UNITED STATES

NUCLEAR WASTE TECHNICAL REVIEW BOARD

WINTER BOARD MEETING

January 26, 1999

Alexis Park Hotel
375 East Harmon
Las Vegas, Nevada

PROGRESS IN DESIGN, SCIENCE, AND REGULATORY CRITERIA

<u>NWTRB BOARD MEMBERS PRESENT</u>

Mr. John W. Arendt
Dr. Daniel B. Bullen
Dr. Norman L. Christensen
Dr. Jared L. Cohon, Chair, NWTRB
Dr. Paul P. Craig, Afternoon Chair
Dr. Debra S. Knopman
Dr. Priscilla P. Nelson
Dr. Richard R. Parizek
Dr. Donald Runnells
Dr. Alberto A. Sagüés
Dr. Jeffrey J. Wong

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SWEDISH NATIONAL COUNCIL FOR NUCLEAR WASTE

Gert Knutsson
Nils Rydell
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I N D E X

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P R O C E E D I N G S

1:00 p.m.

COHON: Good afternoon. My name is Jared Cohon. I'm the Chairman of the Nuclear Waste Technical Review Board, and it's my pleasure to welcome you to this winter meeting of our Board.

As most of you already know, in 1982, Congress enacted the Nuclear Waste Policy Act. That law created the Office of Civilian Radioactive Waste Management, or OCRWM, with the U. S. DOE, and charged OCRWM with developing repositories for the final disposal of the nation's spent nuclear fuel and high-level radioactive waste from reprocessing. Five years later, Congress amended the 1982 law to focus OCRWM's activities on the characterization of a single candidate for a final disposal site, Yucca Mountain, about 100 miles from here, on the western edge of the Nevada Test Site.

In the same 1987 amendments, Congress created the Nuclear Waste Technical Review Board as an independent federal agency for reviewing the technical validity of OCRWM's program. The Board is required to periodically furnish its findings, as well as its conclusions and recommendations, to Congress and to the Secretary of DOE.

The President of the United States appoints our Board members from a list of nominees submitted by the National Academy of Sciences. We are, by design, a highly multi-disciplinary group with areas of expertise covering all aspects of nuclear waste management. In introducing the members of the Board to you, let me remind you that we all serve on the Board in a part-time capacity. We all have day jobs, as it were, most of them full-time or even more. In my case, I am president of Carnegie-Mellon University in Pittsburgh. My technical expertise is in environmental and water resource systems analysis.

John Arendt--John, if you could raise your hand--a chemical engineer, retired from Oak Ridge National Laboratory and formed his own company. He specializes in many aspects of the nuclear fuel cycle, including standards and transportation. John chairs the Board's Panel on the Waste Management System.

Daniel Bullen is a professor of Mechanical Engineering at Iowa State University, where he also coordinates the nuclear engineering program. Dan's areas of expertise include nuclear waste management, performance assessment modeling, and materials science. Dan chairs our Panel on Performance Assessment.

Norm Christensen is dean of the Nicholas School of Environment at Duke University. His areas of expertise include biology and ecology.

Paul Craig is professor emeritus at the University of California at Davis. He is a physicist by training and has special expertise in energy policy issues related to global environmental change.

Debra Knopman is direct of the Center for Innovation and the Environment at the Progressive Policy Institute in Washington. She is a former Deputy Assistant Secretary of the Department of Interior, where she was also a scientist in the U. S. Geological Survey. Her area of expertise is groundwater hydrology, and she chairs the Board's Panel on Site Characterization.

Priscilla Nelson is program director in the Directorate of Engineering at the National Science Foundation. She is a former professor at the University of Texas in Austin and is an expert in geotechnical engineering. She chairs the Board's Panel on the Repository.

Richard Parizek is a professor of hydrologic sciences at Pennsylvania State University and an expert in hydrogeology and environmental geology.

Don Runnells is professor emeritus in the Department of Geological Sciences at the University of Colorado at Boulder, and he's a vice-president at Shepherd Miller, Inc. His expertise is in geochemistry.

Alberto Sagüés is professor of civil and environmental engineering at the University of South Florida in Tampa. He's an expert on materials and corrosion, with particular emphasis on concrete and its behavior under extreme conditions.

Jeff Wong is chief of the Human and Ecological Risk Division of the Department of Toxic Substances Control in the California Environmental Protection Agency in Sacramento. He is a toxicologist whose expertise is in risk assessment. Jeff chairs the Board's Panel on Environment, Regulation and Quality Assurance.

That's our board.

Many of you know our Board's excellent staff, which we're very proud and for which we're very thankful. They are arrayed decoratively there across the wall. Bill Barnard--Bill, raise your hand--is the Board's executive director.

I'd also like to take this opportunity to introduce to you three guests from Sweden who are attending the meeting. As some of you may know, the Board has had for many years a cooperative relationship with the Swedish National Council for Radioactive Waste, or KASAM, in the Swedish acronym. With us today and tomorrow will be two members of KASAM, the board KASAM: Willis Forsling, who is professor of Inorganic Chemistry at Lulea Technical University in Sweden, and Gert Knutsson, professor of Hydrogeology at the Royal Institute of Technology in Stockholm. Also present is Nils

Rydell, expert and senior technical advisor to KASAM, and a long-time associate of ours with the Board.

Welcome to our meeting. We're very glad you could be with us.

We have a very important program for this meeting. As you know, it will cover a day and a half, this afternoon and all day tomorrow. Today, we will hear about recent progress in site characterization, engineering, and repository design at Yucca Mountain. We will also hear from the Nuclear Regulatory Commission about its proposed draft for the disposal of high-level radioactive waste at the proposed Yucca Mountain repository.

Tomorrow, starting at 8 o'clock in this room, the entire day will be devoted to presentations and a discussion of the DOE's recently issued viability assessment of a repository at Yucca Mountain. This assessment is a critical landmark in the development of the proposed repository, and tomorrow's session will be especially important.

Before I turn the rest of the meeting over to today's chair, Paul Craig, I'd like to say several things about the opportunities we're providing during the meeting for public comment. The Board has always been very interested in and sensitive to public participation in our meetings, both through comment and questions. We've made an effort to enhance that participation for this meeting, enhancements that we consider to be an experiment, and we'll see how they go. If we like them and you like them, we'll continue them.

They're comprehensive. They even relate to our seating. Those of you who have attended past meetings know that we're usually arrayed strategically so the backs of our heads are pointed at you. We've tried to alter that today by breaking open into this broken semi-circle, if you will, with your seating accordingly, trying to make for a more open setup and one in which interaction is easier.

We're also planning three public comment periods in this day and a half meeting, one at the end of today's meeting at approximately 5 o'clock, another at the end of tomorrow's morning session, approximately noon, and a final period at the end of tomorrow's afternoon session, again 5:00, 5:30, depending on what time we end. You'll follow that in the agenda.

Those wishing to comment are encouraged to sign the Public Comment Register at the check-in table over there in the corner. Linda Hiatt--Linda, will you raise your hand--of our staff will be glad to help you if necessary. Depending on the number of people signing up, we may have to set a time limit on individual remarks.

As an additional opportunity for questions, and this is new, you can submit written questions to Linda during the meeting. We'll make every effort to ask these questions, that is the chair of the meeting with ask the question, during the meeting itself rather than waiting for the public comment period. We will do that only if time allows, however. If time does not permit during the meeting itself, we will ask those questions during the public comment period.

In addition, you know we always welcome written comments in addition to oral ones. Those of you who prefer not to make oral comments or ask questions may choose the written route at any time, and we especially encourage written comments when they're more extensive than our meeting time allows.

I'd also like to encourage you to keep in mind the topics of the meetings, that is today and tomorrow. If your interest is in viability assessment or it's a comment that seems to fit in that, we'd encourage you to save that for tomorrow, if you're going to be here tomorrow. Obviously, if today is your only opportunity, we welcome your comments on any topic.

We've also added an additional session. Tomorrow morning at 7:15 to 7:45 in this room, the Board members, and only the Board members, no staff, will be here for coffee, and we invite anybody who would like to join us to do so. It will be an informal session. We will not be convened. There will be no record. It will simply be a bunch of people having coffee together, and it's a way to have informal interaction if you choose to do it. We're going to have coffee anyhow, so you might as well join us. Don't feel obligated though.

Finally, I need to offer a disclaimer so that you're all clear on the conduct of our meetings and what you're hearing and its significance. Our meetings are spontaneous by design. These are not scripted events. Those of you who have attended our meetings before know that the members do not hesitate to speak their minds, and let me emphasize that is precisely what we are doing when we're speaking. When we do speak, we're speaking for ourselves. We are not stating Board positions, unless we indicate otherwise. When we speak, we're speaking as individuals.

With that introduction, I'm now pleased to introduce to you Paul Craig, my colleague on the Board who will chair the rest of today's meeting. Paul?

CRAIG: Thank you, Jerry.

Today's session is entitled Progress in Design, Science, and Regulatory Criteria. We're covering a number of very different and interesting topics this afternoon in a very short period of time. The first presentation will be on the DOE's efforts to re-examine the repository reference design, in light of different alternatives. Rick Craun of DOE will summarize the information on these efforts which were presented yesterday at the meeting of the Board's Panel on the Repository.

After Rick's presentation, we'll hear from Tor Brekke, an internationally known geotechnical engineer and professor emeritus at the University of California, Berkeley. Last month, he chaired a DOE sponsored workshop on drift stability at Yucca Mountain.

The Board has been concerned about drift stability, its effects on design and performance, and the need for the DOE to take a serious look at this issue. We're looking forward to Professor Brekke's summary of the workshop and his panel's conclusions on drift stability.

Mark Peters of the Management and Operating Contractor and Los Alamos National Laboratory will then present an update of recent site investigations at Yucca Mountain. The updates have become an integral part of Board meetings, and we're particularly interested in results from and plans for investigations in the now completed east/west cross-drift in the repository block. The Board views these investigations and their potential for increasing understanding of seepage into the drifts in particular as being of great importance.

We're also interested in what's being learned about retardation in the unsaturated zone from the Busted Butte Test Facility. We were impressed with the speed of which this particular project got underway.

In addition, new boreholes have been drilled, such as the SD12 and WT24, such as the C-wells, others such as C-wells have been revisited. The question is what are we learning about the hydrological regime at Yucca Mountain.

Nick Stellavato of Nye County will then tell us about the initiation of work in the Nye County Early Warning Drilling Project. These boreholes will fill a data gap in saturated zone studies that was identified in the DOE expert solicitation on the saturated zone. It will be the major source of data on the saturated zone during the next few years.

Paul Dixon of the Yucca Mountain Project Management and Operating Contractor and Los Alamos Laboratory will fill us in on what tests the DOE is carrying out and is planning to carry out at these boreholes.

The final presentation of the day will be John Greeves and Tim McCartin of the Nuclear Regulatory Commission. John is the director of the Division of Waste Management at the NRC. Tim is a senior analyst in that division. As we all know, there has been a vacuum in recent years in the standards and criteria by which Yucca Mountain will be evaluated.

In the Energy Policy Act of 1992, Congress initiated a process by which these standards and criteria would be developed. The National Academy of Sciences completed its analysis of the technical bases for Yucca Mountain standards, and the Environmental Protection Agency has been hard at work since then trying to come up with a standard for Yucca Mountain.

The NRC decided to take the bull by the horns and has issued a draft proposed rule for implementing such a standard. This draft proposed rule has caused a good deal of comment from many groups, including the EPA. We have asked the NRC to brief us on this draft proposed rule. I'm sure there will be many questions. I'm also sure the speakers will outline the extent to which they can answer the questions, given the draft nature of the rule.

I'd like to remind all the speakers that they should allot half their time to questions and comments from the Board, and I will keep track of your time, speakers, and begin to wave at you when you run out, so that we have time for questions.

After each presentation, I will then ask Board members for their questions and comments. If time allows, I will ask if our guests from Sweden have anything to add. That will be followed by questions from the staff and possibly individuals from the audience. And I reiterate what Jerry just said. If individuals from the audience would like to address questions to the speakers, please fill out a form and that form will be passed by the staff to me.

After the last presentation, I will turn the meeting over to our chairman, and we will have the first of the three public comment periods that he mentioned earlier.

Rick Craun, your turn.

HARRINGTON: Unfortunately, Rick Craun is still out sick. We didn't get that message to you. I'm Paul Harrington. I'm also in the DOE Yucca Mountain office and will go ahead and do this presentation.

We wanted to capture today a little bit of what went on yesterday. It was a full day's meeting with most of the Board members, quite an active discussion of what it is we're doing in the License Application Design Selection process. We got quite a bit of input through the day, and particularly at the end of the day, so we'll talk through a little bit about what we did yesterday.

We opened it with a discussion of the LADS process. It was basically an update to the previous design efforts that we had done. One of the questions at the end of the day asked us why it is we were even doing this. There are a number of factors that play into that, not the least of which are the Board's annual reports suggesting that given current understandings of the mountain, other alternate design approaches might be appropriate.

Folks from within the project had the same sort of thoughts. So December of '97, we started an alternative process that ran for about six months, and the results of that prompted the LADS process, which we'll talk through today. Basically, it's to review alternate designs, given a relatively clean sheet of paper, to see what we think the most appropriate design might be, given our current understanding of the mountain.

We talked through the design selection process and we got into a discussion of the Defense in Depth process. I'll go through these fairly quickly. I have 15 minutes to get all of this out to you, and then we can go back to questions if you want to go back to some of these in more detail. We also talked through the role of performance assessment and identification of the benefits for various design approaches.

We broke out this LADS process. It was a two week workshop. It was the culmination of the first phase of it. There had been four or five months leading up to that point of analysis by the organization of various components.

In the Phase I culmination workshop, we took the input to that and came up with a series of enhanced design alternatives, and then farmed those out to three sub-groups for evaluation from Thursday of the first week, through Wednesday of the second week. To try and handle that, distribute that work, we did it in three modes. One was a high temperature concept. That team was sent off to try and define, given all of the design features and alternatives that had been discussed in the first three days, what steps of those features and alternatives were most promising for high temperature designs.

A second team was sent off to do the same test looking at low temperature designs, and a third team was sent off to do the same test looking at enhanced access designs. The concept behind enhanced access is to facilitate potential off-normal operations. I know that's one thing we've briefed the Board in the past, is what do we do to recover from an off-normal operation.

One of the main focuses of this work was to reduce uncertainties. What is it we can do in the design role to minimize the uncertainties that are inherent in both the natural processes and the physical processes, the engineered features.

The Phase II process we then discussed. That's what happens at the end of this two week workshop that we closed a week and a half ago out through May. We had a roundtable discussion at the end, invited Chris Whipple up here, and then closed out the day with a public comment period.

What this is intended to do is update the design process to support the site recommendation and license application. The project has gone through a number of design evolutions over the years. We had an SCP design a number of years ago. We evolved that to an advanced conceptual design. That evolved to the viability assessment design. We're now trying to focus on what are the best attributes of that, and what other attributes might we invoke to come up with a suitable design for site recommendation.

There will be a report that's generated by the M&O contractor to the DOE on April 15th of this year. That will contain their recommendation for the design to take forward to site recommendation. Now, that report will be reviewed by the DOE from mid April to mid May. The M&O has two weeks for comment, then that report becomes a deliverable from the DOE project to the DOE program office in Washington. That may or may not be a specific design. We would not propose a single design unless we felt there was sufficient technical basis to warrant a down select.

If we don't have that basis, it may well be a fairly high level recommendation, possibly just a selection between a high and low temperature repository. There may be a couple of alternatives, or a primary plus a couple of options.

The LADS workshop, we just talked about what happened there. We started into that with 26 design features. Actually, a few of those have been consolidated.

There were 22 features. They're in the handouts from yesterday if you want more detail. And also eight design alternatives. The difference between alternatives and features; alternatives we felt were more broad based design approaches, things like a borehole emplacement versus an in drift emplacement. Some of the features were things that we felt could be applied to most any fundamental design approach. You could lay a dual corrosion resistant material design into either a borehole or in drift emplacement scheme. So that's the difference between features and alternatives.

At the end of the breakout session, the teams had come back with--those three teams I mentioned earlier--23 enhanced design alternatives. In a scrub-down during that last day that was brought down to eight enhanced design alternatives, and we're still working on defining the details of what we review of those in this Phase II activity between now and the May 28th closure date.

Before I go into the issues, let me put up a couple of slides from yesterday, give you a little better concept of what those eight are. These are not in your handouts. I pulled them out of yesterday's. In the low temperature area, there are two fundamental design approaches. One is line loading; the other is point loading.

In the line load, the packages are thermally balanced. There's some blending that goes on, mixing hot and cold individual waste assemblies into a single package so that we can stick them very close together, less than a meter. That's to ensure heat transfer from one package to the next.

In a point load concept, we're treating that as an equivalent energy density concept. We'll look at the thermal content of each package and space the packages appropriately, given their high versus lower loadings. There's some value to each of those. The line is being looked at as a 50 MTU per acre, and the point as a 40.

Within those, there are also considerations about just how hot the packages can be. Possibly this will result in smaller waste packages, lower thermal content per package. Those are the two fundamental low temperature approaches.

The high temperature summary had three. There's an 85 MTU per acre line loaded, a 150 MTU per acre line loaded, and even hotter or denser, 170. The significant feature about this is the bowtie post closure ventilation. I didn't bring the schematic of that, but in essence, there are parallel drifts that are staggered between upper and lower peripheral drifts, and you would set up a convective thermal flow to remove heat and moisture from the center of the repository area where the packages would be located, and transfer that to the outside of the package to try and keep the actual package emplacement area cooler and dryer than otherwise would be the case.

The enhanced access had three. The first one is the waste package itself would provide access. That is a thicker waste package, dual CR rim. The thicker package would be on the order of 200 to 300 millimeters. It's a stainless steel with C-22, if I remember that one right. The waste package and emplacement mode providing access would be having short emplacement cross-drifts between the main drifts. Those main drifts would be available for personnel access. The packages would be in short ones. This also would have a relatively thick waste package, 30 centimeters of carbon steel, 8516. Then the emplacement mode access is a trench in the bottom of the emplacement drifts where the waste packages would be emplaced and then covered over with a slab.

Some of the issues that are key to us is how does defense in depth play in this, the relationship of performance of engineered features to the natural system. How can we use that to mitigate uncertainty or variability of the natural system? Also, of the engineered system itself, and certainly there's uncertainty in our knowledge of the integrity of fuel cladding, for one.

The technical bases that we have for making the decisions; do we have enough scientific and engineering knowledge about the performance of the mountain or the engineered features to warrant making the selection between design alternatives. The evaluation criteria consolidation; we had in December assembled an independent review panel to help ensure that what we were doing made sense, that this process was transparent, that we weren't missing some fundamental features.

One of the points of feedback we got from them was don't have segregate or acceptance criteria, or review criteria, as much as we had. We had about eight or nine separate review criteria. We have consolidated some of that.

