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UNITED STATES  
NUCLEAR REGULATORY COMMISSION  
WASHINGTON, D. C. 20555

December 9, 1994

Mr. Ronald Milner, Associate Director  
for Program Management and Integration  
Office of Civilian Radioactive  
Waste Management  
U.S. Department of Energy, RW 30  
1000 Independence Avenue SW  
Washington, D.C. 20585

SUBJECT: SUMMARY OF THE TECHNICAL EXCHANGE ON THERMAL-MECHANICAL-  
HYDROLOGICAL-CHEMICAL COUPLED PROCESSES, NOVEMBER 9, 1994.

Dear Mr. Milner:

The purpose of this letter is to transmit the summary for the November 9, 1994, U.S. Nuclear Regulatory Commission/U.S. Department of Energy (DOE) technical exchange on Thermal-Mechanical-Hydrological-Chemical (TMHC) coupled processes. The technical exchange was also attended by representatives of the State of Nevada, Nye, and Clark Counties, Nevada. The purpose of the technical exchange was to discuss DOE's plans for demonstrating compliance with the regulatory requirements of considering the TMHC coupled effects in the design of HLW repository.

After presentations by M. Nataraja and A. Chowdhury on NRC's regulatory overview of TMHC considerations in the repository design, and by A. Simmons on DOE's approach to demonstrating compliance with the 10 CFR 60 requirements, the technical exchange included presentations on the ongoing and planned work on the TMHC coupled processes by Lawrence Livermore National Laboratory and Sandia National Laboratory personnel. In addition to commenting and discussing during the presentations, the participants took part in discussions during the closing remarks session. There was free exchange of information on DOE's approach in understanding the role of TMHC coupled processes in repository design and in demonstrating compliance with the regulations. A brief summary of the technical exchange meeting is enclosed.

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If you have any questions regarding this letter, or the technical exchange summary, please contact Banad Jagannath of my staff at (301) 415 6653.

Sincerely,

Michael J. Bell, Chief  
Engineering and Geosciences Branch  
Division of Waste Management  
Office of Nuclear Material Safety  
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**SUMMARY OF U.S. NUCLEAR REGULATORY COMMISSION AND  
U.S. DEPARTMENT OF ENERGY TECHNICAL EXCHANGE ON  
COUPLED THERMAL-MECHANICAL-HYDROLOGICAL-CHEMICAL PROCESSES**

On November 9, 1994, representatives of the U.S. Nuclear Regulatory Commission, the U.S. Department of Energy (DOE), the State of Nevada Nuclear Waste Project office, Nye, and Clark Counties, Nevada, participated in a technical exchange on Thermal-Mechanical-Hydrological-Chemical (TMHC) coupled processes at the Yucca Mountain, Nevada. The list of attendees and the technical exchange agenda are included as Attachments 1 and 2 to this summary. Copies of presenter's handouts are included as Attachment 3. Technical presenters included representatives from NRC, Center for Nuclear Regulatory Analyses of Southwest Research Institute (CNWRA), DOE, Lawrence Livermore National Laboratory (LLNL), and Sandia National Laboratory (SNL).

Mysore S. Nataraja (NRC) presented a brief overview of the regulatory bases for consideration of the TMHC processes and an acceptable procedure for demonstrating compliance in the license application. A. Chowdhury (CNWRA) presented a brief overview of the ongoing work at the CNWRA on TMHC coupling processes. CNWRA products are published as either NRC NUREGs or CNWRA reports. DOE participants were aware of NUREGs, but many were not aware of CNWRA reports and wanted to be on the distribution list. Michael J. Bell (NRC) and A. Chowdhury, stated that DOE is on the distribution list for CNWRA reports, and they agreed to provide a copy of CNWRA report distribution list to Chris Einberg (DOE) for his information on who gets the CNWRA reports in DOE. Distribution list for CNWRA reports is included as Attachment 4, to this summary report.

Ardyth Simmons (DOE) presented an overview of DOE's approach to demonstrating compliance with regulations requiring consideration of TMHC coupling processes. DOE's approach is an iterative process encompassing available predictive models, predictive models under development, sensitivity analyses and bounding analyses on the effects of thermal load on the performance of the repository, performance confirmation testing, and phased approach to licensing. The DOE presentation reflected the NRC staff technical positions presented earlier by M. Nataraja and showed DOE was considering them in conducting its program.

