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SUBJECT: TRIP REPORT FOR SITE CHARACTERIZATION AND MODEL VALIDATION
(FOCUS '93) CONFERENCE

On September 27-29, 1993, Keith I. McConnell, Stephen McDuffie and John T. Buckley of the Division of High-Level Waste Management attended the Site Characterization and Model Validation (Focus '93) Conference in Las Vegas, Nevada. Focus '93 was the third in a series of focused technical meetings on High-level Waste Management (HLWM). In particular, the purpose of this conference was to provide a forum for discussion of site characterization research activities and development and validation of models to be used to evaluate site processes and events.

Focus '93 was well attended by members of the HLWM technical community. In addition to the NRC and the Center for Nuclear Waste Regulatory Analysis (CNWRA), participation a total of 31 organizations were represented at the conference (see Attachment 1). Technical presentations were organized according to the following general session topics:

1. Flow and transport/emphasis on flow characterization of flow processes; development and validation of conceptual models and quantitative predictive models describing fluid flow in saturated and unsaturated geologic media.
2. Flow and transport/emphasis on transport characterization of transport under ambient conditions in the laboratory and scaling to intermediate, field and site scales: may include model development, experimentation, and model testing at each scale.

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3. Near-field environmental conditions characterization of thermally, mechanically, and hydrologically perturbed near-field conditions and development and validation of models; may include effects of engineered materials on water chemistry, transport, and coupled thermal effects.
4. Disruptive processes and events development and validation of conceptual models for the occurrence and consequences of disruptive events.
5. Integrated system modeling development of system models incorporating conditions and processes and disruptive processes and events; including model validation, data and model uncertainty, use of expert judgement, and treatment of coupled processes.

The conference agenda is presented as Attachment 2 to this report.

The FOCUS '93 meeting began with an opening plenary session with three featured speakers. The first speaker was Harry Smedes, a private consultant not presently working in the high-level waste program. Smedes is retired from the U.S. Geological Survey where he worked for 27 years, his expertise being in the area of volcanology. He had previously worked on DOE's Nuclear Waste Program. He expressed strong support for the creation of a chief scientist position, suggesting that it would be good for the program. Specifically, Smedes considered a chief scientist was needed to assure adequate support for the technical part of the project and to act as the judge for determining how much data collection on a specific topic was sufficient to meet program needs. Smedes challenged the audience to ask themselves tough questions during site characterization, such as, "How much data is enough," and "What is 'reasonable assurance' of the performance objectives being met?" He expressed his philosophy that models should not be used to make predictions, but rather to evaluate trade-offs in the system. Applying a model is an exercise in thinking about how the system functions. He also indicated that full validation of models was not possible.

The second speaker was Mick Apted of INTERA. Apted was formally involved with the Basalt Waste Isolation Project. His presentation dealt chiefly with engineered barriers such as gravel and clay which could conduct infiltrating water around and away from waste packages. He referred to a Low-Level Waste (LLW) Management NUREG that described a design for a LLW facility that included having waste surrounded by a barrier of gravel which in turn was surrounded by a barrier of sand. He also cited a 2,500 year-old burial ground in Japan which was built with primitive versions of such barriers and remains dry, even today. Apted suggested that if he was correct, and such a barrier was effective, research on the waste package and colloid formation/transport would become moot, for water would never reach the waste packages.

The third speaker was Allan Freeze, a private consultant. Freeze presented the audience with the concept of data worth. Data have worth only if the risk reduction which can be achieved when the data is greater than the cost of obtaining the data. Data have worth only if additional data has the potential to change the current design alternative, help smooth the regulatory process,

or improve public perception. The latter value applied to data was termed a social cost to the program. Freeze included the data collected to meet regulatory requirements in the social cost category. Freeze also addressed the model validation issue by suggesting that total system models could not be validated or invalidated and that geologic process models could not be validated, only invalidated. In discussing parameter uncertainty, he preferred the term, "model calibration" which he felt was in a continuum with "model validation." Freeze described the process as data collection providing calibration of models, which in turn results in uncertainty reduction leading to risk reduction, which in the end would be evaluated to determine the "worth" of any further data collection.

Session I: Flow and Transport/Emphasis on Flow

In the first technical session on the topic of Flow and Transport, a presentation was made on the "Evaluation of Geohydrologic Predictions in the Access Ramp" for the ASPO Hard Rock Laboratory. Apparently, the predicted inflow of water through fractures was substantially different from what was observed when the tunnel was constructed. In the next presentation, Tim Brown of L. Lehman and Associates, stated that water content alone is insufficient to validate a single unsaturated zone flow model. He also concluded that fracture flow may play a major role in the unsaturated zone, and water content profiles are too insensitive to infiltration rates to use them for accurate predictions of unsaturated zone fluid flow. Several other significant findings presented during this session, came from Edward Kwicklis of the USGS, who believes that lateral flow occurs at the base of Bedded Interval 2, immediately above the Pah Canyon Member. Kwicklis also suggested that tritium data indicate that fracture flow has occurred in the Tiva Canyon Member of the Paintbrush Tuff at Yucca Mountain and that flux profiles indicate large, relatively recent, influxes in UZ 4 & 5. Similarly, G. S. Bodvarsson of LBL, found elevated tritium levels at 20 and 135 meters depth in hole UZ-6. This anthropogenic isotope may have migrated laterally from the nearby Solitario Canyon Fault, and/or vertically by means of fracture flow. Rapid infiltration was further supported by J. Fabryka-Martin of LANL. Cl-36 data indicate to her a highly heterogeneous flow system at Yucca Mountain, with multiple flow paths contributing to the moisture at any given location.