Also level of design recommendations to be made; the presentations that you'll see tomorrow will include the VA design. That's quite detailed. It has a lot of design on the waste package on the sub-surface and even on the surface. We certainly will not at the end of this alternatives design exercise have anywhere near that level of design detail. We don't have the basis for that. We need to develop that. So we will not be trying to over commit through this design alternative work.

And transparency of the LADS process; is it understandable, is it defensible. Have we documented what we did enough to withstand scrutiny?

We think the process is working. During the EDA development activity in the workshop, there was an awful lot of we think frank interchange between engineers, science and

PA on the relative merits of the different approaches. There was open discussion of those. The people who were assigned to go off and look at the various design features and alternatives we think generally bought into the concept of what they were asked to look at. We don't believe that it was done with an intent of submarining it. The workshop ended with the eight EDAs to be taken forward. Those are the eight I just showed you a moment ago.

There were a lot of comments made through and at the end of the day. I tried to pull out some of the more representatives ones. Certainly in 15 minutes, I can't relate everything that was said.

I think the first one was what I took anyway as the most broad based comment I got from the Board. There's a great deal of concern, I sensed, as to whether or not we can even appropriately do this in the time frame that's allotted to us. There were some suggestions that possibly we should set this design activity, design alternative activity, further out in time, do more data gathering, more research.

I made a comment to that yesterday, and I'll do it again today. It's really two-fold. One, this activity between now and May, yes, that's four months, but it's really the culmination of years of design activity that have been going on here. We certainly know that there are more design and scientific activities to be done, but it's not something that we're trying to do in a period of just a few months.

The second item was we're also not trying to create more of a design or propose more of a design than we think we have a basis for. The weighting factors in this decision process have to be defined before we can propose to make a decision. What are the relative tradeoffs that the Department would propose to make to support proposal of one over another alternative?

DID is a concept. Certainly it is. We have a lot more work to do. One of the pervasive themes is we're not approaching DID in the same manner as we did in the commercial nuclear industry. That's certainly true. We don't have quite the same set of problems, circumstances on this project as a standard nuclear power plant does. What we're trying to do is take that approach. What is it you gain from a DID perspective, and translate that to our set of circumstances and how might we best approach DID activity here.

Another was that there's limited experience with many of the engineered materials, particularly the waste package materials, C-22. It's not a historically long lived material. It hasn't been around a long time. That's true, and that's why we're doing the analyses that we are now. Certainly more time gains more understanding. We'll try and quantify what the uncertainties are for the materials as we take them forward.

One comment was that most of the EDAs as proposed also included drip shields and backfill. That's true. Generally, though, those were not integral to the EDA. There were some other things that were included in there, such as activities to be done at reactors that also are not integral. Drip shields and backfill will provide some benefits. They also have some drawbacks to them. So they're being evaluated as part of the overall process.

Also, how can PA really reflect differing uncertainties with respect to hot and cold, the amount of perturbation from ambient conditions, the relative degree of uncertainty with respect to that. That's one of the things we're having to work. And we had put up one slide in particular that showed a lot of performance credit taken for waste package at 10,000 years versus other features in the natural system. That generated a lot of discussion. It would have maybe been helpful if we had put up something for extended periods at 100,000 and a million years, that delta wouldn't have existed in those outer year projections, but that was a feature of a 10,000 year look-see.

Okay, questions?

CRAIG: Okay, thank you very much, Paul.

Questions from the Board?

KNOPMAN: Debra Knopman, Board. Paul, I think it would help us, I was one of the Board members who did not attend yesterday's meeting, it would help me to know what your operational definition was in the course of your LADS workshop, and all this stuff, for defense in depth. Can you give a succinct characterization of how you all collectively are thinking about defense in depth insofar as you're using that as one of your--

HARRINGTON: My take on that would be we're looking at each of the features that provide performance in an overall design. We're eliminating the features on a one by one basis, and looking at the result and contribution then of that feature to the overall performance, with an eye toward ensuring that there is no single feature that would unduly compromise the ability of the repository to perform if that feature were not to perform.

Now, if Larry Rickertson is here, he can add to that. Okay, I'll leave it at that. Does that address it?

KNOPMAN: Yeah, that's good. But there's no sort of a priori requirement that your key features each make some contribution, that is, you're not sort of starting with some idea that every one of your key features has to pull a certain amount of performance?

HARRINGTON: That's true. We haven't assigned a minimum performance to a key feature, if that's the question.

CRAIG: Other questions from the Board? Bullen, Board.

BULLEN: Bullen, Board. Paul, I was very pleased to see that you caught a lot of the comments that were made yesterday afternoon, and I was also very interested as I observed the process of the EDAs to see the open and free thought. I am concerned, however, a little bit about the transparency, and so I'll ask a question that I asked again yesterday, that dealing with the 3-5 reports and their availability. I'm assuming that the 3-5 reports--

HARRINGTON: I knew that was going to come up today.

BULLEN: The 3-5 reports, for those of you that don't know, are a QA report that documents the process of evaluation of all the alternatives and design features, and they were prepared and provide sort of a traceability in the selection, and I was just wondering about their availability.

HARRINGTON: They will be available on the Web. Yesterday, I didn't know that for a fact, so I didn't want to commit to that. But I talked to both the DOE and the M&O people responsible for creating them and putting them on the web. They are going to be primary reference material. We've committed to making primary reference material available on the web, so we will go ahead and put those on.

BULLEN: So in answer to our question from the gentleman from UNLV, they'll be web-available?

HARRINGTON: Yes.

BULLEN: Okay, thank you very much.

CRAIG: Other Board questions? Jerry?

COHON: Cohon, Board. I'd like to question you further on this issue of time, the time available to do what you're trying to do. And I understood and accept what you said before that it sounded like you just started this design process, alternative design process, cold. You've got years of prior work behind you, including the reference design work for VA. This is going to be somewhat putting you on the spot, and part of it is just a speech, but I hope to get you to react to it also.

I guess knowing what I do about the process, and we got a pretty good report from the Board members who were able to attend yesterday, it sounds like the process you've embarked on is very interesting as well as very important, that is, it's got the features that Dan Bullen just attributed to it, it's open and creative. You're starting to think outside the box, to some extent. I think almost unavoidably, and very productively, in doing so, you're likely to, and perhaps you already have, identified some new ideas and new questions you'd like to pursue, including, and especially, connections between the design and the natural system. And that's the part that's very hard to deal with as a designer, yet it's a crucial characteristic of the site, the interaction between the engineered system and the natural system, so let me try to get to a question.

Could you give us a little more insight into how you see iterating back to the natural system, presuming through TSPA and further data collection analysis, from this alternative design process so as to make a decision for the system and not just for individual pieces of it? And how do you do that by May?

HARRINGTON: I think that's really what we created the design modeling group for. There have been somewhat of a separation between the scientists and the modeling that they were doing and the results that they were getting from that and the engineers and what they were doing. About a year and a half or so ago, in recognition of that, we created within the engineering side a modeling group, if you will, that's Jim Blink and his folks, to be that link between the modelling activities, the scientific side of the house, if you will, and what the designers are doing. So I see that role being filled by that group to make sure that what the engineers are trying to create in this process, and Jim is actually a member of the core team in the LADS group, is being integrated with the scientific world.

The people doing the LADS design activities are having to identify what data they need. They feed that out to the support organizations through a 3-12, which is just a document form transmitting data need requirement. Those support organizations then pull together the data, feed it back to the group. But the design modeling group is there really to try and make sure that is all pulled together.

CRAIG: I think we've now run out of time, so we're going to have to move on. Thank you very, very much, Paul.

HARRINGTON: Okay.

CRAIG: Maybe everybody else can catch Paul Harrington during the break.

We now move to a report on tunnel stability workshop by Professor Tor Brekke from the University of California at Berkeley.

BREKKE: Mr. Chairman, Board members, Ladies and Gentlemen, guests from Sweden. In November this year, there was a group of seven people invited to constitute a panel to evaluate the drift stability questions. This is for the drifts for emplacement that are at hand. It was myself, Ed Cording from the University of Illinois, Jaak Daemen from University of Nevada at Reno, Roger Hart from NEDASKA in Minneapolis, John Hudson from Imperial College in England, Peter Kaiser from Laurentian University in Canada, and Sebastiano Pelizza from Turin University in Italy.

This was an independent panel. We were invited to produce individual reports if we disagreed on something. I'm glad to report to you that it was a consensus report. We are wrapping it up right now. I got the last comments from one of my panel members about a quarter to 1:00 today, and hope to have it all done by next weekend, or thereabouts.

Now, the scope that we were given was this; to obtain an expert opinion and report regarding drift stability and the degree of ground control needed for varying design conditions, and that's very important. The report will be used as input to a decision analysis that will determine the types of ground control to be proposed for use on the project. In other words, it's not a final report where the design in any way or fashion is set by this committee. It is just an input report to try to sort out some of the questions at hand.

And then we were told or asked to produce a report that addressed these things; degradation mechanisms, we see it, temperature effects, drift diameter effects, water mobility effects, host rock strata effects, identification of other significant variables, expected effectiveness of varying ground supports.

Now, the way we went at it was that we started with rock mass characteristics. We asked for and was awarded the time to spend a day out in the field to visit the main drift as well as the cross-drifts, and that was very helpful to us. And the report has a summary of the conditions out there as we see them, as we understand them, and as part of that discussion, there were also questions that we raised that we think should be addressed.

We did a little comparison of support conditions in main drift and cross-drift. It turns out that the cross-drift has quite a bit better ground, if you don't mind, better tunnelling conditions, than most of the main drift, and there are several reasons for that that we go into, one of them being that they used a different kind of tunnel boring machine that didn't pluck as much rock as had happened in the main drift where they had more blocky rock.

It talks about rock mass properties of the lithophysal zones, buggy zones, if you don't mind. It's a place where the rock during cooling, there were gas holes entrapped, and so they're small, kind of egg shaped or golf ball shaped or up to softball shaped holes. And the interesting thing about that is that when you look at the fracture system close, you'll find that a lot of the fractures are just going from one bug to the next bug, maybe for a distance of maybe one meter.

The importance of that is that when they did exploratory drilling here, there's no way with exploratory drilling with that core that you can decide if you have a fracture, whether that fracture will go across this room, or just go this far. As a result of that, the postulated rock mass behavior or ground quality, if you like, was much lower than that actually encountered. And, in fact, the rock mass classification systems that were used, which we all use on other projects, may not be as accurate in predicting the stability of the ground conditions in this case with lithophysal zones.

Factors affecting drift stability, there's a whole chapter on that in our report. We go through each and every one of these factors, and see how they will affect the stability of the openings of the drifts, including those that I listed on the third slide, temperature, water, and so on.

Anticipated excavation degradation modes. The important thing there is to try to get a handle on what will happen when temperature goes up in the rock mass. There is presently, as you probably know, there is a heated drift experiment going on. It's not complete. But we believe that the observations made there are critical to understanding what is going on, and also critical in terms of input to the methods and analysis that has been made relative to the response of the rock mass to heating or cooling, for that matter.

We're also interested to see everything they can get out of that experiment would be very helpful and should be put into input into the analysis, the field data from there, rather than, for example, the pertinent rock properties derived from laboratory samples. We have out there now the possibility for really finding out more accurately what's going on.

Now, support design considerations, there are many of those that come into play, but one of them is--well, let me just take a few of them here. Are we going to have support that is going to last 100 years, 150 years, 300 years? We as a panel get more and more nervous the longer that period is in terms of really predicting what will happen. It's our consensus that to make the retrieval period as short as possible, including of course consideration of a lot of other factors than just the drift stability itself, making that as short as possible is very important.

What's the need? What are we supporting against? Is it a load? What kind of loads? Structure load? Is it thermal loads of course? Is it loads that follow from, say, moisture migration that could lead to degrading of the joints, sheer stiffness, for example, or sheer strength? We looked at that. The ease of installation of a support system and compatibility with the tunnel boring machine, excavation system. We were told that it could be acceptable if there was some maintenance to be done after emplacement, and we also looked at the influence of things like radiation and heat and moisture, as I've said before.

Now, we were aware of the fact that the Department of Energy and its consultants have developed kind of a systematic way of looking at different support systems, including concrete lining, including steel sets, including segmented concrete lining, including rock reinforcement, and we discussed and debated that. The one thing that we did not concur with was the soundness of selecting a segmented concrete lining system. That is where you have precast concrete lining segments that are put together in a ring. It is a system that's used extensively now days, for example, in the Los Angeles Metro, because it's a quick way of getting the initial support system in. At the LA Metro, as an example, we put those in, but then we came back with a second lining.

If such a system was going to be permanent, then in the instances where you've done that, they are heavily reinforced and bolted lining segments. The analysis performed by DOE or its consultants shows that due to temperature heating, there could be very high stresses building up, and they have suggested that there should be some crushable material between some of these segments that could take care of that. We respectfully disagree with that. We think it's a shaky system and we think in particular under dynamic load, that is, under earthquake load, that that system is not too good.

The system that we selected, not for the project, but selected as a panel to be looked at most seriously, is rock reinforcement. For those of you who have been out there in the tunnels, you know, for example, that in the cross-drift, there is wire mesh and rock bolts in the crown that could easily in that instance be installed right behind the cutter head of the TBM because of the type of machinery used. We believe that that is the way to go. We believe that as pointed out in the report, they don't have it only to reinforce a pier, you may have to bring it down to the side like this because as we discussed in the report, some of the loading that you may see down the road, so to speak, is right there at what we call a spring line, or the launches, heavier mesh than perhaps was used. A great asset of that system is that you leave it to the rock to take care of most of the problem, rock reinforcement, reinforced rock. We don't look at load that comes and sits on us, like it would do for example in terms of a steel design. So that is our recommendation, with quite a bit of detail.

Concluding remarks. I want to just say that we felt very comfortable as a panel with regard to the information that we got in advance, the field trip, and the presentations that were given to us over one day. The last of the three days we used to deliberate and to prepare an outline of the report. It's important, and we are very comfortable that we had the whole story, as we see it.

Thank you.

CRAIG: Thank you, Professor Brekke.

Questions from the Board?

RUNNELLS: Don Runnells, Board. I'd like to ask you about the lithophysal rock units.

BREKKE: Yes.

RUNNELLS: The repository, the proposed repository will reside about 70 per cent in lithophysal units. You mentioned that the observations suggest that the rock properties are better than you would have anticipated from drill cores.

BREKKE: Yes.

RUNNELLS: Can you expand on that a little bit in terms of why the rock properties are better and what the surprises were versus the rock core?

BREKKE: If I can use this as a rock core, if I had intersecting discontinuities, from that and from the nature of those discontinuities, this roughness, filling material, whatever, you can deduce these are to be the method, the rock mass rating system. All right? And from that, and based on experience, looking back over the years, and as documented for literally hundreds of tunnels, they say, ah, when we had these value rates for these, then we had these and these measures that had to be taken to stabilize the wall. In other words, it's a quality index.

When you get these smaller fissures that I discussed between these bugs, then they don't really affect tunnel stability. They are important, however, otherwise, because when it comes to the thermal reaction of the surrounding rock mass, they play a role, and we think a positive role, incidentally, because you don't get the very high stresses you do if you just put in, you know, a continuous rock mass without any discontinuities in it.

RUNNELLS: Thank you.

CRAIG: Priscilla Nelson?

NELSON: Nelson, Board. Thank you very much, and look forward to seeing the entire report. Congratulate DOE on inviting such a wonderful group of people together to meet on the project and actually hope and suggest that continuing involvement can be arranged, as I think your input is very valuable.

But let me ask you just one question, and I suspect you've made comments on this in your report. Regarding the difference in behavior between the lithophysal and the non-lithophysal zones, and given that the test that's being done, the thermal heat load test that's being done in the tunnel that we saw is in the non-lith rock, what kind of a difference in response would you expect, or would you expect any difference, between the lithophysal rock responding to a thermal pulse and the non-lith responding to a thermal pulse?

BREKKE: I don't know the answer to that. I don't know. This is the first heating experiment that I've ever been involved in that involves rock mass. I don't know.

Clearly, without being too general, I think in the non-lithophysal rock, there are more joints, and so on, if I observe that correctly. It's a little bit of a different rock mass. When I say I don't know, I'm not ashamed of saying that because I don't think anybody knows.

CRAIG: Let's see, Cohon, Bullen and Parizek.

COHON: Cohon, Board. You talked about the segmented concrete liner.

BREKKE: Yes.

COHON: Was there anything to add with regard to the non-segmented concrete liner, or would your comments to one apply to the other as well?

BREKKE: No. The comments I made were to the segmented concrete liner as we were presented with. Obviously, the same segmented concrete lining can mean a lot of things. If it's fully bolted and can be even designed for internal pressures and whatever have you, that's a different story. But cost wise, it then goes out of the window. The only reinforcement that is in the segmented concrete lining, which is unbolted, is the reinforcement you need so you can handle the segments without having them fall apart.

Those comments do not--we have different comments on the placed concrete lining. All right? We don't think a placed concrete lining is necessary if we have understood the rock mass correctly. That goes in there after you're all through. You have for tunnel safety purposes, for the rock bolts and mesh anyway, and rock bolts and mesh, I forgot to say that, I guess, that's the beauty with it, that you can advance the tunnel, utilize the TBM, get production, and then later beef up, if you don't mind, the rock reinforcement system to the extent that you deem necessary after all of the heat tests and all of that are fully understood. You decouple that from the driving of the tunnel itself, and that's where there's a lot of savings.

BULLEN: Bullen, Board. We learned yesterday of a number of opportunities that DOE is investigating to reduce the thermal impact of the waste package on the near field and on the waste package environment. Could you comment on tunnel stability with respect to keeping the temperature, say, below 100 degrees C. near field? And I've got a quick follow-on after this, but go ahead. Could you comment on that one first?

BREKKE: Well, let me answer you this way. As our Swedish friends would tell you, they bit the bullet on that many years ago and said we are not going to heat the rock so that we get boiling water under atmospheric pressure. And they simply said we're going to take our whole process and base it on that premise, and that's what they have done.

I think that the higher the temperature goes, and the more temperature gradients you get, for example, this blast cooling that has been suggested, the more degradation you will find taking place in the rock. I can't quantify that for you, but there is in the report a significant discussion of that.

BULLEN: Similarly, the follow-on of what we learned yesterday with respect to enhanced access, you mentioned that one of the criteria was that maintenance is acceptable after emplacement, and I assume you mean emplacement of waste. What type of maintenance did you foresee, and how long of access would you suggest? Could you comment a little bit on that?

BREKKE: Well, now I talk only for myself and not for the panel. I would say once the garbage is in there, whatever you have to do, backfilling or whatever, and I know there are other questions related to that, bye, bye, you're gone. Okay? That's my assessment. Once I've said that, if they want to maintain a maintenance option, then this rock reinforcement mesh system lends itself much better to that than any of the other systems, because that you can literally, at least the rock bolts you can install remotely.

BULLEN: Thank you.

PARIZEK: Parizek, Board. You perhaps did not consider the role of rock bolts or wire mesh or steel struts in the performance of the repository and its effect on chemistry, as an example. That was not part of your charge?

