

102.2/RC/87/06/30

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MEMORANDUM TO:

Ronald Ballard, Chief  
Technical Review Branch (Return to WM, 623-SS)  
Division of High-Level Waste Management

FROM:

Richard Codell, Sr. Hydraulic Engineer  
Hydrology Section  
Technical review Branch  
Division of High-Level Waste Management

SUBJECT:

ATTENDANCE OF DOE MEETING ON GROUNDWATER TRAVEL TIME FOR  
YUCCA MOUNTAIN SITE

I attended a meeting in Albuquerque NM held June 15 and 16, 1987 at the invitation of Paul Kaplan, who is the Sandia project manager for the NNWSI hydrology investigations. The meeting agenda and partial list of attendees are attached. The purpose of the meeting was to review the DOE's program, through Sandia National Laboratories for determining the pre-waste-emplacment groundwater travel time at the Yucca Mountain site. The review was conducted by a panel consisting of Jacob Bear, Allen Freeze, William Nelson, Ben Ross and Milton Harr. The first two are authors of well-known textbooks on groundwater hydrology. Milton Harr has authored four textbooks, dealing mainly with uncertainty and probability in civil engineering construction. The meeting was also attended by most of the Sandia staff dealing with the hydrology of the Yucca Mountain site. There were also attendees from Los Alamos, USGS, Desert Research Institute and the State of Nevada. Marty Mifflin, representing the State of Nevada and I were invited as observers.

The stated objective of the panel was to review the DOE's program on GWTT, and to classify sources of uncertainty according to their relative influence. They were also supposed to develop strategies for addressing the uncertainties. The five panel members met in the morning of both days. The remaining attendees held their own discussions. Both groups attended the afternoon sessions. Allen Freeze was the panel chairman and presented synopses of the panel's findings and recommendations.

The attendees were understandably curious about the current status of the NRC position on GWTT. They indicated that they were reasonably comfortable with the previous (June, 1986) version of the GWTT position. I was asked to present the current understanding within NRC of the direction that the revisions are likely to take. I indicated that there are strong sentiments for simplifying the position, and eliminating any reference to phenomena dealing with matrix diffusion or immobile water as in the June 1986 version. The attendees were surprised to learn that DOE has never commented officially on the position. I urged them to request that DOE forward all comments.

I was also asked to give my presentation on the the use of synthetic data bases to test characterization schemes for determining groundwater travel time. I learned that Sandia also has several efforts to use synthetic data bases in

such a manner. A Sandia staff person described how they have simulated the sampling of cores from an artificial site, in order to determine how much data are needed, and whether the collection of that much data was reasonable under projected budget constraints. Paul Kaplan alluded to a fourteen layer synthetic data base for testing characterization strategies.

There was lively discussion later on the subject of matrix diffusion. Jacob Bear recognized the difficulties of defining groundwater travel time in a fractured porous medium. The panel recommended that this subject be explored further as one of the categories of uncertainty.

Marty Mifflin suggested that there might be field evidence which would indicate whether or not fracture flow occurred at the site. This evidence might take the form of geochemical alteration or mineral deposition in fractures. There are plans for hydrochemistry data collection in Chapter 8 of the SCP, which has a tentative release date of August. Several Sandia people said that the SCP needs considerably more attention, and hope for a later release date.

Mike Campana of the Desert Research Institute mentioned that the geochemistry of seeps from G tunnel on Ranier Mesa have been studied. He indicated that the nuclear explosions there change the nature of the water, because water normally held in the pores is released. There is also evidence of meteoric water and recent bomb tritium from atmospheric releases, indicating that the groundwater in Ranier Mesa is relatively young. I asked for a copy of the reports, which I have since received.

I learned to my surprise that the exploratory shaft will not be excavated to the Calico Hills non-welded unit, and that there are no plans at this time to conduct any in situ experiments there by means of drillholes, cores or drifts. The decision to stop short of the Calico Hills unit was apparently a political rather than scientific one. The Sandia staff would like to see experimental data in this unit, since it is responsible for most of the credit for groundwater travel time and radionuclide sorption. In fact, they are restricted from doing very much in the way of any testing close to the repository site.