Session II: Flow and Transport/Emphasis on Transport

In the second session Malcolm Siegel of SNL, discussed the three stages of model validation; replicative, predictive, and structural, with structural being virtually impossible to achieve. In his opinion, most regulatory definitions of validation demand structural validity. A. Meike presented a paper on colloids and asked the question as to whether colloids could act as a transport mechanism. He believes that if transport does occur, it might not be in significant quantities. Another significant finding was reported in a paper by Ning Lu of Disposal Safety, Inc. His model predicts that at any time over the first 10,000 years, Carbon-14 can travel to the surface in less than 1,000 years from the time of release from a waste package. In his

presentation, Arend Meijer of Los Alamos National Lab indicated that the retardation of Carbon 14 would be enhanced by the presence of a waste package that develops a significant coating of iron oxide. Specifically, goethite and hematite retard the migration of Carbon 14.

Session III: Near-Field Environmental Conditions

Bill Murphy of CNWRA began the third session with a discussion of geochemical models for gas-water-rock interactions at Yucca Mountain. A key point of his talk was that the evolution of the ambient conditions at Yucca Mountain must be properly modeled before one can hope to model repository-induced perturbations. Subsequently, Tom Buscheck of LLNL, suggested that sharply contrasting bulk permeability zones could potentially focus drainage of fluid under both boiling and non-boiling repository conditions. His analysis indicates that there would be a "chimney" effect in fractures above the waste package where water would condense and drip on the waste package. Other areas would be dry. Model validation was again addressed at the end of the session, this time by Larry Costin of SNL. He believes models should be judged by two criteria: the adequacy of the physics in the model and how well the model predicts actual behavior.

Session IV: Disruptive Processes and Events

The fourth session was the most contentious of the meeting. All five presentations dealt with volcanism. Bruce Crowe of LANL began by discussing the consequences of repository disruption by a dike. The LANL researchers are looking at an analog site of small-volume basaltic vents near Grants Ridge, New Mexico to study near-surface xenolith entrainment by dikes. Results could possibly constrain the amount of waste which can be entrained within a dike. Chuck Connor of CNWRA followed with a presentation on his nonhomogeneous Poisson model for volcanism at Yucca Mountain, which Geology/Geophysics Section staff are quite familiar with. After the presentation there was some discussion between Crowe and Connor about Connor's model. Crowe challenged that Connor is applying a bivariate process to a multivariate problem, and may not have captured all the variation in the system. Connor responded that the spatial clustering is strong enough to overwhelm all other variables in the system. Following Connor was a second presentation by Crowe. This presentation contained little new information; most of his results can be found in the recent draft LANL Technical Report on The Status of Volcanic Hazard Studies. The fourth talk was by Peter Wallmann of Golder Associates. He discussed a discrete feature model developed by Golder called FRACMAN, which he used to model dikes intersecting a repository. A major conclusion was that volcanic clustering does not increase disruptive probability. McDuffie gave the last presentation on methods of assessing future volcanic activity at Yucca Mountain. During the wrap-up for the session, there was some lively general discussion generally following the lines of discussions held at past technical exchanges between the NRC and DOE. A key point in the discussion was the data-worth issue, in other words, will further data collection on the topic of volcanism reduce the uncertainty in the analysis.

Session V: Integrated System Modeling

In the final technical session, Rick Spengler of the USGS described how a 3-dimensional lithostratigraphic model for Yucca Mountain is being constructed with the Lynx Geological Modeling System. This was similar to a presentation given by Dave Buesch during the Appendix 7 visit to observe Lynx in August 1993. Spengler indicated that the results of these modelling efforts were being used in the recent proposed redesign of the ESF. He also indicated that the model currently depicts faults with 25 feet of displacement, but will eventually be able to depict faults with 10 feet of displacement. Paul Summerville of Woodward-Clyde, in his presentation on seismic design ground motion values, stated that the minimum peak motion velocity to cause damage in an unreinforced tunnel is 90 cm/sec. For comparison, the Landers earthquake in 1992 had a value of 75 cm/sec. Summerville also noted that the largest velocities at Yucca Mountain are associated with surface waves based on a shot at Pahute Mesa. Carol Bruton of LLNL provided an overview of the Wairakei geothermal field in New Zealand, which is being used to validate some geochemical modeling codes. The conference agenda is presented as Attachment 2 to this report.