BREKKE: No.

PARIZEK: And the length of time it would remain stable? I mean, how long a rock bolt is good for, and are we going to have rock falls?

BREKKE: We addressed that. I mean, there's a longevity question here, clearly, and then again we are not the experts to decide how much humidity, if you don't mind, or water and air together down the road will get in contact with the mesh and the rock bolts.

There's another question here that we raised. Rock bolts, if they are fully grouted with cementitious grout, will there be a reaction between that grout and the rock, considering all of the non-crystalline silica that is in that rock? We don't know that. We pose that as a question. And we also pose as a question if you heat and cool and heat and cool, will the rock bolts become loose teeth that will fall out because of the incompatibility in terms of thermal expansion, contraction, and so on and so forth?

PARIZEK: I have a followup question regarding the stress relief damage that could be done by tunnels of different sizes, and this is the so-called onion skin effect of propagating open apertures away from the tunnel, and if you were to use rock bolts and those onion skin stress relief features help funnel water flow in a beneficial or harmful way, would rock bolts connect to those and maybe cause dripping that otherwise might not have occurred in the repository? And if so, could you design rock bolts to support the roof in a way they wouldn't leak or drip on a canister?

BREKKE: I think the answer to that is that the Swellex bolts that they are now using, as they are being used, they have a little groove when they are expanded, and that is obviously a pathway for water. I can't see that to be something that should stop us in the sense that we can't take care of that one way or the other. Drift size really doesn't play much of a role in terms of the disturbed zone.

PARIZEK: Did you see a disturbed zone? Did you see evidence of a disturbed zone?

BREKKE: Well, right there, I mean it's loosening up a little bit. What I'm referring to here is, for example, both in Sweden and in Finland, they have made estimates of typically how deep is the disturbed zone that in terms of mobility of water, you know, has an effect, and that zone in a TBM tunnel is typically in the order of one foot. And in a drill and blast tunnel, it is typically in the order of one meter. And that is backed up by Japanese data that they have done for other purposes.

PARIZEK: Thank you.

CRAIG: Other questions from the Board? Why don't we turn to our Swedish guests? Would you care to comment? It's not required. This is optional. I think the answer is no, not at this time. Questions from the Staff?

(No response.)

CRAIG: I see no questions from the staff, and it's about time to move on, so we will now. Thank you very, very much, Professor Brekke. And we turn to the report on recent site investigations. Mark Peters, Management and Operating Contractor from Los Alamos National Laboratory.

PETERS: Okay, I'm going to give you all an update on the list of things that we heard at the beginning that you all wanted to hear about. I have a whole bunch of things to talk about today. I've got a lot of slides so I'm going to go through them. I'm sure we'll have lots of questions.

I'm going to talk some about ESF testing, focusing on the infiltration/percolation testing that we've done recently, also touch on results from the drift scale test in Alcove 5, and then spend a good bit of time on the cross-drift, talk a little bit about the predictions that we did for lithostratigraphy, and also how that compares to the mapping results; have a slide or two on the moisture monitoring results, the data we've collected to date, and also talk some about the current plan for the cross-drift, which I know is of some interest; give an overview of what we've seen at Busted Butte in terms of Phase I and Phase II results, and the status of where we're at there; discuss the Prow Pass testing results from the C-Well complex, which we're just now finishing up; give an update on the status of SD-6 and WT-24, and also give a brief overview of the objectives and plan for the EBS pilot-scale testing at the facility in North Las Vegas, so a lot to cover. So I'll start with ESF testing.

This is just a slide, a layout of the ESF and the cross-drift with the repository block to the west of the ESF main, just to get you oriented. I'm going to focus today on results from Alcove 1 up near the north portal, talk some about the infiltration and percolation experiments we've done at Alcove 4 in the Paintbrush non-welded, and then also touch on again thermal testing activities in Alcove 5, and then down to fracture matrix interaction studies in Alcove 6 in the middle non-lithophysal in the Topopah Springs tuff.

This is just a schematic diagram showing the locations of some of the hydrologic testing in the ESF. Again, we're addressing infiltration in both Alcoves 1 and 7, looking at how the Paintbrush non-welded acts in terms of diverting flow as it comes from the Tiva into the PTn, in Alcove 4, looking at seepage, issues related to seepage in the niches in the ESF main, and also looking at fracture matrix interaction in the fracture welded tuffs in Alcove 6.

Let's start with Alcove 1. Here, we're doing an infiltration and percolation study, basically associated with the El Nino studies. We're basically flooding the top of the mountain right above the north portal, and then looking for water drippage into Alcove 1 below. We're using traced water. In Phase I, we used lithium bromide traced water, and we were using very high infiltration rates, akin to a superpluvial type event. We're looking for not only the timing of when the water reaches the opening, but how much actually enters the opening, and the character of the flow through the fractured welded tuff and the Tiva.

This is just a layout to get you a little better oriented. The top part shows a plan view with the infiltration plot that sits over the top of Alcove 1. There's about 30 meters between the infiltration plot and the crown of Alcove 1. And then the bottom just shows a cross-section of that, so the infiltration plot is right up in here.

In terms of results, the first phase was completed back in calendar year '98. We applied about 63,000 gallons of water at the infiltration plot. We actually saw seepage at close to 60 days, it took to get seepage into the opening, and it was after about 30,000 gallons had been applied. And of the applied water, we've collected about 10 per cent in the collection trays in the roof of the alcove itself.

Again, that was with lithium bromide traced water.

The second phase has begun, and here we're going to vary the infiltration rates and also use multiple tracers to get a feel for more of the transport phenomena within the Tiva Canyon.

I should comment that we did do predictions for the first phase, and within the range of the sensitivity analyses that we did using an ECM conceptual model, we actually were able to predict the first arrival in terms of seepage into the opening very well.

To move on to Alcove 4, Alcove 4 is again in the Paintbrush non-welded units, and as you know, that's a key part of the natural barrier at Yucca Mountain. Here, we're doing some smaller scale percolation tests to look for not only how the PTn, the microstratigraphy within the PTn diverts flow, but also how faults and fractures within the PTn perturb that flow. Faults and fractures in the PTn are of course very important to conceptual models for Chlorine 36 and some of the other observations in the Topopah itself below.

So what we've done here, we've really just started this test, and we don't really have much in the way of any significant results. We have done predictions, but to date, I don't have much in the way of results to talk to you about. But I can show you the layout, what we're done to date, and where we're going.

This is a map of the back of Alcove 4. This is again in the PTn. What we've done is we've excavated a slot down here and we've drilled a series of boreholes above. The key part about this part of the section is that you have a fault with about a quarter of a meter of offset, and also a large fracture.

We've injected at this point in Borehole 12 several hundred liters of traced water, and we were looking for water to come down the fault and enter the slot. As of yet, we have not seen any water in the slot, but again, it's very early in the test. We're about to start back up injections in the next month or so.

Okay, moving on to Alcove 6, the fractured welded units in the repository horizon. Here, we're doing a similar experiment as in Alcove 4. We've got a slot. We've got a series of boreholes above. Again, we're doing injection and looking for fracture matrix interaction within the Topopah. We've done two liquid injection tests in Alcove 6, and some of the preliminary results for the high permeability, we did air k prior, so we characterized the permeability structure on the meter scale, and we've done some injections again, and in the high permeability zone, we found that as much as 70 per cent of the water that was injected actually flowed through the fractures, and that's consistent with the model predictions that we did prior to the test.

The next one will show you a sort of scale drawing of what that looks like. The scale on here, it's about a meter from the injection borehole down to the slot. Again, we've primarily been injecting in this borehole here.

SAGÜÉS: What's the scale?

PETERS: It was about a meter between the injection borehole and the slot.

Moving on to Alcove 5, focusing on the drift scale test today, just to remind you of the objectives of our in situ thermal testing program. We're developing a more comprehensive understanding of the coupled processes, and we're focusing on temperature distribution and heat transfer, as well as looking at some of the mechanical, thermal mechanical properties, thermal expansion, modulus, et cetera, looking at the movement of moisture during heating, and then subsequent cooling, and also monitoring the changes in water chemistry and gas chemistry due to heating and cooling.

Again, I'm going to focus on the drift scale test today. This is a diagram showing temperature and power on the same plot.

NELSON: This is about where we start hearing the Defense in Depth jokes.

PETERS: Again, this is just showing where we're at in terms of drift wall temperature. On the left-hand side, we're plotting power versus time, and we started the heaters December 3rd, and we've been running over a year. We've been running at right around 190 kilowatts. And on the right, we're plotting temperature. This is a representative sensor on the drift wall about halfway down the heated drift, and we're at about--as of today, we're probably closer to about 160 degrees C. This is data as of our earlier January.

Again, our original target with the drift scale test was to get to 200 degrees C., so we're still working our way towards that goal.

Some more in terms of the temperature response. This is temperature data as a function of time for one of the boreholes that runs horizontal from the heated drift. It's actually parallel to wing heaters, but above the plane of the wing heaters. So remember the wing heaters are actually two elements, outer element being higher power than the inner element. So that's where you get the humped profile. There's a cold spot in the middle. So the borehole collar is there, and you're moving into the rock there, so you can see that we've heated up. When we got to 100 degrees, to local boiling, about 96 C., we saw significant flattening at local boiling. We stayed there for on order of two weeks, and then we moved on through and continued to heat up, and close to the wing heaters, we're getting well into the range of 200 degrees C. We picked up again the hump profile.

Some example contours of measured temperatures at one year, this is a vertical slice through the heated drift, comparison of measurements versus predictions. For the most part, our predictions have been--we've matched our measurements very well. The drift wall is probably not heating up quite as fast as we would have predicted. But for the most part, inside the rock, our predictions are matching very well.

BULLEN: A quick question. Bullen, Board. Have you changed your models so that your models now match the prediction? Have you used the data that's--

PETERS: That's part of the process, but this prediction is a pretest prediction.

BULLEN: Okay, thank you.

PETERS: I'll talk some about some of the issues that came up in the previous talk; thermal mechanical properties of the rock. There has been a lot of laboratory measurements of thermal expansion. The thermal test, the single heater test and the drift scale tests are a great opportunity to get measurements of thermal expansion of what I'll call the field scale, address the scaling issues. So what we've plotted here is data from both the single heater test in blue, and the drift scale test in the red triangles, and we're plotting coefficient of thermal expansion versus temperature, as well as gage length.

And you can see that as you go to a larger gage length, there is a correlation where you get to lower thermal expansions, and also the correlation of increasing thermal expansion with temperature. The decrease in thermal expansion as you increase your gage length is probably attributed to the fracture nature of the rock. This is the kind of data that we're getting out of here, which is going to be very useful for some of the issues related to tunnel stability and things like that.

To move on to the cross drift, start with the lithostratigraphic predictions and results. A couple of important points to start out with is the unit variability within the Topopah. The formational thickness of the Topopah is predictable. We were within less than two meters of SD-6. But when you look at the subunits, meaning the middle non-lith, the lower lith, et cetera, they're much more variable, and you see variations, nine meter thickness changes over 150 meters, as we've seen it in outcrop primarily, and also boreholes. But in general, the predictions, the lithostratigraphic predictions for the cross drift have actually matched our mapping results very well.

This is a tabulation of predictions from the most recent version of the geologic framework model versus the actuals, and then from that, the vertical difference between the mapping results and the framework predictions. You can see this larger difference in the lower non-lith contact is primarily due to three small faults that have actually offset us by greater than eight meters that weren't in the framework model.

This is the tunnel station, so this is basically 1000 and 15 meters from the breakout of the cross drift. So to go through it, we encountered the middle non-lith at about a thousand meters in. We encountered the lower lith at about 14, 50 meters in, and we encountered the lower non-lith at about 23, 20 meters in.

In terms of mapping results, we've seen some interesting fracture zones and some faults. We've seen three unexpected faults, all less than five meters offset. They do not correspond to any known faults at the surface. The main splay of the Solitario Canyon was encountered very near the predicted location, and there's the strike and dip information as measured in the tunnel. The main splay has greater than 250 meters of vertical offset. Footwall is in the lower non-lith and the hanging wall is all the way up to the upper lith. The footwall was highly fractured as we approached the main splay, which actually had an impact on the TBM production. And then in the hanging wall again we were in the upper lith, and it's cut by several smaller faults with minor offsets.

Moisture monitoring. We have drilled systematic boreholes in the cross drift. Every 25 meters, we've installed heat dissipation probes which allow us to measure water potential. And we were also drilling holes to try to track construction water use and understand how the water we were using during excavation was interacting with the rock. So these are some bullets that summarize some of those results. We're continuing to collect water potential data as we speak from the systematic boreholes.

But to summarize, we found that over 50 per cent of the water, construction water that we applied, moved into the fractures. 45 per cent of the total evaporation of water from the cross drift due to ventilation, et cetera, was from construction water, with the balance being rock formation water. And we saw penetration of the construction water in the upper lith more than three meters, which is much less than we see in the middle non-lith, which is more than 30 meters, and that's simply basically a function of the fracture density.

But overall, the bottom line, which I think is the most important point, is there's a net loss of water. On average, we're drier than we were in pre-construction.

In terms of current plans in the cross drift for '99, now, this is what's in the current plan, we're finishing up the geologic mapping. We've completed systematic drilling and coring and as I mentioned, we're continuing the moisture monitoring. We've taken consolidated samples to support Chlorine 36 studies, as well as the fracture mineral geochronology work and sent it to the USGS. And we had done a lot of hazardous mineral analyses associated with TBM construction last fiscal year.

In terms of the current plan for FY00 through 02, we have a series of alcoves and niches in the plan that address seepage as well as thermal and flow issues within the repository horizon rocks. We have the cross-over alcove, which is an alcove we're going to excavate out over the top of Niche 3, ESF Niche 3, and we'll do a flow and transport test. They're separated by about 15 meters, so we'll get a good understanding of the scaling within the fracture welded units.

We've also got two seepage niches, one within the lower lith, Niche 5, which will likely move further down tunnel. This diagram is from earlier stations, as well as Niche 6, which is a seepage niche within the lower non-lith. And then we have a crest alcove where we're doing hydrologic monitoring under the high infiltration area that's at the crest of Yucca Mountain. The crest of Yucca Mountain projects across the cross drift right in this area here.

We also have a cross drift thermal test within the lower lithophysal in the plan.

This just summarizes what I just said in words. Again, Niche 5 in the lower lith to look at flow and seepage, Niche 6 in the lower non-lith to also address flow and seepage issues. Again, this is the first time we've seen lower non-lith and lower lith in the underground setting. We saw a little bit of lower lith in the ESF, but we're getting much deeper in the section.

Then the cross-over alcove, again, that starts out in the upper lith within the cross drift, but when you get down to Niche 3, you're in the middle non-lith. So you infiltrate in the upper lith, but you've moving into the middle non-lith between there and Niche 3.

Crest alcove, again looking for flow under the high infiltration area that's present at the crest, and again the cross drift thermal alcove, thermal test within the lower lith, because the Alcove 5 work is all done in the middle non-lith.

This is just a schematic of what one of these niches, one of the seepage niches in the cross drift will look like. We have an access, and then we have the characteristic niche like you're used to seeing in the ESF itself at the back end, with the boreholes that we use for liquid release tests. And also in the plan, we have a slot cut similar to what I described in Alcove 4 and Alcove 6 for looking at fracture matrix interaction in the lower lith, as well as the lower non-lith.

NELSON: Where is that?

PETERS: One of these would be in the lower lith and one would be in the lower non-lith, according to the current plan. The lower non-lith would likely be at about 1620 or so into the tunnel, pretty much smack dab in the middle of the lower lith that's exposed.

Moving on to Busted Butte, some of the results from there. This is just a location map to show you here's the block, repository block, showing Yucca Mountain and then showing Busted Butte to the southeast of Yucca Mountain where you get the distal extension of the Calico Hills. And so what we have is we have a very similar section at Busted Butte that we have under the repository, just significantly thinner.

The layout of the Busted Butte transport test. We're looking again at the Calico Hills formation. We're talking flow and transport underneath the repository horizon here. Previously, we've been talking about above and within the repository horizon. Here, we're below it. The test really takes place across three sub-units, the lowest vitrophere within the hydrologic Topopah, as well as the upper part of the hydrologic Calico. So you've got two vitrophere units and then the bedded tuff unit below.

It's broken up into two phases--really three phases; Phase 1-A, which is being done in the hydrologic Calico, and that's primary four injection boreholes. Phase 1-B, which is two pairs of injection and collection boreholes, and those are done in the upper vitrophere unit, which is a fracture vitrophere. And then Phase II, which exploits all three of those units on a much larger scale and is a much longer test.

Just some results. Initiation of testing for both phases was completed on August 5th of this past year. In Phase 1-B, which is again in that fractured upper vitrophere unit, we saw breakthrough of the fluorescein on June 16th, which means we travelled 30 centimeters in 30 days in that fracture.

For Phase II-B, and for all phases, we're varying the injection rates to get an idea of the sensitivity to the flow and transport to injection rate. For Phase II-B, which is located in the lower part of the Phase II block in the bedded Calico, we're injecting at 10 milliliters per hour per injection point, and we've seen breakthrough in three of the boreholes to date.

Phase II-C, a much higher injection rate, more superpluvial like injection rate. It's in the upper part of the Phase II block in the fractured vitrophere. There, we initiated in August and we've seen breakthrough in two boreholes.

And then for Phase II-A, which is in the same part of the upper part of the block, but at a much lower injection rate, one milliliter per hour per injection point, and we've seen no breakthrough to date.

For Phase I-A, which is, as I was describing it, is the four blind injection holes, we're doing a mini mineback as we speak. We're mining back, mapping the surface as we go back, and it's probably six successive steps, and actually using a black light to map how the tracer has travelled. That's going on as we speak in the field. So the results of that, hopefully for the next meeting, you will hear more about that.

We did the overcoring on the Phase I-B boreholes. That was the two pairs of injection and collection boreholes. And we did a lot of preliminary observations again with a black light to see where the fluorescein tracer travelled. And in general, we found that the ingress of the tracer was very consistent with what we thought we were going to see from the breakthrough data.

Implications for some of the early results for flow and transport. This is mainly focused on the results of the overcoring of the Phase I-B. We're seeing a lot of interesting things in terms of providing insights on fracture matrix interaction in that fractured vitrophere unit. And also, we're finding that fracture flow does not occur in these lithologies unless it's accompanied by substantial matrix flow, and this of course has important consequences for transport beneath the repository. And we're working to quantify the fracture matrix coupling, and incorporate that into the site scale models that we use for the SR-LA process.

C-well complex results. This is a map, plan map showing the layout of the C-wells complex, with C-1, C-3 and C-2. I'll refer to ONC#1, which is in this direction up here, about close to 3,000 feet away. A nice schematic of the stratigraphy of the C-well complex. The testing zone marked here is the Bullfrog test zone. This is an over slide, so this is when we were testing the Bullfrog. We're actually testing the Prow Pass right now, which is this blue right here.