The panel reported their findings on Monday afternoon. Little was resolved in the first session, which was only the second time that they have met. They produced a "laundry list" in which they defined types of model and parameter uncertainty. Among the sources of uncertainty identified were the question of capillary barriers, perching and matrix/fracture interaction. The panel indicated that the release of C-14 in the vapor phase may be an important consideration. I mentioned that our contractors have produced several documents which classify uncertainty and that most if not all of the same uncertainties have been identified. It would be interesting to compare the lists. It was difficult for me to assimilate the material covered because of the rapidity at which it was presented. The panel will be producing a written report in the near future, however.

Several interesting issues were identified in the Monday afternoon general discussions. Several people questioned whether the Richardson equation, which is the basic equation solved in most unsaturated flow groundwater models, is generally valid. Jacob Bear commented that experimental measurements should not be attempted until one has a conceptual model in mind. He sees little alternative to stochastic models because of the great uncertainty in the data. Models should be used to determine the direction of data collection.

There was a brief discussion about the usefulness of data collected at other unsaturated tuff sites. Someone inquired whether any useful data on groundwater travel time have been extracted from the waste disposal studies in tuff conducted at Los Alamos, or whether anyone has made use to date of the NRC funded work being performed by Dan Evans at the University of Arizona. Several attendees commented that much greater use should be made of the G Tunnel data from Ranier Mesa.

In the Tuesday morning session. Marty Mifflin sees no effort lately for field data. The USGS stop work order has put a damper on the collection of new experiments, but monitoring has continued. Mifflin reiterated that experiments which have long lead times must be started immediately if the data are to be available at licensing time.

Gail Cederburg, a geochemistry modeler at Los Alamos said that there is little in the way of geochemical experiments planned for the exploratory shaft, other than a few simple diffusion tests with inert tracers. The hydrologists warned that most of the exploratory shaft money is being spent by the rock mechanics people to examine problems of mine safety and retrievability, leaving little in the way of in situ experiments for hydrology or geochemistry. There are proposals for drilling into the Calico Hills unit, and also into the saturated zone, but these tests are not planned for the time being. Marty Mifflin indicated that these tests are forestalled because of the psychological problem of compromising the effectiveness of the unit by drilling into it.

The meeting digressed frequently to topics of performance assessment. Marty Mifflin questioned the effects of heat on the repository performance. He worries that the heat from the waste will drive moisture away from the repository, and that part of the moisture driven upward would condense and drop back into the repository through the fractures. Additionally, water may be liberated as water of hydration from minerals which dehydrate at temperatures around 100 °C or less. He also felt that "heat piping" caused by the vapor release and condensation would cause the effects of heat to spread more rapidly than for a saturated repository. He was corrected on the latter point by almost everyone, myself included, who stated that the heat piping effect is relatively minor and effective over only a short range near the waste. Gail Cederburg commented that mineral alteration by heat is indeed a subject for study, and that they have already been exploring such changes as dehydration of hydrated minerals and redistribution of silica. Joe Wang from LBL commented that the effectiveness of heat piping for the flow of heat and transport of vapor and liquid depends on phenomena such as the ability of the walls of

fractures to carry liquid water. Little is known about the properties of the fractured tuff, so no good model has yet been proposed.

Paul Kaplan indicated that it was ironic that he, as project manager in hydrology could not require DOE to run a basic test at the site. As an example, he would like to see a fundamental study of the hydrogeologic properties of the soils found on the crest of Yucca Mountain, because such information would be useful in calculating ranges of infiltration, evapotranspiration and overland flow to be expected, in order to calculate a reasonable range for recharge at the site.

Dwight Hoxey from the USGS Denver office was asked whether any relevant information that the USGS has obtained lately. He mentioned the experiments being conducted by Ed Weeks on airflow through the unsaturated fractured tuffs. He said that this airflow would be expected to be a factor in reducing infiltration at the site, since the net airflow is upward. I asked him about the apparent mounding of water to the north of the site, and what USGS intends to do about its characterization. He commented that there was concern, and that they wanted to drill a test well to better quantify head and hydraulic conductivity. The USGS is concerned that if the mounding is due to a fault control caused by a "catastrophe", that a release of this control would cause a precipitous rise in the water table. Only one datum exists for hydraulic conductivity near the mound. Plans for characterizing the mounding should appear in the SCP. George Barr from Sandia commented that inverse modeling studies indicate that no fault control is necessary to explain the mounding. There is no fault expression at the surface. He likened it to a waterfall into a lake. The mound is probably an expression of the water table and is not perched water.

