip shield. This allows us to evaluate whether the DOE has also considered these parameters of importance. By using a variety of rock block sizes and velocities, the effects of rockfall can be established for various kinetic energies. It is hoped that it will then be possible to predict the results of a rockfall for any rock mass at any initial height, which was not modeled by FEM analysis, thus saving valuable computational resource time. This work will also be important in implementing updated rockfall scenarios in the SEISMO model of the TPA code.

Future Work

The input decks created for the various kinetic energies will be run by Doug Gute at the CNWRA as computational time allows. The outputs will be evaluated by myself and Doug and then compared to the previous runs made under the scenario of a rockfall on a per meter length of drip shield. If the model shows drastic changes in results or if the drip shield fails as a result of these rockfalls, the model must be further refined.