In terms of the hydraulic tests in the Prow Pass, we're pumping out of C-2, and then we're observing in C-1, C-3 and ONC#1 as well. We've actually analyzed some of the data and we've seen draw-down in C-2 primarily from well losses, but we've seen response in C-3, C-1 and ONC#1, and to date, the analysis yields the transmissivity that you see here of 400 square feet per day and a storativity of about .001 between C-wells and ONC#1, which again is in this direction.

And as a generalization, the Prow Pass test results were applicable to low permeability tuffs at Yucca Mountain, whereas the Bullfrog results, which were discussed in previous meetings, are more applicable to high permeability tuffs.

In terms of conservative tracer tests in the Prow

Pass, we're doing a forced gradient, partial recirculation test. Here, we're pumping in C-2 and partially recirculating back into C-3 and also injecting into C-3. We're injecting iodine as well as a fluorobenzoic acid, and the results to date have allowed us to estimate longitudinal dispersivity between C-3 and C-2, and that gives us a value ranging from .0 to 4.5 feet for dispersion along the direction of the flow path. But we aren't able to calculate transverse dispersivity from this particular test because it's a forced gradient test. We need a natural gradient test to do that.

Moving on to the reactive tracer testing, again we're pumping in C-2 and partially recirculating back into C-3, and then injecting into C-3. We're using microspheres of different sizes, polystyrene microspheres to understand colloid response.

We're also injecting both non-sorbing and sorbing tracers, fluorobenzoic acid, chloride and bromide, both non-sorbing, with varying diffusion coefficients, as well as Lithium, which is the sorbing element and has an intermediate diffusion coefficient, and again some colored spheres.

In terms of data today, I'll show a diagram in the next slide that shows the breakthrough curves for the different tracers. But today through close to right before Christmas, recoveries have been 46 per cent for the fluorobenzoic acid, to 16 per cent for the sorbing Lithium.

We've seen evidence of matrix diffusion, and we'll see evidence of that in the next slide. That's primarily from the responses of the non-sorbing solutes with various diffusion coefficients, as well as the rebounds that you'll see after we've had flow interruptions. And the Lithium attenuation is consistent with the dual porosity concept of the saturated zone at Yucca Mountain.

Lithium sorption is slightly greater than we observed in the lab tests, and that suggests that the lab sorption data that we're using is conservative as it goes into fee the performance assessment. And the microspheres are highly attenuated relative to the solutes.

An example of breakthrough curve for the reactive tracer testing, the brown is the fluorobenzoic acid, and then the bromide and chloride with the different diffusion coefficients, and then finally the Lithium, which is sorbing in this particular system, and also way down here is the blue and orange microspheres that were injected.

Surface-based testing. Update on where we're at with SD-6 and WT-24. SD-6, the current depth is 2541 feet. We're in the Bullfrog right now at the bottom of the hole. We encountered drilling difficulties. The planned depth is 2850 feet. In terms of the objectives that have been met to date, those are listed here. We've obtained the planned core. We've collected samples for mineralogy and chlorine

36. We've got critical stratigraphy described down to the base of vitrophere. That was important information for design. And we've also completed logging to 2540 feet.

You can read some of the objectives we have not yet met. We have no water samples from the regional aquifer at SD-6. We've encountered the water table, but we have not measured the water level yet quantitatively, and we haven't done an aquifer pumping test.

We do have a plan in place now to go forward and complete that borehole to meet all the original objectives.

WT-24, we've completed the borehole to the planned depth, but at total depth, we encountered perched water. We pumped the perched water. We took perched water samples. But at total depth, we're in a relatively tight portion of the regional aquifer, so we have not done a pump test. At this time, we are demobilizing the equipment. We would have had to have deepened the hole another 500 to 700 feet to even have a chance of pumping, and there was no guarantees that we'd be able to pump it at that point. So at this point, we're demobilizing the rig, but we're not precluding the ability to go back and finish that, deepen that hole at a later date if it's deemed necessary as we go through the TSPA process, up to SR-LA.

EBS pilot scale testing. We're doing a series of EBS concept tests using a DOE facility in North Las Vegas.

Again, here we're demonstrating the performance of the various EBS concepts at the field scale. We're actually doing it at quarter scale to the current design, and we started out with ambient temperature tests, but there's plans to go into elevated temperature tests at a later date.

We're primarily focusing on how water moves through the EBS materials, so we're using not only instrumentation within the Richard's Barrier of the backfill, whatever we're studying, but we're also using fluorescein tracer to try to actually visually see how the water travels through the EBS. We're varying infiltration rates. Right now, we're primarily running at very high infiltration rates, superpluvial type values, but we do have plans to maybe lower those to more like present-day values.

As we do these infiltration tests, after we're finished with the test, we're actually going to go in and physically start to pull the material out, and not only characterize the material, but also try to observe the fluorescein path. It's going to be artful to go in there and do that, but we're going to try to go in and characterize how the fluorescein has travelled. We're doing these in test canisters. There's a diagram at the end that lays out a schematic of what one of these canisters looks like.

We've initiated Canister 1 in mid December. That's ongoing as we speak. The EBS concept there is a Richard's

Barrier. We have a medium sand over topical coarse sand, and we're again at ambient temperatures and superpluvial type rates.

We just started test Canister 2. That is a coarse sand backfill. The coarse sand is the same coarse sand that we're using in Canister 1 for the Richard's Barrier. And, again, we're at ambient temperatures and the same superpluvial rates. That's just starting.

CRAIG: That's a time warning. You're now cutting into your question time.

PETERS: I'm almost finished.

Right now, the plan for test Canister 3, which we'll initiate later in February, is another Richard's Barrier, this time fine sand over coarse sand, similar configuration to Canister 1, but different hydrologic properties, different materials, different hydrologic properties.

This is a schematic of what these test canisters look like. They're large metal canisters with a clear plastic tube in them which is meant to be like the waste package. They sit on pedestals and then we emplace in this case the Richard's Barrier over top of that. This is an open tube that we can run camera in and things like that to actually see if we can visualize the fluorescein contacting the canister. Again, we have instrumentation throughout the fill to understand how the water is moving through the fill. We also have wicks on the side of the canisters that also measure and help us constrain how the water is moving.

Right now, in test Canister 1, we've been infiltrating since mid December, and we're seeing a lot of wicking of the water with these wicks over here. We see no failure of the Richard's Barrier today. It's actually being diverted by the Richard's Barrier.

I believe that's all I have. The rest is backup.

CRAIG: Thank you very, very much, Mark. Questions from the Board? Priscilla?

NELSON: Nelson, Board. I've got two questions, Mark. The first is what parameters about the sand are you controlling in your experimental work in terms of the sand itself, in addition to I assume there's a grain size? What about mineralogy or lithology?

PETERS: It's just an Overton sand, it's a straight quartz sand.

NELSON: It's pure quartz sand?

PETERS: Yes.

NELSON: And are you planning on varying that at all, or staying with only quartz sand?

PETERS: Right now, they're mainly concerned with varying the hydrologic properties of the sand. Are you getting at the chemistry? They're going to vary hydrologic properties, so the test Canister 3 will use a different sand with a different hydrologic property, set of hydrologic properties.

NELSON: Okay. But there's no investigation like of the matrix characteristics of sands that have some porosity in their grains as well?

PETERS: Well, they're measuring that in the lab. I'm not sure if I'm answering your question.

NELSON: I'm not sure either. It seems like it's important, and when people say backfill, lots of times in the mind we get backfill and Richard's Barrier sort of get used interchangeably, but they're treated quite separately in this study.

PETERS: They are, yes. And I guess to try again, they're characterizing the hydrologic properties of the sand prior to the test.

NELSON: Of the bulk sand, though?

PETERS: For Canister 1, they had a medium sand. They'll characterize that. And then they have a coarse sand, it's the lower part. They'll characterize that separately.

NELSON: Okay. Let me ask you this. In Alcove 7, was there a seal-off and waiting for re-establishment of ambient humidity?

PETERS: Yeah, there was a dual bulkhead set up down there. It returned to ambient very quickly, and we didn't see any evidence of any dripping into Alcove 7, although near the fault, we might be seeing some response now, but it's a little early to tell.

NELSON: That would be very interesting. You can tell me who to follow up with on that, and to see how the rock is responding as well in terms of regaining of humidity.

PETERS: Sure.

NELSON: And just finally, in Alcove 1, is the Lithium bromide concentration in the caught water matching the Lithium bromide concentration of the injected water?

PETERS: I don't know the answer to that, to be honest with you. I can find out, but I don't know.

NELSON: Thank you.

CRAIG: Okay, we now have Dr. Sagüés, Knopman and Runnells on deck. Alberto?

SAGÜÉS: Thank you. On the drift scale thermal test, how is the gas chemistry coming along? Specifically, how is the oxygen partial pressure inside?

PETERS: Inside the drift?

SAGÜÉS: Yes.

PETERS: It's atmospheric. The O2 levels within the drift right now are very much like what they are in the AOD outside.

SAGÜÉS: Wouldn't one have expected complete steam sparging by now?

PETERS: Well, yes, I think if you had a sealed bulkhead. I think part of it is that bulkhead is not a pressure bulkhead. It's not hydrologically sealed. I think we're getting communication across the bulkhead. That's partly why I think we're not seeing--yes, because you'd expect the air mass fraction to change significantly as you heat, but we're not seeing evidence of that as of right now.

SAGÜÉS: So you're getting about 20 per cent oxygen?

PETERS: Yeah, 18 per cent.

SAGÜÉS: And the water vapor is--what fraction would that be?

PETERS: We haven't done any measurements of water vapor fraction in there as of yet. We're measuring primarily O_2, CO and CO_2, but I believe there's efforts underway to start measuring water vapor fractions.

SAGÜÉS: I see.

PETERS: We're not doing it yet.

SAGÜÉS: Are there any plans at all of closing any section of the east/west drift to attempt to detect seepage in the actual drift locations, as opposed to just an alcove?

PETERS: Right. We're actually putting together--we're working on a plan to try to bring--I'll give you a bit of a bigger answer than just the question. We're working on a plan to bring forward the crossover alcove and Niche 5 excavation, and starting drilling into 99. We're trying to bring that forward from 00 into 99, and the context of that, we're starting to look at do we want to possibly bulkhead off part of the cross drift under the high infiltration area. That's something we're exploring. We haven't really come to any conclusions yet. But the crest alcove was meant to be just that, in the lower lith under the crest, we would bulkhead that off, and then that would be like Alcove 7, but we'd be in the lower lith under the high infiltration area. But there has been some discussion of possibly bulking it off, but we're just in the discussion stage.

SAGÜÉS: It would seem that closing off a section of the cross drift, a couple hundred meters, something like that, would give a unique opportunity to observe how drips occur within the tunnel.

PETERS: Right. And like I said, we've started, in the last month or so, we've started to think about that.

SAGÜÉS: Okay, thank you.

KNOPMAN: Knopman, Board. You went through--you had by necessity to go through this material pretty quickly. I'm wondering if we could just quickly turn back to the results that you summarized for Busted Butte?

PETERS: Sure.

KNOPMAN: Because I just want to make sure I understand what the implications are of the flow rate that was calculated for the fluorescein tracer. That's a centimeter a day. This is Page 32.

PETERS: Yes. That one?

KNOPMAN: Right; a centimeter a day. What happens to that result? What do you do with that now? It seems to me that's fast.

PETERS: We combine that with the overcore results. We had snapshots as we collected the pads through time. At the end, we overcored, so now what we see, particularly in this particular case, is everything is covered with fluorescein. But what we have here is we have initial breakthrough, and then as we collected pads as a function of time, we've got a snapshot of how that breakthrough changed in terms of down the borehole, and the nature on the pads. So we just take this breakthrough and then the subsequent collections, as well as the overcore results, integrate that into an understanding of how the tracer flowed through the fracture vitrophere.

KNOPMAN: Well, what did you think--what kind of rate had you expected?

PETERS: That particular breakthrough I believe was a little bit faster than we predicted. We've been on both sides in terms of predictions for Phase I and Phase II, we've both under and over predicted, but they've been within reason.

KNOPMAN: Okay. And if you can just clarify for me one other question here?

PETERS: Sure.

KNOPMAN: Not just Busted Butte results, but in some of these other alcove studies where you're looking at flow and transport, where are you or how are you trying to quantify relative flow volumes between matrix and fractures? Where does that number come out from these various studies, or where are you going to get some better statistical handle on how much flow is going through fractures?

PETERS: I think from the fuel testing perspective, one of the keys are the Alcove 6 work that I talked about, the fracture matrix interaction stuff from the middle non-lith. Also, I think the Alcove 4 work in the Paintbrush non-welded. Those ares really key to understanding at a sort of meter scale how things are partitioned between fractures and matrix.

KNOPMAN: And right know, what's your hypothesis about that? You're presumably going in with some hypotheses for those studies. What's your hypothesis?

PETERS: In the Paintbrush non-welded, it's dominated by matrix flow. It's not a fractured unit. It's a bedded tuff, and it's dominated by matrix flow. One of the important things we need to understand is how faults impact that matrix dominated system. The case of the Topopah, it's a fractured unit, we expect to see significant fracture flow, and we did in that test.

KNOPMAN: So in Topopah, what would be the percentage--

PETERS: I can, based on the field observations in the high permeability zone, there was more than 50 per cent of the water that we injected went through the fractures.

KNOPMAN: Okay.

RUNNELLS: Runnells, Board. I just want to thank you for an excellent presentation. That's a huge amount of material in a short time.

PETERS: Thank you.

RUNNELLS: I also want to endorse the possibility of closing off some portion of the east/west cross drift and doing something simple like looking at the back to see if it drips, a good opportunity. But my question concerns communication. I continue to struggle with how the various components of the investigations communicate with each other. You have a huge amount of very basic scientific information you've given to us, and we heard earlier from Paul Harrington that within the engineering group, there is a modeling group that kind of goes out and asks for the information they need to come back on the engineering side. Can you describe to us how you see this vast amount of basic information feeding into, being used by the engineers for designing the repository and the canisters?

PETERS: I can speak--that's a big question. I was hoping you were going down the path of how is this used in the process models for the natural system.

RUNNELLS: No.

PETERS: I didn't think so. Well, a lot of the ambient stuff, the seepage work, I might defer that to somebody in the audience.

CRAIG: Okay, I'm looking for somebody from DOE.

PETERS: But Paul, you can take a stab, or do you want me to take a stab and you can follow it up? Or Jean, maybe.

SNELL: Dick Snell with the M&O, the engineering group. I think I can answer your question, at least in part. But would you restate for me briefly, was it how do we get the scientific information into the engineering activities, in essence?

RUNNELLS: That's right, especially in terms of a compressed time frame. That plays into it.

SNELL: Okay. We have an EBS, engineered barrier system group within the subsurface design organization. That was set up about a year and a half ago, I think, something like that, maybe a little bit longer. That's the group that Jim Blink has come out of, and that's the engineering interface that Paul Harrington mentioned, I think, with the scientific community with PA, and it was set up with the purpose in mind of first of all, making sure that the performance assessment models accurately reflect the engineering designs, and secondly, a vehicle for getting information from PA and from science into the engineering designs.

The EBS organization still exists, reports to Cal Buttacheria of subsurface design. Specifically, some of the testing for the last thing that Mark covered on the EBS testing facility, that testing was planned with the EBS organization working with representatives from all the labs and the scientific community. A test plan was developed with inputs from I think all four of the national labs, USGS and some of the designers from EBS, and is being implemented with their inputs.

With regard to data coming into the design process, a couple of things. First of all, we have with the EBS group that Blink was in, an interface between PA and design, which is ongoing over about a year and a half or so, and I mentioned especially we have on our alternatives group a representative from the PA organization. We have a representative from the scientific organization, from NEPO.

The designs, as you already understood, and there was a comment earlier from Jared Cohon, I think, about how do you reflect the site, the designs are all based on the site. The whole premise for design is what does the site look like, what are its characteristics, and so forth.

So engineering uses scientific data that's in the database that the project maintains. Data is fed in regularly from all the testing organizations, as well as those that are doing modeling and laboratory testing. It goes into the technical database, and it's extracted from the database for use by engineering, and that's a routine mechanism that we have.

For our alternatives work, we'll use the database to the extent that we have the information we think we need, but recognizing that testing is ongoing, there's a delay in getting into the database, we go out and ask for it, so that the representative we have from science is available to us. We can request data, recent data from tests, interpretation of test results, so we can incorporate it into the PA models and into design rapidly, if you will.

I guess in summary, I would say that the interfaces are continuous and ongoing, and they've gotten substantially better over the last year to two years as we've gone forward and as the project has changed a bit in its texture from pure scientific investigation to one of a combination of science and engineering.

Does that help?

RUNNELLS: That helps a lot. Thank you.

SNELL: Okay.

PETERS: There's another specific example, too, that I thought of as I was sitting up here. Thermal testing data, for example, the repository design group is in a lot of cases taking that data directly and comparing that to their models. So there's free data transfer. I'm more familiar with the thermal test, but there's free data transfer between repository design and the science side to help them confirm their models that they use for drift stability, et cetera. That's kind of an example of some of the things.

PARIZEK: Parizek, Board. The last question dealt with the pile of information already at hand and how that factors into design. On the other hand, the license application and design selection process is on a fast, fast, fast track. The year 2001 is right around the corner, and the hairy head of LA is 2002, and then I look at Figure 25 that shows niches, niches, niches, niches, and I understand we're going to probably get going in 1999 with the cross drift seepage experiment. So there's a lot of data in 70 per cent of the rock mass that probably is needed in design. It may not have science backing for it, and so the question is how fast will these areas of the niche experiments get programmed in with the vital information to come out of those? If that doesn't happen till 2001 or 2002, you know, then we hope there's delays in the licensing process maybe in order to--

PETERS: They're available as confirmatory information as we go into the LA, but you're right, they're not, as the design freezes here really in fiscal year '99, there's testing information coming in beyond that. That will be used as confirmatory for design.

PARIZEK: Design freezing doesn't mean there won't be opportunity to make changes.

PETERS: Somebody else can address that more than I can. I think the answer to your question is yes. But the data will continue to collect and we can provide confirmatory information to the design, and like you noted, we are bringing things forward and trying to prioritize what we feel is most important to do first in the cross drift.

COHON: Cohon, Board. Your Figure 25 showing the cross drift showed two Solitario Canyon alcoves. I don't recall you saying anything about what you're going to do there.

PETERS: Yeah, I forgot to mention that. Right now, the alcoves, we're no longer planning on excavating alcoves. What we're thinking of doing is drilling long boreholes to explore the west splay of the fault. Remember the TBM stopped short of the west splay of the Solitario Canyon. We cut through the main splay, but we stopped short of the west splay. So we would drill forward with long boreholes to explore the west splay, and possibly drill angled back to look at the main splay further from the excavation. We aren't planning--the original plan called for 50 meter long alcoves. We would probably use a drilling niche and drill along the boreholes.

COHON: What were you going to do in those alcoves?