Conference proceedings containing all of the papers presented at Focus 93 are scheduled for publication in December 1993. However, Attachment 3 contains copies of all papers available to date. A copy of the published proceedings will be routed to the staff for information when it is received.

Summary of Meeting**Summary: McConnell:**

I found the meeting provided little new information or concepts from what has been discussed at other meetings. However, the meeting did serve to bring together a diverse group of people working on the project to discuss difficult issues such as "data worth." The question of model validation has been around for many years and there is basic agreement in the scientific community that process models cannot be validated only invalidated. It appears only those who want to rigidly apply requirements used in the past to validate computer codes or engineering design see the issue differently. The one area of the discussion that was new to me was the apparently increasing evidence that fracture flow does occur in the unsaturated zone at Yucca Mountain. The weight of data and analysis presented at this meeting on unsaturated flow suggests that local saturation and fracture flow in the unsaturated zone is not uncommon at Yucca Mountain. With respect to the discussions on the volcanism issue, I found the discussions to be a mirror image of those that occurred at the June 9, 1993, technical exchange.

Summary: McDuffie

To summarize the meeting, I found that it broadened and deepened my knowledge of several technical issues relevant to Yucca Mountain. This helps to fulfill one of the central objectives of my Individual Development Plan. The tone of the volcanism discussions seemed to be

dominated by the LANL opinion that repository disruption probabilities are well enough constrained at this point to move on to other issues such as consequences; the numbers calculated by various researchers are fairly similar. There seems to be a difference in fundamental philosophy between NRC and DOE, as to how the volcanic hazards at Yucca Mountain should be assessed and incorporated into Performance Assessment models. As Chuck Connor mentioned during discussion, it is inappropriate to completely divorce the probability of occurrence from the consequence models. The two are intertwined when volcanism with all of its attendant processes are considered, and volcanism should be treated as an inseparable category of events.

Summary: Buckley

From group discussions following the technical presentations, it became evident that many scientists within the high-level waste program are struggling with the issue of model validation; including what constitutes validation, what type and how much data must be collected to validate models. The issue of model validation in general did not receive as much discussion as it probably should have. Instead, a majority of the presentations and the follow-up question and answer discussions, dealt with very detailed research efforts supporting the site characterization program.

FIELD VISIT TO FIELD OPERATIONS CENTER AND YUCCA MOUNTAIN

On Thursday, September 30, 1993, Steven McDuffie and Keith McConnell accompanied Philip Justus and Jerry Heaney of SAIC, to the Field Operations Center (FOC) and Yucca Mountain. Upon arriving at the FOC, we attended the weekly project participants meeting, where upcoming activities are discussed. From this discussion it was learned that drilling for NRG-7 was to begin the next week and that double shifts would be used. The job package and work plans for this activity were in review. Also, the grouting of the flowing sections of UZ-14 was discussed. Apparently, the grout that had been applied previously was leaking about 3.8 gal/hr and they were going to have to go back in and regROUT the hole to stop the leaking. It was noted that the blasting for the 60'x 18'x 16' test alcove was to begin the next week. One part of the discussion focused on additional tests to define the geology along the west side of Exile Hill in anticipation of construction of the north ramp. Apparently, there are still some significant uncertainties about the quality of the ground on the west side of Exile Hill in the vicinity of the Bow Ridge fault zone. DOE was considering the drilling of six additional boreholes and construction of some trenches to attempt to resolve this uncertainty.

On leaving the FOC, we traveled to the portal for the north ramp. Rock bolts were being grouted while we were there. Most of the starter tunnel had been shotcreted, and there was little to see from a geologic standpoint. The location of the test alcove was the only area where shotcrete had not been applied.

We continued on to the location of the bench being constructed to examine the Ghost Dance fault zone. The bench was under construction, and there was little to see, however, Rick Spengler (USGS) had indicated previously that work over the past year had indicated that the Ghost Dance fault zone could be wider than the 213 m. documented in recent publications. We then traveled to the location of UZ-14 passing on the way the drill pad location for NRG-7. There was no activity at UZ-14.

Our next stop of the day was at the Fran Ridge site for the large block test. The area being constructed for the large block test is just north of where the Bureau of Reclamation performed the prototype testing for their photogrammetric mapping technique. Blasting and sawing activities were just recently initiated, however, we were able to gain a perspective on the nature of the testing to be performed.

Our final stop was at the SMF, where we observed some drill core of several NRG drill holes which happened to be out and accessible at the time. Doug Switzer of SAIC talked with us about some of the core. We examined the NRG-2B core in some detail. The core is fairly competent down to approximately 50 foot depth, but is quite fractured much of the distance between 50 and 160 feet. The 120 - 130 foot interval is nothing more than loose sand. NRG-2B penetrates the Ranier Mesa Unit all the way down to about 150 feet. According to Jerry Heaney, the ESF tunnel will pass by this hole at a depth of about 80 feet.

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