The panel spoke again on Tuesday afternoon. They still had not produced a ranking of uncertainty, and agreed that several more meetings would be necessary before they could produce a final report. We discussed whether or not the addition of one or two panel members would round-out the panel. It was suggested that the team add a geochemist and especially a geostatistician.

I spent the morning of Wednesday June 17 at Sandia National Laboratories listening to a lecture by panel member Milton Harr on his development of the point estimate method. The point estimate method is a way of quantifying uncertainty and sensitivity with minimal data. It is being tested as a possible means of identifying uncertainty in the Sandia models for groundwater travel time and performance assessment. I was joined in this lecture by Paul Davis and Tito Bonano, who are NRC's Sandia contractors.

### Conclusions

I thoroughly enjoyed attending this meeting. Little was resolved in the way of addressing the problems of uncertainty, but it was a good dialog between individuals from many disciplines, laboratories and agencies on all sides of the licensing table. The discussions were frank, with little posturing or grand

standing. Sandia admitted their own frustrations with the unavailability of data where it is needed most. They were exploring different mechanisms for fast pathways and mechanisms for transport, and in my estimation were not trying to trivialize any important mechanisms. The panel will address several of the issues raised by by Marty Mifflin and myself.

In light of the meeting, I think it would be useful to request that DOE collect data that Sandia has identified. In particular, we should encourage DOE to perform tests in the Calico Hills unit in connection with the exploratory shaft studies. We should also emphasize the need for collection of data at close-in locations rather than only at the periphery of the site. I believe it would be useful to continue to follow the panel meetings, which will be conducted several times a year. I was lead to believe that I would be welcomed back as an observer.

**ORIGINAL SIGNED BY**

Richard Codell, Sr. Hydraulic Engineer  
Hydrology Section  
Technical Review Branch  
Division of High-Level Waste Management

Enclosure:  
Agenda and partial list of attendees

AGENDA

Sandia National Laboratories, Division 6315  
Geoscience Analysis Division

Second Meeting  
Technical Advisory Committee  
"Uncertainties in Groundwater Travel Time Calculations  
at Yucca Mountain, Nevada"

June 15th & 16th, 1987  
Ranada Classic, Albuquerque, New Mexico

~~Starlight 3~~  
*NEWS ROOM II*

Monday, June 15

8:30	Preliminary remarks, groundrules, technical and procedural objectives of the meeting.	Paul Kaplan
9:00	Committee meeting.	Allen Freeze
NOON	Lunch	
1:00	Preliminary Committee Summary	Allen Freeze
1:30	Presentation	Bill Nelson
2:00	Presentation of Sandia questions to committee and discussion.	Paul Kaplan
4:30	Review Tuesday's agenda.	Paul Kaplan
5:00	Dinner - cable car to Sandia Peak, spirited conversation over drinks and food.	

Tuesday, June 16

8:30	Committee Meeting	Allen Freeze
NOON	Lunch	
1:00	Summary Committee Report, role of consultants, review.	Allen Freeze Paul Kaplan
2:30	Meeting dismissed.	

**PARTICIPANTS**

**Sandia National Laboratories, Division 6315  
Geoscience Analysis Division**

**Second Meeting  
Technical Advisory Committee  
"Uncertainties in Groundwater Travel Time Calculations  
at Yucca Mountain, Nevada"**

**June 15th & 16th, 1987  
Ramada Classic, Albuquerque, New Mexico**

**Sandia Personnel, Contractors, & Consultants**

**Jacob Bear  
R. Allen Freeze  
Milton H. Harr  
William Nelson  
Ben Ross  
Joe Wang  
Polly Hopkins  
Ralph Peters  
Brian Rutherford  
Dave McTigue  
Roger Eaton  
Bob Prindle  
Paul Kaplan  
George Barr  
Scott Sinnock  
Floyd Spencer  
Lee Orear**

**Invited Observers**

**Richard Codell - NRC  
Dwight Hoxie - USGS  
Gail Cederberg - Los Alamos  
Kay Birdsell - Los Alamos  
Marty Mifflin - Nevada  
Mike Campana - DRI**

JUL 06 1987

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MEMORANDUM TO            Ronald L. Ballard, Chief  
                                  Technical Review Branch  
                                  Division of High-Level Waste Management

FROM:                        Richard Codell, Sr. Hydraulic Engineer  
                                  Hydrology Section  
                                  Technical Review Branch  
                                  Division of High-Level Waste Management

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CONCURRENCES

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