PETERS: Borehole testing across the fault akin to what we've done in Alcove 6, the Ghost Dance, primarily instrument across the faults, basically measure temperature pressure, relative humidity across the fault zone, hydrologic monitoring, and also take samples for looking for tritium and other tracers that might tell us something about the flow paths.

NELSON: Nelson, Board. Mark, the panel that we heard from earlier that Tor Brekke was the chair of has some recommendations about investigations of the disturbed zone.

PETERS: Right.

NELSON: With recommendation to do some testing, either direct measurement or modulus or some sort of surface seismic, be it sheer, compressional, do you have any plans to do those at all, considering that that can fit into support design?

PETERS: I have not seen the report, so in general, I don't think we've really addressed what's in the report, whether we have it in our program. I will say that as we go into the ECRB, we are going to be doing drill and blast, which we're going to evaluate excavation effects from that. We're going to drill and blast the accesses to these alcoves, and then mechanically excavate the actual test beds. So we are going to look at effects of excavation technique on air permeability. That's the focus.

NELSON: On air permeability. So how are you going to--

PETERS: Right now, I can't really speak to how we're going to address the report on tunnel stability.

NELSON: And you're going to do air permeability by pumping out of boreholes, or what?

PETERS: We inject air and do single hole and cross-hole tests.

KNOPMAN: Knopman, Board. Would you, Mark, review what the schedule is in FY 99 for actual analysis of the Chlorine 36 samples that have been collected?

PETERS: Yes. They've collected multiple samples. We had, every 50 meters, we drilled boreholes primarily last fiscal year. Those samples, as well as feature based samples that have been taken since in the tunnel, concentrating on the highly fractured zones and the fault zones. Those are being processed, and my understanding is about 15 to 20 of those are going to the accelerator next month for analysis. So we've collected a lot of samples, but for this fiscal year, I would say, and we're focusing on the faults when we do these early samples, we're probably looking at maybe 20, 25 analyses by the end of the fiscal year.

KNOPMAN: And you have how many samples? So it's 25 out of how many samples collected? 200?

PETERS: I don't know the exact number. Hold on a minute and I can come up with a pretty good number for you.

The core holes were every 50 meters. That right there generates, let's say, just 40, 50 samples. And then they probably took an additional 40, 50. I'd say 80, 70 or 80.

KNOPMAN: So roughly a quarter of the--

PETERS: In this fiscal year. But we would continue analyses next fiscal year.

PARIZEK: Parizek, Board. Can you give us an update on the earthquake information from yesterday up at the test site? Does that have any--

PETERS: It was a 4.3 at about--it was in the south end of Frenchman Flat, underneath Frenchman Lake. There's been at least four above magnitude 3 in the same general area in the last couple months.

PARIZEK: Were levels reported to rise great amounts all over the desert?

PETERS: No, not that I'm aware of. It looks like--the one yesterday looked like it was at the east end of the Rock Valley Fault, which is a strike slip fault that runs basically east/west from Frenchman Flat across coming north to Mercury and out that way.

PARIZEK: Whether that showed us as what level responses in any of the monitoring wells on the project--

PETERS: Not that I'm aware of, no.

PARIZEK: But somebody has data on that?

PETERS: Well, we collect the data, so we can certainly go look that up, and as of right now, I have not heard any major water response.

CRAIG: Other questions from the Board?

(No response.)

CRAIG: In that case, let's give our guests an opportunity if they wish.

KNUTSSON: Gert Knutsson. I found that this infiltration and percolation study is of great interest, especially for the future if you have a climate change.

PETERS: Right.

KNUTSSON: Which tracers do you plan to use?

PETERS: Which tracers?

KNUTSSON: Which tracers?

PETERS: In the second phase of Alcove 1?

KNUTSSON: In the second phase, yes.

PETERS: We'll still use the lithium bromide, and then we'll add, I don't know the specifics, but there's going to be a suite of conservative, and maybe even a reactor tracer in there, a similar suite to what we've got planned for some of the other alcoves.

KNUTSSON: And the deep ground water is also of great interest. Did you have any figures of the age of this water? Age of ground water in the deep wells is of great interest. Did you have any dating?

PETERS: I thought I saw Zell. Zell, can you address the age of the ground water? Age of the ground water in the SE. Maybe you're better to address that than me.

PETERMAN: There are a number of Carbon 14 ages from wells in the saturated zone, and the uncorrected ages, many are greater than 10,000 years. There's also Chlorine 36 values on a lot of the saturated zone samples, and those have ratios of 500 or a little bit more, which are permissive, say, with early Holocene ages. So I think everybody agrees the uncorrected--the raw Carbon 14 ages need to be somehow corrected for incorporation of dead carbon that's acquired during infiltration.

KNUTSSON: Do you know the Swedish method to use the organic content in ground water?

PETERMAN: There is some new work that will be done this year trying to date the organic carbon from the samples, and we've collected samples, especially down gradient, for that work, but there are no results available yet.

KNUTSSON: In the Swedish studies, we have got much younger dating with the organic content. Thank you.

CRAIG: Are there questions from the staff? Yes, Leon Reiter.

REITER: Leon Reiter from the staff. A couple quick questions. The WT-24 was supposed to give us insight on the large hydraulic gradient. What have we learned about that?

PETERS: Somewhat inconclusive at this point from the 24 perspective, because we weren't able to do a pump test.

REITER: So if you went down deeper, you could get some information?

PETERS: We were going to attempt to try to get into a better part of the aquifer to do a pump test, but there was no guarantees.

REITER: The second question, you said that you expect significant increase in sorption as a result of the Busted Butte test. Can you give us some idea of how significant, what are you expecting, what numerically are you expecting?

PETERS: I probably can't--I'm not--

REITER: Is there anybody here who can tell us that?

PETERS: Gilles is probably the only guy who can actually give you a number for that one.

REITER: Well, yesterday, we saw overheads and analysis and it showed very little performance being provided by the UZ transport, and I was wondering how these results might affect it.

PETERS: Well, whether it's dominated by fracture flow or not, one of the issues is is does fracture flow bypass a lot of the sorptive characteristic of the Calico. Let's put it that way. One of the things that the Phase I-B results would say, I would argue, is that you see a lot more matrix as you go through that part of the Calico, which is real important sorption, because as you flow through there, you have much longer time to sorb. So I would say it's positive for site performance, but that needs to be incorporated into the thinking for the UZ flow and transport model, and that's what these results will do.

CRAIG: Other questions from staff?

(No response.)

CRAIG: In that case, we're exactly on schedule and we will reconvene at 3:30.

(Whereupon, a break was taken.)

CRAIG: Okay, I haven't seen Nick, but--all right, we're now starting the second session, and we have Nick Stellavato from Nye County talking about the early warning drilling program.

STELLAVATO: I want to thank the Board for inviting Nye County back. This has been an exciting 35 days, the last 35 days, and as the last time I talked, gave you a little bit about our drilling program, and today I'll give you some results since our last discussion.

First, this is the layout of the wells this year that we had planned on drilling, starting with 1Dx, which is the farthest north towards Beatty, which is in the paleo, that horsetooth paleo discharge site, over to 5S, which is right off the edge of the Nevada Test Site boundary, and in the alluvium there.

Just a little background. Again, these are the wells for the three year program that we had preliminarily laid out, although after this year's drilling and some of the results I show you to date, we may want to relocate quite a few of those wells.

First, I'll just give you a quick update. We've generated a tremendous amount of data in the last 35 days. In fact, we've drilled 6,438 feet of well to date. These are the wells that are in some state of being completed, or are complete. And over here at 5S, I'll explain it doesn't have a--these are water levels. It doesn't have a water level, and I'll tell you why in a minute.

First, starting at the paleo discharge, we first encountered water, the static water level is at 56 feet. We continued to drill this well. We finished that well at 2500 feet, a tremendous amount of difficulty drilling. We didn't want to use mud, so we just used soap and polymer so that we wouldn't screw up the water. We're in the process of completing that well, but we found one of the problems, it was supposed to be a paleozoic carbonate well. We drilled 2500 feet and we're in tertiary sediments, clays, silt and sand and volcanic sediments. So we're drilling along and our water temperature is running about 30-some degrees, and we were watching spikes in the water temperature. The water temperature would go up and down to 104 degrees F. and then back down to 75 to 80. At 1150 feet, we hit a bad zone, which we think is a fault, and we went in there and did a temperature log, and the temperature was 52 degrees C. at 1150 feet.

So we continued on drilling and we got down to 2500 feet, and we have another zone at the bottom of the hole. We ran the logs on it. We had the log in stages. Due to the bad conditions, we could only log about 100 to 200 feet at a time in the open hole, and we just had to come out the bottom of the drill string, log a little bit, pull up, log a little bit more. Down at 9S, which was right at the mouth of Crater Flat in this canyon here, this was about a 500 to 600 foot hole we drilled, and we encountered four water zones. The first one was 98 feet. We have since completed this well, put six and a half inch screen casing in four zones, and have run a pump test, and I'll talk about that in a minute.

Moving on down towards Lathrop Wells, which sets right here, is our Well 3D. We're right now at 2,000 feet as of this morning in 3D, and we're still in tertiary sediments. However, we hit the first water, static water level is at 240 feet. You can see a trend. We're going shallow. As we go towards Forty Mile Wash area, Lathrop Wells, the water table, static water is getting deeper and deeper. 3D, though, as like 1D, at the water table, our temperature is about 40 degrees C. right at the water table. At 1200, we went in and ran a temperature log because we thought we were getting hotter. We were 67 degrees C. at 1200 feet in 3D. We don't know the facts, deep paleozoic water heating up, the same as this one here, we don't know what the gradient is in this area because there's nothing been drilled before. So we will finish this hole at 2500 feet, and then we'll get completion so we can get chemistries on all these specific zones so we know exactly what these deep waters are. Are they paleozoic water, carbonate water, or are they some intrusive water or volcanic water? We'll get the data on those.

We're at 2D, we drilled this down to 500 feet, and we hit with our hammer rig, and we got water at 343 feet. This is in the Valley filled alluvium right off north of I-95, the I-95 highway. And then the Washburn Well was the first one we drilled, and we wanted to confirm whether the water table was below 815 feet, as per the driller's log in 1958. We hit perched water higher, and then deeper, and I have it on the sheets, I'll go through it, but the static water level in one of our piezometers was 359 feet. The other piezometer, the perched water is dried up, so we have two piezometers in that well, one at 359 and the other one dry.

Now, we come over to 5S, we just completed 5S to 500 feet with the hammer drill, and it's dry. It was a duster. We didn't get any water yet in this one. We've set casing to 500 feet, and we're going to go back on it later and drill it down 300 or 400 more feet until we get good water in 5S. We don't know why it's dry, but we don't know why--what's going on out there.

So I have a couple other slides, I'll show those last, but I'll just go over some of the things. Again, the last time I talked, we were in the process of doing these things, and we did get everything done that we needed to do, and we did get in the field. We started drilling November 30th. We did the Washburn Well first. We drilled to 658 feet and the static water level was 359 feet. Water samples of the first water, and by the way, we got water samples of every time we hit first water, we called, our geochemist came out, got samples, and the USGS personnel came out and got their samples.

Our main water bearing zone was at 385 to 460, and we ran our geophysical logs inside our drill string because the hole just kept collapsing on us. We couldn't do anything with it. Very difficult drilling conditions, and after this, we brought in the hammer rig, which actually hammers down and uses air and hammers down a dual wall drill string that we can set seven inch casing inside the dual wall drill string, so where we have really bad ground, we can drill down through it, set the casing and then we don't have to worry about it.

Then we were looking for this 400 feet of clay that shows up in a lot of the wells in Lathrop Wells, a lot of the water supply wells. However, at the Washburn Well, it's about seven feet thick. And then we installed those two inch and a half piezometers.

The 1D well which--we're still setting on 1D well. We've been on it about 24, 25 days now, and I think we will get it completed within the next ten years, but it's been a tough one for us, because of the swelling clays. You know, we can't do anything in the hole, even the geophysical loggers, so we have to do something different in that hole.

This was the paleospring deposit, the horsetooth, and we tried to core with our regular rotary rig, and it wasn't any good, turned to a talcum powder. So we tried a split spoon, we got a little bit of sample, and I am in the process of putting the hammer drill back up on there and drilling the first 300 feet so we can get that upper water zone in another hole parallel to the 2500 foot hole.

We did finish the 2500 foot with a dual wall. Static water level, however, is 52 feet below the surface, and we have three zones in that upper 300 feet. We want to complete all for monitoring. And then we have two other water zones, one at 1150 and one at 2160 for so many feet. I can't remember what it is. So those five water zones we're going to complete separately so we can get water samples out of each one of them.

We did get water samples at the first water, and those samples should be analyzed, and we're anxious to see what that upper water looks like. At this time, they set geophysical logs at 1560. We do have geophysical logs to 2500 now. This was last Friday, and we did finish that up. So we do have those all the way to the surface. And the water temperature again at 1155 was 52 degrees C., and this is obviously deep carbonate, deep paleozoic water coming up the fault zone or some other thing that's got the water temperature at 52 C. We had, again, the difficult drilling and the swelling clays. But we have solved that problem with the 1D well. We will get that one completed and be able to get the water quality samples from that 1155 and that 2160 zone separate.

And then 2D, again 420 feet, and then the static water level was at 311 feet. We're going to finish that one later. We're at 500 feet with casing set now. And then 3D is the one where we're down to 2000 feet now. This was done the other day, and we're down to 2000 feet, and again we have up to 67 degree water temperature in that 1200 foot interval, and we'll be doing a temperature log later when we get the hole done.

And then 9S, we did 9S and I think I need to say this. We screened this off with a six and a half inch steel screen, and ran a pump test. We ran 47 3/4 hours because we couldn't run over 48 hours because of the law, so we had to stay below 48 hour pump test. However, we have got some data in our bottom two zones, the bottom zone which contributed about 60 to 75 per cent of the water, we did run a spinner with this at the same time, got about 80 darcy permeability. And the next zone up has about a 40 darcy permeability, which is extremely high permeabilities. It pumped two days with five foot of draw-down at about 175 gallons per minute. And we put Westbay in it now. We'll be monitoring each one of those zones over the long term.

And then just some of the drilling methodology and some of the things we learned, and I won't talk about them. You can read it. If you have any questions on it, you can ask me, because I think I'm about out of time.

CRAIG: Why don't you just leave that one up there, and people can look at it.

STELLAVATO: Well, I just wanted to show a couple quick slides of the type of samples. This is out of 9S with that hammer rig, as you got a picture of it. It brings up samples as big as seven inch, so we can get some good samples. It's not typical cuttings. We know exactly where it's from because he brings it up with the air right at that zone, and someone can look at these calcite, silica, or whatever, and do analysis on these samples.

And that's just a picture of that hammer rig. I think that's the way to drill. It actually hammers the dual wall casing in the ground. We get all of our samples back right here and we sample right at the discharge. And that's all I'll say right now on that. If you have any questions, you can ask me and I won't go into the last one. I'll just put it up.

CRAIG: Just leave it there. Questions from the Board?

PARIZEK: Parizek, Board. The program is moving at high speed, from what I see. This is definitely what you predicted you would be doing, and it seemed like you're ahead of schedule. I would imagine you're beyond. At the rate at which you're drilling, is it too fast in order to get good quality data? You know what I'm saying, too fast and maybe the driller is being paid to get the job done and get out of there. You're not losing useful information?

STELLAVATO: No, we've got complete samples from--composite samples from top to bottom on every well. Every time we hit water, we stop and we get water samples. We've had quite a bit of down time also, just to do testing and do water sampling. You know, we're not exceeding ourself. In fact, I'm shutting down two rigs starting next week. I ran three rigs at one time. I wasn't running one rig; I ran three.

PARIZEK: I wasn't aware you were running three rigs.

STELLAVATO: Yeah, we run three rigs continuously, 24 hours a day, seven days a week. We ran 18 straight days from November 30th to December 18th, and so we've decided--we shut down for two weeks at Christmas. I don't have the slide. Someone took it.

PARIZEK: You mentioned perched water in several different intervals. How do you know you have perched water when the Department hasn't been able to solve its perched water problem up on the mountain?

STELLAVATO: Well, with that hammer rig, we know exactly where we hit the water. It uses air, it uses nothing else but air, and when we hit our first moisture, we have a fellow logging the cuttings right there, along with one of the GS fellows on the project, and we get that first water, we shut down. Okay? Then we start drilling and then we hit the main water below, and then we run our log, we can see the two waters.

PARIZEK: I mean, you're looking for water content or some way of deciding it's dry or it's wet or it's saturated, or something?

STELLAVATO: Yeah, exactly. You can see it. We're getting dust the whole time until we hit water.

MONTAZER: May I say something?

STELLAVATO: Yeah, go ahead, Parvis.

MONTAZER: We don't really know, and I don't believe it's perched water. What Nick is referring to is perched water is the first--

PARIZEK: That's the difference, water bearings, all of which are saturated, you could have 18 or 19 or 50 of them, and it's a big difference whether it's saturated the whole way, or whether it's distinct.

MONTAZER: We believe it's mostly--once we hit the top zone, I have no reason to believe that we have any unsaturated zone. But we won't know until we're done with the completion.

PARIZEK: Next question. Parizek again. Would it be reasonable to try Shelby Tube sampling of the horsetooth formation, if split spoon sampling gave you something, or would Shelby Tubes crimp over on you?

STELLAVATO: Yeah, we've talked about it, and there are other methods to get that. We're going to put the hammer rig on it again, and this will be the third hole on that horsetooth, and we'll take samples with that hammer because we've got to do the first 300 feet because the water is too hot to run my Westbay in the deep zone, because it's just too hot for the PVC. So I've got to go to a steel completion, and then we're going to do a parallel hole to 300 feet and use the Westbay. So we'll get all the samples again from that, and then next year, I can go back in, you know, we can hand auger it's so soft, we can just about hand auger the thing.

PARIZEK: Now, another question about the QC/QA. You have a lot of new data that will be extremely valuable to program. Will the program be able to use your drilling information and the data that's coming out of these drill holes, or will it say well, no, it doesn't meet some criteria, and then as a result, we can't pay attention to any of that? I don't know that, and I want to make sure the program--

STELLAVATO: Well, I can't answer for the program. You know, that's the program that decides what they want to do with our data. I know that we follow NQA1 program. We wrote all our procedures and all our testing plans and all our procedures, and the NRC has looked at our program.

PARIZEK: To me, and for the good of the country at this point, it would be extremely important to know that the data sets that are coming in can be used to help calibrate a revised model, either done by Nye County, State of Nevada, U. S. Geological Survey, whoever does it, that these are control points that are going to be useful, considered valid, have good chemistry, whatever chemical samples are taken aren't going to be compromised by the drilling method. You know, here we are at a critical stage of filling data gaps in a modeling area where there was almost no control up until now, as you know, and you're the best act in town, and I want to make sure the act is the best on the strip.

STELLAVATO: And I agree with you 100 per cent. Okay, Dick Spence from DOE can talk about that, because they are looking at our program and I know the NRC has.

SPENCE: Yes, the answer to that is we looked at this on the front end before we embarked upon--with Nye County, and the answer is they have an equivalent QA program, and we've looked at it, NRC has looked at it, we're going to use that data.