Dale Wilder of LLNL presented DOE's testing plans, goals, and intended use of testing results for understanding the TMHC coupled processes. He talked about different scales of testing, both time and size, mechanistic and total system integration models, characterization tests, and experience gained from tests conducted at Climax site and G-tunnel at the Nevada Test Site, Nevada.

Wunan Lin of LLNL presented DOE's plans for the Large Block Test (LBT) at the Fran Ridge Site. The LBT project includes laboratory tests on small blocks and a field test on a large block to obtain an improved understanding of the mechanistic aspects of the TMHC coupled processes. The experience and data gained would be used in the in situ field tests planned in the Exploratory Studies Facility (ESF). This is a multi-year project and its scope and schedule will depend on DOE budget constraints.

Thomas Buscheck of LLNL talked about preliminary analysis and testing of coupled thermo-hydrological processes which operate within a heat-driven flow

regime and a heat-altered property regime. The results of preliminary studies on the coupled effects of thermal load density, buoyant gas-phase convection, heterogeneity of heat load distribution and hydrological properties, and repository depth below ground surface were presented. Future studies include investigation of THC and THM coupled effects.

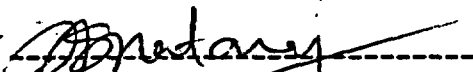
William Glassley (LLNL) presented his ongoing work on the geochemical aspects of coupled hydro-geochemical processes including determination of chemical characteristics of water that may come in contact with the waste package and the hydro-geochemical properties of the near-field system.

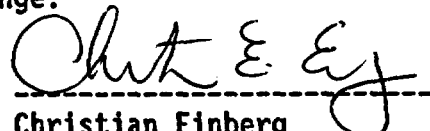
Bruce Robinson (LANL) presented his work on geochemical modeling to assess the importance of rock-water interaction on thermohydrologic behavior. Preliminary results indicate that regions of dissolution and precipitation depend on the thermohydrologic conditions, and mineral deposition in the boiling region may extend the dry-out region in the rock mass.

Stephen Blair (LLNL) presented experimental and modeling work on geomechanical aspects of TMHC coupled processes. Data and experience gained from small-block tests in the laboratory are expected to provide input for the Large Block Test at Fran Ridge. Predictions by models are expected to be compared with the observed results in the laboratory and field experiments.

John Pott of SNL presented proposed field experiments associated with coupled processes. SNL plans to perform preliminary laboratory tests to provide data needed to design and conduct field experiments in the ESF. Planned heater tests in the ESF are Axisymmetric Heater experiment, Heated Block experiment, and Heated drift experiment. The data from the planned experiments will provide information on the thermal, mechanical, and hydrological response at the rock mass scale. DOE's planned approach to site characterization may require some changes in the scope and schedule of some of the in situ heater tests.

There were no closing remarks from the State of Nevada Nuclear Waste Project Office, Nye, and Clark Counties, Nevada. The NRC participants stated that the technical exchange provided an opportunity to understand DOE's approach to the TMHC coupled processes and the presentations from several investigators were very useful. As there were so many tests being conducted by different groups, NRC staff observed that it would be desirable, if a future presentation indicated how these different testing programs are integrated and how each test would provide data or input to demonstrating compliance with 10 CFR 60 requirements. In closing, the DOE thanked the participants for their input and discussion during the technical exchange.

  
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 Office of Nuclear Material  
 Safety and Safeguards  
 U.S. Nuclear Regulatory Commission

  
 Christian Einberg  
 Regulatory Integration Branch Division  
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 Waste Management  
 U.S. Department of Energy