PARIZEK: I'm feeling better as a taxpayer.

The other part of my question was the model--

CRAIG: Last one, Rich.

PARIZEK: Okay. The model is plunging or sloping to the east. Is that the result of any model forecast that came out of, say, Frank's regional model or earlier models of the regional flow, or is that a surprise?

STELLAVATO: There was no data in there, so no one knew.

PARIZEK: I know. But the model says there was some contour there.

STELLAVATO: The model didn't say anything about in there, because I don't think there was any data.

PARIZEK: You don't need any data for a model when you're making--what I'm saying is there's a contour line somewhere in there, and was that forecasted at all close to what you're observing?

STELLAVATO: No, we're surprised. The only thing is the--in Forty Mile Wash, the data in Forty Mile Wash, the contour for in here I think was 350 feet, and so we were wondering with this Washburn, why in 1958 they had a desert land reentry well was 815 feet and didn't have any water. So we went back in there and redrilled, and we hit that at--I think I got it on there at 385 to 410, we hit a water zone and came up to 359. So that clay is partially confining, and once we go through it, it's coming up.

PARIZEK: I have more questions, but I'm told I can't ask them, so I'll--I won't go away.

CRAIG: No, no, capture him later. Clearly, you've got one of the hottest acts in town, Nick.

STELLAVATO: Well, we wanted to get this data because Parvis and Tom and our people need this data for our modeling, too, so we can analyze what's going on up there, because there's just no data from Yucca Mountain down to the Felderhoff Well right here.

CRAIG: Okay. Well, thank you very, very much, Nick. And now next we turn to Paul Dixon talking about EWDP DOE, gosh that's a lot of initials, sponsored studies. You've got ten minutes.

DIXON: Good afternoon, all.

Just to kind of repeat where we're going here, what I'm going to try to do is answer some of Richard's questions maybe, and that is DOE initially looked at what Nick was going to be doing, and we put together a scientific program to look at some of the saturated zone chemistry and mineralogy, hydrology type aspects, kind of independent, other than Nick's drilling the wells, we're kind of collecting samples and QAing them on site and archiving them and I'll kind of go over those activities, so that we do have a program where we can generate data.

The work that's going on right now, you'll have to excuse me, I'm just getting over having laryngitis over the weekend, so if I squeak out, I apologize. Within the saturated zone, the type of work we're looking at right now is the USGS Los Alamos, as well as UNLV, are doing different types of studies on the samples as we go on real time as well as core and collect cuttings.

The USGS is looking at water chemistry, major and minor element chemistries, stable isotope signatures of these waters. I also know that although not funded strictly out of DOE, Zell Peterman is also looking at some of the fracture mineralogy and some of the paleo discharge deposits independent of this.

Los Alamos is looking at the Eh/pH of these waters by direct measurements. This is Arend Meijer, and he's using his probe down hole measuring things directly. Samples are being collected from some of the pump tests to look at colloids and organic contents for use in our colloid models, and Martin is also collecting some of the saturated zone waters to look at the Chlorine 36 content of these things.

In addition, UNLV is doing Eh/pH studies also, and this is through the University set-aside program. It's initially been funded out of DOE, but the funding will transfer over to the University set-aside after the first part of this year.

And, again, the other thing that's kind of important, as Nick mentioned several times today, they found high temperature waters and they're speculating or hypothesizing where that water is coming from. Between the work that the USGS is doing, as well as the work that UNLV is doing, we hope to try to get a handle on whether those are truly waters coming out of the paleozoic, whether they're heated waters from the volcanics, what's driving these chemistries. We have an idea where the waters are coming, kind of ground water tracing from these different programs.

In addition, as Nick pointed out, we're running a suite for the--DOE is running a suite of just geophysical logs in addition to these things, in combination with what they're doing. So we'll have a full suite of geophysical logs to accommodate what's being done in conjunction with them.

I kind of put this slide in here. This is just to point out that the saturated zone work here is being done, and we hope to get data for use, and the way that Nick has been drilling, I think we'll get a long ways to getting there and getting data that feeds the saturated zone process level models that we have right now. So the DOE sponsored studies are feeding data into those, and there are data feeds at time frames which feed the process level models.

In addition, data that comes in after those analyses that come in after that stuff, there is a program set up with the Performance Assessment group to use some of this information in their abstraction and testing, sensitivity analysis of the abstracted codes as we get them out. So there is a lot of effort being applied to use as much of this information that we obtain for site recommendation and ultimately for license application.

As mentioned earlier, and you were wondering what was going on, the person who's in large part responsible for this and spoke earlier, and that was Mark Peters, and that is that sample management is headed up by NEPO, the test coordination office. And the test coordination office basically has sample management personnel out there, and they track, they record, they bag on site all the samples as they come up hole, and they set those--splits of those aside from Nye County for use in DOE studies so that we will have a good handle on where these samples came from, and we do have Q pedigree for them within our program.

The TCO also coordinates all the field sampling activities for the DOE with Nye County. We have a direct interface there, so when we hit water, the different PIs get informed when to come out and do testing, and stuff. We have pretty good communication there as far as I can tell right now.

And the last thing is the TCO is archiving all these samples in the SMF for future studies that aren't being currently used in studies as we have them today.

Besides the kind of water testing stuff, Inez Triay at Los Alamos and her co-workers are basically also doing column and transport experiments with the sediments and core that we get out of here to try to get some handle on transport characteristics through these rocks for use in the models.

And I'll kind of conclude up here just to say that in my opinion, as you pointed out, Richard, this is a great resource, and I believe that we will get a lot of very important information to help the regional saturated zone flow and transport models being generated by the project. And the effectiveness of the alluvial system is a barrier, an additional barrier within the SZ, I think will be better evaluated and integrated into our defense in depth arguments as we proceed on by having these studies going up through

DOE.

And with that, I'll stop and entertain questions.

CRAIG: Okay. Priscilla, followed by Richard and Debra.

NELSON: I'm curious. A question was raised yesterday which I'm following up on because it was of interest and it's of interest to some of our Swedish visitors as well. Is there any microbiological assessment or testing being done on water samples here or coming out of the other wells that are being completed?

DIXON: At this point in time, there are no funded studies to do that. When we looked at the key technical issue that came out of the NRC related to saturated zone and other barriers, although microbial induced corrosion and other things are considered important, there are no real burning issues as far as I know that drove us to put funding into those things this year either, from PA or other places. So microbial as a whole for DOE this year is not being addressed in our current study plan across project wide, except for a few independent studies within Waste Package on corrosion, I believe. I can be corrected on that if somebody is in the audience who's more wise.

NELSON: Not necessarily just for the corrosion, but generally--

DIXON: Well, for transport, I know we had studies in FY 98 that looked at some of that stuff on transport, both at

Los Alamos and Livermore, and those studies were curtailed in '99 due to funding. And the bottom line was they weren't considered issues within those zones right now where there was a drive within DOE to do those.

PARIZEK: Parizek, Board. Could you comment a little bit on the Eh progress that's being made? I know the program has been looking at this, and that's so critical to the transport of some radionuclides, do you have an update on how that's going?

DIXON: Eh in the sense of on the site?

PARIZEK: On the site.

DIXON: On site? The end of the year report that came out, which is in NEPO right now, from Aaron Meyer basically they looked at two different wells to describe this in situ down hole measuring instrument that Aaron had, and WT-3 and WT-17 were the two weeks looked at. WT-3 had oxidizing water and we were able to reproduce, had Eh's on the order of 300 millivolts. They were able to reproduce within that well down hole probe measurements, as well as in situ measurements taken along the way down where they pumped out certain sections, took grab samples, were able to get a good match between those two measurements, between what we saw.

WT-17, which is further in towards the repository, actually had reducing conditions, about minus 100 MEV in the hole, and that kind of compares well with some of the earlier work done by Olgard and others. What we saw, there was some reducing waters within the repository footprint. The program to continue looking at the test site, within the Yucca Mountain area at WT wells was deferred to 00 due to funding this year, and we're using the money we have this year to look at the Nye County stuff to keep things in real time.

PARIZEK: Parizek again. Do VA have reducing water, I forget, for transport? Did we get any reducing conditions?

DIXON: I don't believe that we did anything with reducing water in VA, but I could stand to be corrected there.

PARIZEK: So far, from the two presenters now, mother nature is doing us a lot of good, I think. It looks like mother nature is adding--

DIXON: Mother nature is adding a lot of things, weather that can potentially help us along the way. I will say that there's a lot of information we hope to get out of Nye County on lateral dispersivities and horizonal dispersivities. To get an idea, right now, all the water, when you go down like in WT-17, you have about 30 feet of oxidizing water before you hit reducing waters, and the real question is is what is the mixing within that oxic zone. Does the water hit that and stay within the oxic zone, or does it mix down through that 30 foot zone.

PARIZEK: That's the whole idea of the layering or mixing.

DIXON: Layering, mixing, and that's part of the saturated zone modeling that's going on.

PARIZEK: One general question. About how many Westbays are planned, which is really a three dimensional characterization of head distribution and chemistry? I know Westbays we talked about, but I don't have any idea how many wells will be equipped with Westbay sampling ports.

DIXON: As far as I know, Nick can answer that probably better than me, but right now, most of the wells that are completed through the water table will have Westbays for sampling.

STELLAVATO: Every well that's not too hot will have a Westbay.

PARIZEK: How hot is hot to melt plastic?

STELLAVATO: 41 to 42 C. is as hot as we're supposed to go.

DIXON: And at this point, I don't know if Nick is looking at in some of the hotter wells of doing something different, putting in steel things.

STELLAVATO: I'm just putting in steel tubing in the hotter wells so we can actually pump them and get the sample.

PARIZEK: And the diatomite needs hot water, I understood at one time, and that's consistent with what the horsetooth formation temperatures are. We always had this magic as to why diatomite was so restrictive in the paleospring deposits, and the warm water--

STELLAVATO: I don't know anything about that.

CRAIG: We're setting up a special meeting amongst the three of you at the end of this session.

STELLAVATO: I would say that Zell is probably a better person to answer.

CRAIG: Debra, and Alberto.

KNOPMAN: I have two questions. One, I'm reassured about the cooperation that seems to be going on between Nye County and the program. Can you say categorically there was not any issue about the drilling fluids affecting some of the geochemical samples that were taken? Is it not an issue now?

DIXON: In some of the early wells like Washburn and stuff, we used a lot of things due to drilling probably when we first got started. Some of those wells we will probably not be able to do a lot of chemistry on. On the deeper wells, air hammer drilling and doing those sort of things, I don't think we're compromised at all in the chemistry that we'll get out of those wells. Again, Nick has to weigh off when he gets into wells, and he does converse very well with us about when he has to add additives and stuff, to let us know when he's done things. But the bottom line is he has to get to a drilling total depth, and we try to, if we run into problems, we try to make sure that we've been sampling along the way so that before we get to those problem zones, we may potentially contaminate with using polymers and other things, that we've gotten samples up higher.

KNOPMAN: Okay. Second question focuses on these two conclusions. Can you give us an idea of the time frame in which you will get the kind of information out of these--the various experiments and data collection efforts that will--when will some of this information get fed back into the flow and transport modeling and when will you think you'll be able to integrate it into your defense in depth arguments?

DIXON: We have data feeds to the technical database in mid summer this year, with all data collected up to that point on Eh, pH and chemistry from the different participants. And as far as I know, the saturated zone flow and transport process of a model isn't due until sometime much later this fall, and then we have at the end of this fiscal year, another feed to the technical database of everything collected for this fiscal year. And anything collected after this fiscal year will not be fed into the process level models, but will in fact probably go into the abstraction testing process. That's why I put both those things up there, so the sensitivity analysis, things that we don't get incorporated up front into the process level models will get utilized during sensitivity analysis and the abstraction process.

CRAIG: Alberto?

SAGÜÉS: Yes, I was just trying to feel out your transparency number for I guess the one on links of saturated zone. What's developed in the first bullet?

DIXON: That's a good question. I think that's just a typo. I'm not sure. That shouldn't be invert. That should just--it could probably just start with data feeds to the saturated zone. I think that's just an extra word added in.

SAGÜÉS: All right. Okay. The other question is as far as I know, this is all planning; right? There are no findings yet?

DIXON: This is all what?

SAGÜÉS: Planning. There's no findings here?

DIXON: They've been collecting samples and doing analysis, but right now, we're in the process of collecting things. Anything that I would have presented would have been, you know, one or two little numbers here and there, but there are numbers being generated as we speak in a lot of different areas.

SAGÜÉS: Okay. The other question has to do with the temperature. First, are the temperatures they're observing in the Nye wells, do they agree with expectations, projections?

DIXON: I would say that the projections of what came out of the paleozoic aquifer and having 50 degrees, you know, 40 to 50 degrees C. water is concurrent with what we've measured before in the paleozoics. I can be corrected out there. Where we have gotten up close to the center, we're seeing higher temperatures, that's probably not beyond expected. But, again, the chemistry in these programs and looking at some of the other things will tell us where those waters originated from and what's causing them to be elevated, you know, what zone they're being generated at the elevated temperatures, whether they are coming from deep where we'd expect temperatures in the 50 degree C. range, or whether they're being heated by a secondary process.

SAGÜÉS: One of the temperatures is as much as 67 degrees; did I hear that correctly? Is that to be expected at those depths?

DIXON: I'm not sure. I mean, I was kind of surprised at 67 myself, but then again I have not been doing a lot with the saturated zone temperatures personally and working in those issues, so I can't really address that question directly, only to say that it's not out of line with where that well is located and what it's located next to to have, you know, secondary heating related to the volcanic processes.

SAGÜÉS: Yeah, and maybe you aren't the right person to ask this, but how important is temperature or temperature variations to the saturated zone modeling?

DIXON: The sensitivity on how temperatures will affect transport out there in the modeling, I'm not sure it affects flow that much, but there probably will be some affects to transport, and those are being determined in the models as we generate them. Again, this is all kind of data that, as Nick pointed out, we only found out here in the last week or so. So we're still trying to digest it.

Zell might want to address from the back there if there is any belief from you, Zell, that there's any reason to believe that the water temperatures are out of whack from what we've been seeing, from what we expected, I guess. I mean, you have the most history on water temperatures and history.

PETERMAN: Zell Peterman, USGS. Well, we were just talking about that yesterday, and I think we took 65 degrees or something and, you know, with the geotherm for that part of the country about 30 degrees C. per kilometer, you're only talking about a source of the water maybe, you know, 1300 meters down, and to me, that's not too difficult to believe that it would certainly suggest that it's probably from the regional carbonate aquifer.

But as Paul says, you know, once we get the chemistry and the isotopes, we should be able to tell much more clearly where that water is coming from. But I think it's--there's something in the hydrologic system there that's forcing the deep water up. We know there is an upward head on the paleozoic aquifer at Yucca Mountain, so it's not inconsistent with that.

CRAIG: Okay. At this time, we need to move on. So thank you very, very much. We now come to the show that you saw advertised when you got off the airplanes coming into Las Vegas. It's called the 10 CFR 63 show. John Greeves and Tim McCartin of the Nuclear Regulatory Commission are on for 25 minutes.

GREEVES: Good afternoon. How much did we charge for entrance?

Let me just, Chairman Cohon and Board members, let me thank you for the invitation to come and talk to you about a very important aspect of the repository program. And I think we probably need to spend some more time together, and I'd invite you when you're in Washington to give me a call and maybe I can talk to you as time permits.

I was here yesterday, and a lot of things came up in the presentation we're going to make on Part 63. I felt like it needed to be put into context, so I've added a slide. And I normally take probably a half an hour to go through this slide with groups like this, including the Commission, and there's not time to do that. But I really think it's important. I sat through the design meetings yesterday, and the context, the licensing context that this program is in needs to be understood by all people, and really all I'm going to be able to do with this slide for today is point out three key parallel paths that are going on, and I apologize for the slide, but I had to call Tim and ask him to bring this one out on the plane.

But there's about eight parallel activities going on here, and I'm really going to only mention three of them, and it's sort of the context of the licensing process, and the three I'm going to speak to are in legislation space. The three are the standard, the license application and so called sufficiency comments. And when you look on this, the one that furthest out is the license application here, and it's in 02. It's a driver.

The next one is the site recommendation, which in legislation space, calls for Commission comments. We're required to do that. It's also a driver. And then the other one that I want to mention is up here, the standard.

In the context that I want to try and portray and maybe come back and talk to you more at length is these are the things that dictate what we do in terms of the Commission, and we're going to talk to you about Part 63 and give you some background on this. But with the application out here in 02, the fact that the Commission is required to comment on site recommendation in 01, and just the design work that we looked at yesterday, these people need to know what is the standard. They need to know what the post-closure part of the standard is. They need to know what the pre-closure part of the standard is. There needs to be--and there's another line here, I don't want to short strip the environmental impact statement. That is also obviously taking place.

So that's the context that a lot of this topic is involved with. People were asking questions yesterday about reasonable assurance, and we need to be able to answer those questions. And in this context, reasonable assurance, by the time you get out at license application, and I'm working on a chart that goes further than this, but the staff will have to review that, develop a safety evaluation. Most of the people in the room are familiar with that. There will be a hearing. You go through the hearing process, and then at the end, the Commission will make a decision. That is reasonable assurance, and this is a big ticket item.

And then reasonable assurance goes all the way down to the smallest item where I have any year, hundreds of licensees who terminate their license, and in that case, an inspector goes out, does an inspection and says did you get rid of that sealed source, and the answer is yes, and he documents that, and that's reasonable assurance in that context. And it varies from those two extremes, so I hope that in some way answers one of the questions that came up.

So at this point, I'm going to just go through about four slides up front, and Tim will do the details. As far as Part 63, we have had interactions with EPA over the last three years. We've tried to be proactive. What the Commission has done is come up with what it believes is a proposal that is consistent with international recommendations, and protective of the public.

We've had extensive experience conducting our own performance assessments. We've met with the Department and had a chance to interact with them, and you'll find that this regulation is a performance based type of regulation.

We developed the strategy late in '97, and sent that to the Commission, and they did approve that strategy in March of this past year, and it basically was driven by that context that I showed earlier.

At this point, just--you reminded people what's driving this process. The National Academy completed their work in August of '95, and the legislation called for EPA to one year later, come forward. That would have been August of '96. And then the legislation said NRC, within one year after that, which would have been August of '97, come forward and put this standard piece together. So we aren't there. We're on a later schedule. But that's why we're proceeding with Part 63. The Act calls for us to do this ultimately. It also calls for NRC to conform with the EPA standard, and gives us a year to do that.

So we decided that we need to develop this rule in parallel with EPA standard development process. The NAS recommendations have been available to all of us for three years, and we think we understand them well enough to get on with this.

We also had to refocus this high-level waste program a few years ago due to budget cuts, and we have been focusing on so-called key technical issues, which are mostly the post-closure issues.

We have, in interactions with DOE in public meetings, looked at uncertainties. This was another question that came up yesterday, you know, how do we address the uncertainties. We use the same types of tools that the Committee saw yesterday in terms of addressing uncertainties. We've got quite a bit of study on what we call importance analysis, and we have been looking at the waste package, and I think we have some different types of results than what you saw yesterday. So I just want to assure you that we are looking at that and we'd enjoy a followup on that particular topic.

The last item on this chart, I'll just make clear that the NRC would modify Part 63 to be consistent with any final EPA standard that is in legislation. There's a number of precedents out there. We've done this with the mill tailings program. We had a standard out there. The EPA came forward later with a generally applicable standard, and we modified our regulation. We got a low-level waste standard on the street. We got a de-commissioning standard on the street. So this is not unique.

The next chart, as far as the way things are flowing out, the Commission approved publishing the Staff draft. Late last year, we gave them what we thought our insights are, and in a sense of openness, the Commission said okay, put that out there while we're reviewing it, let people get some insight. They recently just this month came back to us, gave us directions on how to modify that input, and this is a public document, it's out there available to people. I've made it available. And we're anticipating publication of Part 63 in early February.

We also are sensitive to the need for an outreach process. We're going to look to a facilitated review, and we're tentatively planning in the March time frame to be back out here with several meetings. I'm sensitive to some of the remarks that were made yesterday about--somebody remarked about the NRC turning their back to them. Well, I apologize for that, to the extent it happened, and we can't do that. We need to do a better job, and we will meet with the public on this particular rule. They have input, and we want to hear what that is.

So we would be providing that opportunity, incorporating those comments, so by the end of '99, we would be in a position to finalize the regulation.

As far as this public outreach approach, as I said, we're going to do a facilitated process. Some of you I think met with Chip Cameron. We expect to ask him to come along and help us conduct these meetings. We would have the NRC staff make a number of presentations, explain various aspects of Part 63, listen to comments. I heard some comments yesterday I fully expect to hear in this process, and those meetings would be transcribed, and as I said, we expect to have a meeting in Las Vegas and one out in Amargosa Valley.

So that's the background. I don't want to take any more time.   Tim full time works on the rule, and he's got a good handle on some of these issues. And I pointed out some of the questions that came up yesterday about things like uncertainty, so he'll try and address some of those in the presentation, and I'll just sit at the table and help with some of the questions and answers. Tim?

MC CARTIN: Okay, I'll try to briefly go through the development of Part 63 in the next 15 minutes.

The first three topics, the legislative background, the NAS recommendations, and our conceptual approach for Draft 63, I'll go through fairly quickly, focusing primarily on the technical criteria, and that's the bulk of my slides.

In terms of legislation, the Nuclear Waste Policy Act of 1982 specified criteria for NRC to include in high-level waste disposal, basically provide for the use of multiple barriers, include restrictions for retrievability, and not be inconsistent with the general EPA standard.

The Energy Policy Act of '92 came in, and as people know, it said that the standard should be health based, the maximum annual individual dose should be based on and consistent with the NAS recommendations, and the only such standard applicable to the Yucca Mountain site. And as John mentioned, one year after the EPA standard was finalized, we had, NRC had one year to write its regulation.

Just a brief snapshot of the key NAS recommendations with respect to a high-level waste standard and regulation. One, they specified the limit of the annual risk the average member of the critical group, a starting point was in the range of .02 to .2 millisieverts. International consensus they pointed out was somewhere around .05 to .3 millisieverts per year. They suggest to define the reference for a critical group in rule making, evaluate the consequences of human intrusion separately as a stylized calculation. They also directly talked to the NRS by suggesting imposing sub-system requirements, such as were in Part 60 might result in sub-optimal repository design, and conduct the assessment over the time frame that includes peak risk, which was on the order of a million years.

However, we would like to point out that they also mentioned there's no scientific basis for limiting the time frame. They left open the possibility that there could be policy reasons for not going to peak risk.

The conceptual approach we took in drafting Part 63 was to go with a performance based risk informed criteria. We have pre-closure and post-closure performance objectives. Compliance with those performance objectives are based on quantitative analyses, and there are no additional quantitative measures for judging the repository compliance, such as quantitative sub-system requirements that are in Part 60, and separate ground water protection requirements.

The geologic repository must include a system of multiple barriers consistent with the Nuclear Waste Policy Act of '82, and we wanted to limit the potential for speculation during the licensing process. This is done primarily by specifying assumptions to be used for the reference biosphere critical group, and also a stylized calculation for human intrusion. And I'll go into all those topics in more detail in my subsequent slides.

CRAIG: Excuse me, can I break in a moment?

MC CARTIN: Sure.

CRAIG: I just had a request that you translate millisieverts in millirems for those of us who are not familiar with that.

MC CARTIN: It's a factor of 100. So the .02 millisieverts to .2 millisieverts is 2 to 20 millirems. And the .05 to .03 is 5 to 30 millirems. So multiply millisieverts by 100 and you get millirem. I apologize. I prefer millirem myself.

The performance objective for pre-closure is actually comparable to those for other operating facilities licensed by the NRC. It's 25 millirem to the off-site individuals, and also the surface facilities have to meet Part 20, which covers such things as worker protection. That's during the pre-closure phase. The compliance demonstration with the 25 millirem off-site and the Part 20 calculations will be done with a comprehensive systematic safety analysis. There are also requirements for retrievability and emergency planning criteria that fall during the pre-closure phase.

Post-closure criteria, very similar in that there's a performance objective, an individual dose limit of 25 millirem per year. Compliance period of 10,000 years, and we have a requirement that the system include multiple barriers.

Compliance demonstration also is based on a performance assessment, quantitative assessment of the performance of the repository, and as I mentioned before, the characteristics of the reference biosphere and critical group are specified in the rule, and a separate calculation is used to evaluate the consequences of human intrusion.

Now I'll go into some particular aspects of the post-closure performance criteria. Why 25 millirem? In the absence of the EPA standard, NRC went forward and has proposed 25 millirem. We will, as John pointed out, we will conform to the EPA standard when it's finalized. This is a sole quantitative limit for post-closure performance. We selected this value based on Commission direction and NRC regulation of other related activities. Both low-level waste disposal and de-commissioning have a 25 millirem requirement.

It's also consistent with international constraints that vary between 5 and 30 millirem. The NAS recommended as a starting point for EPA to consider a risk equivalent of approximately 2 to 20 millirem. And when we talk about the 25 millirem dose, it would be a probabilistic calculation, accounting for the fact of the likelihood of the dose occurring.

Why a compliance period of 10,000 years? There are a couple aspects about 10,000 years. One, it does provide a broad range of geologic conditions to evaluate the repository against. 10,000 years is a fairly long time. The radiological hazard of the waste decreases significantly over these initial 10,000 years. It's consistent with earlier court rulings and regulations and NRC guidance. The U. S.

Court of Appeals upheld the EPA's selection of 10,000 years in 40 CFR 191. It was applied at WIPP, and draft NRC guidance on performance assessment for low-level waste also specifies 10,000 years.

We debated this issue quite a bit within the NRC, and the question is when you get much beyond 10,000 years, there was a question of the usefulness of the analysis. It became more and more uncertain. What did a dose at say 400,000 years mean? How would the Commission evaluate that number?

With the new Part 63, we have put a lot of emphasis on performance assessment. Because of that, we have put in the regulation certain requirements for the performance assessment. It's easy to say it must be defensible and transparent. What do we mean? Certainly the PA should include site data to define the relevant parameters in the conceptual models accounting for the uncertainties. We're certainly looking for a range of parameters, not point values.

Also, in terms of uncertainty, it's not just the parameters, but alternative models. We would expect an analysis of alternative models and a basis for the models used in the performance assessment, and also the future, considering events with a ten to the minus 4 chance of occurring over 10,000 years will be different scenarios that will also be included, the uncertainty with respect to what the future is over the next 10,000 years.

Also have to consider the degradation and deterioration and alteration of the engineered barriers over the 10,000 years. And we're expecting topics that contribute most to performance would be supported with the greatest rigor, and the expected annual dose would be the basis for the decision making. And finally, explain fully how the estimated performance is achieved. We do not expect to see just a single curve of performance that gives a particular value below the regulatory limit, but we would expect analyses that make it transparent how that performance was achieved, what the contribution from various barriers was.

And speaking of barriers, we still have the requirement that the repository system must include a system of multiple barriers. There are no quantitative limits placed on individual barriers. However, we believe this gives DOE flexibility in presenting the evidence for the barriers, but we would expect an identification of barriers that are important to waste isolation, describe their capability to perform as barriers, accounting for the uncertainties in the characterizations and the modeling. Obviously, engineered barriers are going to degrade with time. And also provide a technical basis of whatever capability is being accounted for.

The demonstration of multiple barriers should include the capability of individual barriers to perform their intended function in the context of the performance assessment, and the relationship of that function to limiting radiological exposure. We're hoping that that information will allow us to understand the resiliency of the repository system to provide defense in depth.

The reference biosphere and critical group, the NAS suggested that this be set in regulation, using cautious but reasonable assumptions, knowing that it's very difficult to project anything far into the future, especially with respect to human behavior. However, what we've suggested is that arid to semi-arid conditions would prevail over the next 10,000 years, and the critical group would be a farming community located approximately 20 kilometers down gradient from the site.

The reason we've done this is--there's a couple reasons. Number one, it's consistent with present knowledge and conditions with respect to the depth of water table and the diet including locally produced food. If this group is expected to be those most likely to receive the highest dose, a farming community would have a multitude of pathways, not just drinking water.

We also believe that the 20 kilometer location, the depth to water is approximately on the order of 100 meters, which we think is reasonable for people to still farm at that location. Moving closer to the site, the depth to water gets deeper, and the economic viability of farming decreases. The land use, lifestyle, diet, human physiology, metabolic, pathways would all be assumed to be constant over the 10,000 years.

Consequences of human intrusion. Once again as suggested by the NAS, we've recommended a stylized calculation that would be separate from the performance assessment, and consistent with the NAS, we would assume a single vertical borehole that penetrates a waste package and creates a pathway to the saturated zone. And we would assume the event occurs 100 years after permanent closure.

And that's about as quick as I can go through the rule, leaving almost right on time. I assumed there would be questions.

CRAIG: That's fantastic. You're ahead of the schedule. So let's begin. Who wants to--Jeff wants to begin.

WONG: Jeff Wong. I have just two questions. On your Page 9, performance assessment must be defensible and transparent, you say that the DOE can consider alternative models and they must also provide the basis for the models used. How many combinations of models are you going to demand or allow them to offer, number one?

Number two, you said the expected annual dose is the basis for decision making. How do you expect, or how do you want the dose expressed? Single value, range of values, or are you going to take the upper 95 per cent of the mean or the upper 95 per cent of the total range of doses? How do you expect that to occur?

MC CARTIN: Well, first in terms of the conceptual models, we would not expect DOE to analyze every possible conceptual model, but we are assuming there will be a set of conceptual models that are all somewhat consistent with the data. Those models that are reasonably consistent with the data should be analyzed, and we would expect it would be a preferred model they would take, but we would like to see an analysis of why.

In terms of the expected annual dose, there are two aspects of calculating the dose that we have in the rule. One is that you would use the mean of the calculation, weight it by the probability that the scenario has occurred. So you would take--the easiest way to look at it is to say for a particular scenario, you would do, because of the variation in parameters, you may take 100 Monte Carlo runs for a particular scenario. You would get a mean dose for those hundred simulations, weight it by the scenario probability, and then do that for all the scenarios to get one dose curve.

Now, one thing that we believe is very important is that you would do this at particular instance in time, that it's not a dose that--you're not averaging doses at, say, 8,000 years with doses at 800 years. You have a dose history, because obviously an annual individual dose, the individual at 800 is not alive at 8,000 years, so you would go at 800 years, and you would sum up all the doses from all the scenarios at 800 years, say 900 years, but you would produce a single dose versus time history that is representative of the risk to an individual. And whatever the peak on that curve would be, would have to be below the 25 millirem limit.

COHON: Cohon, Board. I'd like to pursue this issue of uncertainty further, as well as another issue of time separately, but together. Based on what you just said in response to Dr. Wong's question, it sounds like the basis for the Commission's decision will not include information about the range of variation in doses. Is that correct?

MC CARTIN: Well, the mean incorporates the range.

COHON: Well, of course, but you'd be able to see one curve is the basis for that. How will the Commission understand the range of variation around that single curve?

MC CARTIN: There is other information that can be presented to explain the results. But ultimately, the mean of the curve is what we would use. But in terms of transparency, we would not expect DOE to come in with a single dose curve and nothing else.

COHON: And what other information? You just said there would be other information that gets to this issue of variation. What other information?

MC CARTIN: Well, in terms of showing how the multiple barriers work.

COHON: But that doesn't go to uncertainty. That goes to robustness, resiliency. We'll come back to that. Certainly, the NRC knows as well as anybody that there's great uncertainty here. You're going to try to get an expected value.

MC CARTIN: Yes.

COHON: You will get an expected value following the process you just described. Certainly that expected value has implicit in it that variation. But in no way is that conveyed, the range of that variation, to whoever is looking at that curve. So the question is how will the Commission, or will the Commission be made aware of that variation and how?

MC CARTIN: Well, certainly we could present different percentiles. We could present a 95th percentile.

COHON: Does the rule anticipate that? It seems like it does not.

MC CARTIN: The rule is not there to limit information to the Commission. It's suggesting what compliance will be based on. There is other information the Commission can ask that we don't necessarily have to require in the rule.

COHON: Okay. But you're saying that compliance will be based on expected value?

MC CARTIN: Absolutely. That's what's proposed.

COHON: Am I correct in inferring that compliance will not be based on measures of variation around that expected value?

MC CARTIN: In terms are you talking about like a percentile or a confidence limit? We could apply a 95th percentile confidence limit.

COHON: You just said that, of course you could, and the Commission is free to use any information it wants. The question is will compliance be based on that kind of information?

GREEVES: Tim, I think the clean answer is, this proposed rule, the clean answer is no. Now, will that be a comment that somebody makes and gets considered? That's what this is about. The Commission has reviewed the draft that we sent up to them. They gave us explicit comments on what to put in this proposed rule, and I think Tim articulated what is in there, and the questions you're raising are not part of the standard.

Now, I fully expect that they will understand the range of those uncertainties as this process goes forward. The staff does those kinds of calculations themselves.

MC CARTIN: In the calculations we've done, there really hasn't been a problem in producing the statistically significant mean. So we're not overly worried about the mean being statistically appropriate. Now, generally the mean is a very high percentile. In the calculations we've done to date, it is much higher than the median.

COHON: The disappointing thing about this from the point of view of this one Board member is that as we struggle with the question of suitability, which is unavoidable for us, inseparable from the question of suitability is the issue of uncertainty. What is the likelihood that the expected dose will be a certain number, and the rule ducks that and we can't. So we learn nothing from this.

I'd like to go on to two other points. This seems like nit picking, but I think there's something to be learned by it. On Page 10, you used the word resiliency for the repository. And resiliency in one branch of decision theory, resiliency is used to refer to the recoverability of a system after failure. And there's another word, robustness, that talks about the likelihood of a system not failing in face of surprises. And my guess is, but it's the question, do you really mean robustness using the vocabulary I just introduced, or do you really mean resiliency, that is, recovery of the system after failure?

MC CARTIN: Well, we were using resilient in the fact that you may not get as much performance out of one barrier, another barrier could. Now, whether resilient is the right word for that, I--

COHON: That helps. Finally, one last question. You made it very clear that the dose standard you've included in the rule would be superseded by anything that might come later if EPA says so. You also made the point that thinking about the report, NAS report, and this issue of when the peak dose occurs and what the regulatory period should be, that there was no scientific basis, but there might be a policy basis for limiting the period to less than when the peak dose occurs. All that is prefaced then to the question would the NRC expect--does the NRC think that it has stated the policy with regard to the regulatory period, or like as with the dose standard, are you proposing this and you're quite willing to have it superseded by some other rule? The policy is the question.

MC CARTIN: Well, this is what we're proposing. If the EPA standard came out with a different time, or if Congress came out with different legislation that suggested a different time, I believe we are obligated to be consistent with either the law or the relevant EPA standard, and we will change. And also during the public comment period, would information come to us that would say we should go to a different time frame also? That could happen.

COHON: And do we expect the EPA standard to include a time frame? Or it's anybody's guess?

MC CARTIN: Yeah.

GREEVES: It's going to have to say something on time.

MC CARTIN: We would be surprised if they don't say something about time period.

COHON: Thank you.

CRAIG: Can I throw one in here? Talking about this last issue, Tim's report certainly said there is no scientific--focused on a scientific basis. What you appear to be saying is that you disagree with that. You appear to be saying that the capability of making predictions out to the times where the peak doses are now appearing is sufficiently good that there is not a scientific basis. So you're making a statement which is quite different from the statement that the TYMS people made. The TYMS people said there is not a scientific basis for a shorter time, and you're saying--but there may be a political basis. You're apparently now saying that you are using the political basis as the hook on which to hang your standard. Is that correct, or am I misstating you?

MC CARTIN: Yeah, I don't think we--in terms of the calculation, we can carry the calculation out to a million years. It's an easy thing to do, and you just let the computer run. We do believe it gets more uncertain the further out in time you go. When you go past the next ice age, approximately 10,000 years and beyond, hundreds of thousands of years, we would say it does get much more uncertain. It is possible to do that calculation, but it becomes much more uncertain.

CRAIG: Well, you then appear to be disagreeing with what the TYMS people said, because they appear to me at least to have said that there is a scientific basis for going to the time of peak dosage. And you now seem to be saying there is so much uncertainty that there is not a scientific basis to go to the time of the peak dosage.

MC CARTIN: I don't think they said it didn't get more uncertain. You can still do it, but the uncertainty does increase to an extent.

CRAIG: Yeah. Debra?

KNOPMAN: Knopman, Board. I want to come back to this bullet about defense in depth, because it's not clear to me how the standard is--what sort of marker you're really laying down for that. So would you elaborate on what you're expecting in terms of a case for defense in depth quantitatively?

MC CARTIN: We are expecting multiple barriers, which will be comprised of at least one engineered and one natural barrier. And there would need to be a demonstration of how that barrier contributes to performance.

KNOPMAN: Right. But suppose you have three barriers and one provides 98 per cent of your performance and the other two provide 1 per cent each. Is that okay?

MC CARTIN: That would be a Commission decision. We have elected not to put any quantitative requirement.

KNOPMAN: That's my question.

MC CARTIN: Yeah, there is no quantitative requirement. Now, we debated the same issue, and that was the problem, is well, should we put a percentage, and what did that mean. We felt that it was going to be a subjective decision that the Commission would have to make in looking at what DOE presents in terms of constituting multiple barriers.

KNOPMAN: But multiple means greater than or equal to three?

MC CARTIN: No. One natural barrier; one engineered barrier.

KNOPMAN: Okay.

MC CARTIN: That's in the rule. Now, we would expect they quite possibly could have more.

BULLEN: Bullen, Board. Just a quick question on human intrusion. Is there a different dose standard for the 100 year drilling event, or is it still 25 millirem?