DOE-NRC  
 TMHC COUPLED PROCESSES TECHNICAL  
 EXCHANGE  
 ATTENDEES LIST. 11/9/24

ATTACHMENT 1

<u>NAMES</u>	<u>ORGANIZATION</u>	<u>TITLE</u>
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<u>CARL JOHNSON</u>	<u>STATE</u>	<u>TECH. PROGS</u>
<u>Thomas Bierstedt</u>	<u>YMSCO</u>	<u>LICENSING/SUITABILITY M&amp;O</u>
<u>Christian E. Einberg</u>	<u>DOE/HQ</u>	<u>Regulatory Integration</u>
<u>Ardyth M. Simmons</u>	<u>DOE/YMSCO/AMSP</u>	<u>Team Ldr. Geochemistry</u>
<u>MICHAEL BELL</u>	<u>NRC/DWM</u>	<u>CHIEF, ENGR</u>
<u>MYSORE NATARAJA</u>	<u>NRC/DWM</u>	<u>TEAM LEAD, GEOTECH ENGR</u>
<u>NICK STELLAVATO</u>	<u>Nye County</u>	<u>ON SITE PLY</u>
<u>E.V. TIESENHAUSEN</u>	<u>CLARK COUNTY</u>	<u>ENG. SPEC.</u>
<u>R. Donald Dresser</u>	<u>Weston</u>	<u>Sr. Scientist</u>
<u>Cruce Robinson</u>	<u>Los Alamos</u>	<u>PI</u>
<u>Bill Gassler</u>	<u>LAWRENCE LIVERMORE HL</u>	<u>LLNL TASK LEADER - GEOCHEMISTRY</u>
<u>Tom Buscheck</u>	<u>Lawrence Livermore National</u>	<u>LLNL Task Leader - Hydrology</u>
<u>RON GREEN</u>	<u>CNWRA</u>	<u>SR RES SCI</u>
<u>Willis CLARKE</u>	<u>LLNL</u>	<u>TPO</u>
<u>Doc McNEELY</u>	<u>PMO</u>	<u>ENGINEER</u>
<u>KEITH, J. LOBO</u>	<u>PMO</u>	<u>SENIOR PROTECT ENGINEER</u>
<u>Ram B. MURPHY</u>	<u>DOE/HQ</u>	<u>OQA</u>
<u>Philip R. Hammond</u>	<u>M &amp; O</u>	<u>Regulatory</u>
<u>Randall D. Mantzfel</u>	<u>CNWRA</u>	<u>Research Engineer</u>
<u>Bob Gumble</u>	<u>M&amp;O</u>	<u>Self Consultant</u>
<u>Robin N. Datta</u>	<u>M &amp; O</u>	<u>Sr. Proj. Engr.</u>
<u>Dwayne A. Chesnut</u>	<u>LLNL</u>	<u>Sr. Science Advisor</u>



DOE-NRC TECHNICAL EXCHANGE DRAFT AGENDA  
FIELD HEATER EXPERIMENTS ASSOCIATED WITH COUPLED  
THERMAL/HYDROLOGIC/MECHANICAL/CHEMICAL (THMC) PROCESSES

November 9, 1994 Las Vegas, Bank of America Building, Room 450

SCHEDULE	TOPICS	PRESENTER
8:00am	Opening Remarks	DOE/NRC
8:15	Regulatory Bases for Evaluating THMC Processes	NRC
9:00	DOE's Approach to Coupled THMC Processes - THMC Processes Requirements - THMC Study Program	DOE
9:45	BREAK	
10:00	Testing Plans & Goals, and the Intended Use of Testing Results	DOE
11:00	Lessons-Learned from Tests in G-Tunnel and the Climax Facility	DOE
11:45pm	LUNCH	
1:00	Fran Ridge Large Block Experiment and Exploratory Studies Facility Engineered Barrier System Field Test	DOE
2:45	BREAK	
3:00	Status of Coupling Approaches	DOE
5:00	Closing Remarks	DOE/NRC State of NV AUG
5:15	Adjourn	

# **STATUS OF COUPLING APPROACHES**

**Analysis and Testing of Heat-Driven Coupled Processes:** FRAN RIDGE LARGE BLOCK EXPERIMENT AND ESFEBS FIELD TEST

**Hydrologic Effects - Tom Buscheck, LLNL**

**Geochemical Effects - Bill Glassley, LLNL**

**Status of Coupled Thermohydrologic-Geochemical Modeling - Bruce Robinson, LANL**

**Geomechanical Effects - Steve Blair, LLNL**

**Field Experiments Associated with Coupled THMC Processes - John Pott, SNL**



### **ATTACHMENT 3**

**THE PRESENTATION HANDOUTS WERE AVAILABLE TO ALL THE PARTICIPANTS DURING THE TECHNICAL EXCHANGE. BECAUSE OF ITS VOLUME COPIES OF THE HANDOUTS ARE NOT ATTACHED TO THIS TRIP REPORT, BUT THEY ARE AVAILABLE WITH THE STAFF FOR ANY ONE INTERESTED IN REVIEWING THEM.**

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