MC CARTIN: The same.

BULLEN: Well, we found out yesterday that juvenile failure of one waste package can have a significant impact on performance of the system. And so this one might appear to be a challenge for DOE to meet?

MC CARTIN: One waste package?

BULLEN: That's what I understand. It looked like one waste package. Correct me, the rest of the Board, if I'm wrong. But didn't juvenile failure of one waste package have a significant effect, particularly if you take away the unsaturated zone, which is what we just do when you drill a hole? 25 millirems might be a challenge. I'm just trying to point that out based on what we heard yesterday.

GREEVES: Dr. Bullen, I showed those charts to Tim yesterday and he was quite surprised at some of those charts. I don't think we're going to be able to get at it in this meeting, but there was some very large doses with the--

BULLEN: Bullen, Board. Yeah, we were surprised, too. That's why I just brought it up.

GREEVES: Tim was very surprised when he saw that chart. I think we need to talk more about that.

BULLEN: Well, you don't need to talk to us about it. You need to talk to DOE about that.

MC CARTIN: We need to know the underlying assumptions behind that. I think it wasn't clear exactly what was being modeled.

CRAIG: Okay, we have Alberto, followed by Priscilla.

NELSON: Can you tell me a little bit about--

CRAIG: I'm sorry, Alberto next, followed by you, followed by John, followed by Richard.

SAGÜÉS: That's okay. I'll go after Priscilla.

CRAIG: Okay.

NELSON: Nelson, Board. Could you tell me what this proposed document says about retrievability?

MC CARTIN: It's just DOE has to provide for a system of retrievability. It's similar to what was there before, and it needs to be retrievable on the same time scale that the repository--that the waste is emplaced.

NELSON: So there's no change?

MC CARTIN: No.

CRAIG: John Arendt.

ARENDT: Arendt, Board. Is there are consideration being given to safeguards that you know that the NRC is giving consideration to safeguards, safeguarding the material? I know there's an IAEA requirement, but is that--I know that's not part of this.

GREEVES: I don't think we're prepared to address issues today, but it's an issue and we really didn't come prepared to talk about that particular topic. And Tim, that isn't his area of expertise. So possibly I could meet with you separately and we could talk about that.

CRAIG: We'll now move to Richard Parizek.

PARIZEK: If two barriers, one natural and one engineered, and just about gets the job done and it looks pretty comfortable in terms of uncertainty, and then if the program has already five or six other already in its pocket and dumps it on the table, do they get any credit for all of that? You know, redundancy, and would that be good or be looked upon favorably, would they get credit for that?

MC CARTIN: Well, it depends on what you mean by credit. They have to meet the performance objective. Whether they meet it by a lot or a little, certainly they can take credit for as much as they can defend. So if they have five different barriers and many different attributes of the natural system, all that contribute to performance, as long as it's defendable, they can take credit for it. I mean, we're not--it's not limiting. What we're trying to specify is the minimum that they have to meet.

PARIZEK: So that comfort level with what they can prove with some degree of assurance is quite critical as to how much of this is carried on in the design process.

MC CARTIN: Right.

PARIZEK: There's a lot you can do in design, and the question is how much of this can you get done and you need to get done.

MC CARTIN: Right. And they may elect to have certain design features that they don't take any credit for, but they think, gee, it's a good idea, but in the demonstration of compliance, we won't take credit for that. And anyone who's seen the various DOE/NRC performance assessments, we tend to take generally a more conservative approach and don't take credit for some of the things that DOE takes credit for, cladding being a prime example. In our PAs to date, we haven't taken credit for cladding. DOE has. But the strength in terms of going to the Commission and to a licensing board would be that we have a slightly different approach, maybe more conservative. If both show compliance, it's a stronger case.

GREEVES: It sort of goes to the context I tried to showed earlier, Dr. Parizek. You're familiar with these processes, and I would expect that an applicant would want to come in and show some margin.

PARIZEK: It's a slam dunk?

GREEVES: Well, somebody's going to want to show some margin here, and so I would expect that we would be seeing multiple barriers with some demonstration of a margin vis-a-vis the standard in the process. It just makes it easier if you have that margin.

CRAIG: Okay, Alberto, are you ready?

SAGÜÉS: Well, I may be ready if the logistics for this works out right. I'm really going to belabor a point that Dr. Cohon made earlier that all of us could benefit from. Perhaps it may be more of an example. Suppose they have two projections, and say take for two particular projections, for two particular cases, take the highest possible doses that would result over a 10,000 year period, you have two cases and both cases would give a probability of 50 per cent of getting a dose of 10 millirem per year maximum dose over that period. But one case is very narrow, in other words, the likelihood of having a little bit less than 10--more than 10 is very small, so that would be an S curve. And let's see how this projects there. This may be invisible. Let's see what happens. Oh, it shows it pretty good.

Look at case one, for example, and that will tell you the probability and percentages in the vertical axis of getting the maximum dose. So case one says that we have a 50 per cent chance of getting a dose of 10 millirem. That would be sort of a medium kind of situation. Right?

Now, the chance of getting, say, 1000 millirem per year will be very small, perhaps 1 per cent or less than 1 per cent, or something like that.

Case two is a case that also gives a 50 per cent rate; right? A 50 per cent chance of getting 10 millirem per year over this 10,000 year period. That would correspond to the maximum possible. And that case two unfortunately has a 15 per cent chance of someone getting a dose of 1 rem per year. This would be the dose in the logarithmic scale in the horizontal axis.

But, again, what I believe that Dr. Cohon wanted to indicate was that the way the proposed criteria were indicated in your transparencies, both of them would have, in principle, an equal validity perhaps, or equal--

MC CARTIN: Yes, but there's one thing that, I know we discussed this quite a bit, the mean is very sensitive to those large doses. When you take--and once again, let's say I do 100 Monte Carlo runs, and we typically use Latin hypercube sampling which makes all the runs are equally probable. One is no more probable than the other. If you have a rem dose with one out of a hundred, you need a lot of zeros on the other end to counter-balance it to get doses down to 25 millirem. And I hear what you're saying, but of these hundred runs, I have no reason to believe one is any more likely, or should I give more weight to one versus the other. I believe when you have the large--if you have a few runs with very large doses, you're going to end up with the vast majority of other simulations giving you almost zero.

COHON: This is unbelievable to me. I mean, you're rejecting decades of findings and decision theory. The Commission, the decision makers, are not being made aware of that range, and to say that they're not sensitive to range is to ignore a huge part of this--

MC CARTIN: Well--

COHON: Let me finish. Especially this problem, which everybody acknowledges to have a degree of uncertainty that's not been precedented, either from the NRC or for anybody else who's involved with it. To mask that by just focusing on expected values is really destroying the problem.

MC CARTIN: Well, I guess I would question in terms of masking it. We never said we would limit information to the Commission to inform their decision with just a single dose curve. The Commission will want more information, and I believe we will show them the distribution of doses. They will have that information. But we believe the compliance calculation is based on the expected value. But we fully expect that we will provide a lot of information to the Commission, and in giving them the full distribution of the doses, is certainly one thing that can be provided to them.

You're correct in that we aren't trying to--we did not put the expected value in there to mask information, but that's the measure for compliance.

CRAIG: Debra?

KNOPMAN: Knopman, Board. I want to understand the way you're planning on using these Monte Carlo runs. You actually say in the standard--do you specify how you're going to generate these means with a hundred, you say you're going to do a hundred runs; you don't get into that?

MC CARTIN: No, not in detail.

KNOPMAN: Okay. Because if you're doing--then you said you're going to weight your mean for each scenario based on the probability of the scenario. But for whatever kind of sampling you're doing, when you've got models that have hundreds of parameters to them, a hundred Monte Carlo runs is nothing; right?

MC CARTIN: Yes.

KNOPMAN: So why do you used a hundred--why did you even use that as an example? That's like off by a factor of two or three that would be appropriate to truly sample over the--that's just parameter uncertainty. That doesn't even get to the model uncertainties in any given scenario. So that's going to need I think a high degree of elaboration before--

MC CARTIN: Well, typically, we use 400 realizations in our particular model. DOE may have more parameters.

KNOPMAN: Well, for how many parameter model?

MC CARTIN: Approximately 220.

KNOPMAN: That means nothing.

MC CARTIN: No. For LHS, that provides statistically significant results, and we have gone to 1000 and to 4000 and we don't see any difference in the results. LHS uses equally probable segments. It's a stratified Monte Carlo sampling, and you're right, there will have to be some evaluation to determine that you have gotten some convergence of your mean. We expect that, but depending on what sampling technique and how many parameters, although there are many, many parameters, there are very few parameters that actually make a big difference in terms of the dose calculation. We find typically six or seven dominate the calculation of dose.

KNOPMAN: Can you say what they are?

MC CARTIN: Not too surprising, seepage into the drift, the alluvium. Waste package lifetime has an impact. It's not as--it delays the dose, doesn't necessarily reduce it. The amount of area, the amount of packages that actually see drips, and the dilution factor. That's off the top of my head. We are publishing a report shortly of that. But generally, it's related to those nuclides, and potentially retardation of neptunium.

CRAIG: We have a question from our visiting delegation from Sweden.

KNUTSSON: Gert Knutsson. You assume a stable climatic condition during the next 10,000 years. Wouldn't it be of interest to do some predictions for the future about climatic change? I mean, you can discuss the greenhouse effect. On the other hand, you can discuss a new ice age. They have found that there will be a new ice age.

MC CARTIN: Well, we, as well as the DOE, look at a change in infiltration due to rainfall and slightly cooler temperatures. But when I said--the climate isn't static, but the conditions, arid to semi-arid, would still remain even with rainfall, increasing by a factor of two or three.

KNUTSSON: Not arid, maybe semi-arid.

MC CARTIN: Semi-arid, yes.

KNUTSSON: Semi-arid. Thank you.

CRAIG: I believe now we've run out of time for this session. We have a public session coming up, and I turn the baton over to Dr. Cohon.

COHON: Let me first thank Paul Craig for his wonderful job, masterful job as chair of this session, and thank all of our speaker and all who participated. It was a very good session, very informative and valuable.

We have five people who have signed up to speak during this public comment period, which is only, let me remind you, the first of what will be three comment periods, in addition to our coffee klatch tomorrow morning. I'm going to read your names to make sure we've got you all, and if we miss someone, you can still sign up. I want to make sure we know the total time requirement we're dealing with.

I have Sally Devlin, Anthony Hechanova--I may have mispronounced that, we'll get that correct later--Judy Treichel, William Vasconi and Steve Frishman.

Have we missed anybody who cares to speak? We're getting one more now. Okay, so there will be six in total. And with your forbearance, I'll ask each person to limit themselves to ten minutes. I will be your timer, and I will be as rigorous about this as Paul Craig was during the session.

Our first speaker is Sally Devlin. Mrs. Devlin?

DEVLIN: Thank you, Dr. Cohon, Mr. Chairman, and members of the Board and the staff, and welcome to our guests from Sweden.

I just started a toastmasters club in Pahrump, Nye County, Nevada, and we just got our charter and we're going to have a tall tale contest coming up, and so I thought I'd write one for you, and I'll be pretty quick about it, and that is I don't want Yucca Mountain, and everybody knows it, and the reason, I think it's unsafe, I think it's all kinds of things, And so my tall tale has the entire board, all of their assistants and everybody else who doesn't listen to us as the public, and they're going to go and get either 77,000 metric tons or 105 metric tons, and they're going to wash them off with CLR and Pledge, and then they're going to put them on imaginary flat cars tied with chains, and then they're going to hook them up to a huge sleigh, and this sleigh is going to be pulled by Pegasus, who I have dyed purple, and then they're going to take the whole thing off up into the heavens.

And I see you listen to me. I must have said something kind of fun. But remember, I haven't told you if you're going to come back, and I'm not going to tell you until tomorrow. But anyway, this is exactly what I came to say. I'm not going to take ten minutes either.

I'm going to just name two, and that was Tim McCartin and Paul Harrington. Paul, you said yes, we will put things on the web. I live in Pahrump. We have copper wiring. We do not have fiberoptics. We do not have computers. There is absolutely no way that I can get information from you. Our Yucca Mountain office is open maybe four hours a day if the guy comes. My friends with computers have a terrible time, and I'm not just picking on Paul, I'm just saying we are under privileged, we are ignored, and so on.

So that when I didn't get an agenda for this meeting, and I'm all grown up for Pahrump, I did get a fax. They faxed it to me. It was absolutely thrilling to get four pages from Washington. I loved it.

But, again, when I came here and I said we didn't get the agenda, and I had to call everybody in Vegas and tell them the agenda, and they didn't get them either. So what happened? They said didn't you get it on the web? And I thought that was a very cavalier attitude, and I hope it will change, because when you're under privileged like us, know about it, be sensitive to a town that doesn't have it.

And then I'm going to get Tim McCartin, because he said a town 20 miles from Yucca Mountain, and of course he's talking about Amargosa. Amargosa has 1423 people, and they count every one that's born and everybody that's died, and they did their own census, and they keep it up. Amargosa is a problem, and if you'd heard my testimony from NRC, I'm talking about the Board, you would have heard what I said about BLM, Bureau of Land Management, and all the rest of it, with the politicizing of that area.

If there is no private enterprise in Beatty or Amargosa and BLM takes over the whole thing, because we have no maps, remember, Pahrump has been in business since 1984 and we still do not have a boundary map, Amargosa may be even a hundred miles larger than Pahrump, which is 375, maybe, square miles, and it's all federal. So we're talking about people. These are real people with the largest area in the United States, maybe the world, and as we all know, they're in big trouble. If the mines close, if the dairy closes and so on, we're still talking about a few people, maybe go down to 1000 people, if that, and Amargosa would probably go down to 700, or less. But they're still people, and we are people.

And that is my point. I went next door to another DOE meeting that is being run the same time as ours, and did we get? We need your impact. Whoever asked the public, Tim and I, if you wanted our impact? I love it that you said you had questions for Russ Dyer or Lake Barrett, because they're never coming back if they put this Yucca Mountain thing in by

May, in my book. The rest of the Board, maybe. I'll let you know tomorrow. But not those two, because you have totally ignored the public.

And so I do hope you appreciate my sentiments. Why you don't have evaluation things, question things going back and forth, why don't we get any of your reports? I asked for them. What happened at this meeting? I don't get any. I know Frank Randall is gone and I don't know who's doing it now. I met her maybe once, but she's not here. But I asked for these things. I asked Carlos for things. I asked all of them, and I don't get them. I really do read them, as you know, and I do make reports on them, and I ask questions.

The other thing that we were talking about was the cancer and the millirems and so on, and my tutor in radio-biology made me read a heck of a lot of stuff, and the one thing I learned, and I use an example, is what someone asked me about it, is I say I was at Hiroshima and I died and you were at Hiroshima and you lived, and nobody knows why. And at the end of every chapter with every cancer thing on every organ, they say we don't know. Bless DOE, they say if you had a job for 30 years, we don't care if you die of cancer. They have never kept statistics. So there's a lot of stuff here that directly involves the public. We do have names. We do have bodies that are important, and I just feel really it is a shameful thing that you don't recognize that we're real people. Amargosans are real people. Pahrumpians are real people.

And also, the other thing, and I'm going to say it, and you know I'm going to say it, you're going to Beatty, you're not coming to Pahrump. Now, I promise I won't poison the cookies again. I really promise. I do. But we would like you to come to Pahrump. We have a lot of things going on there, and we will appreciate your company, because we are hysterical about all the transportation stuff. Our county commissioners don't even realize 373 is very much involved in that.

In the report for intermodal travel, I said two things, and I want you to hear them. The first was that U. S. 95 is a nine hazardous road, 160 is a seven hazardous road, and these are DOT things. There is only one north/south road in Nevada, and I don't mean to bore people with the demographics of our area, but we don't have any ancillary roads, auxiliary roads. They're all two lane, and they're not maintained, and our state doesn't have any laws about them.

So now you're getting a picture. Come out and see Pahrump. Go see Amargosa. Go see Beatty. But most of all, realize where we are. We are in the number one, in my book, wonder of the world, and that is Death Valley, and you're an Easterner and I'm a Nevadan because I've been out here over

30 years, but I'm born and raised in New York, and you couldn't get me back there if you gave it to me. Go and see Death Valley, not in March, but go and see Death Valley. It is absolutely breathtaking. And once you've seen a sunset in Death Valley, you will want to come back again and again and breathe our clean air, so far.

COHON: Thank you, Mrs. Devlin. I apologize. Mrs. Devlin, I apologize on behalf of the Board if we failed to get you reports. We're pretty good about sending reports to people on our mailing list. We'll check it to make sure you're still on it. And of course we'll go back to Pahrump. But Beatty is next.

Anthony Hechanova from University of Nevada, Las Vegas. Did I mispronounce your name?

HECHANOVA: No, you did it quite well.

COHON: Okay, good.

HECHANOVA: I really just have a couple of quick questions. The first question is on the NWTRB, is there a representative from the State of Nevada?

COHON: Does our membership include somebody who resides in Nevada?

HECHANOVA: Yes.

COHON: No.

HECHANOVA: Okay. I think something I hear, and for those who don't know me, I'm sort of the token nuclear engineer at UNLV. I have a Ph.D. in nuclear engineering. My research does not involve Yucca Mountain, so that kind of gives me a little bit of a different perspective, and I'm not too familiar with the NWTRB. That's why I'm asking the questions.

One question I have is is part of the problem I see is the perception and the communication with the public especially in Southern Nevada. Is there any part of a mission statement for the NWTRB that includes communication or public outreach?

COHON: Yes. And, in fact, we reviewed this, our Mission Statement, about a year ago, and subjected that to public comment at a meeting in Nevada. We didn't get a lot of comment, and we took that as an endorsement for our Mission Statement. But it most definitely includes outreach to the public.

HECHANOVA: Okay.

COHON: That's one of the reasons why we meet in places like Pahrump and Beatty, because we want to give especially those people most directly affected by the repository the chance to interact.

HECHANOVA: And just for my own sake, the way I find out about these meetings actually are from Sally giving me a call saying there's another NWTRB meeting. I'm not too sure how extensive your list is for Southern Nevadans.

And, finally, maybe one recommendation would be considering possibly having someone, a Ph.D. level person, on the Board from Nevada, maybe as a point of contact to interact with the scientific community in Nevada.

COHON: Thank you for that. Let me clarify one thing. All members of the Board are appointed by the President on the advice from the National Academy of Sciences. That's by law.

Would anybody on the staff like to respond to the point about how we disseminate information about our meetings? Paula Alford.

ALFORD: Yes, just by way before I just explain briefly our distribution lists and our mailing list, I'd like to apologize to Sally if we weren't--if you didn't receive any of our recent information, because you are on our mailing list and you should be getting everything.

We have a fairly extensive mailing list, but at this point, it is done mostly--it is kept up mostly by people who request to be put on the mailing list, and we update it annually. We also post everything on our web site. I would be more than happy to put anyone who's interested for meetings such as this, they're noticed in the Federal Register six weeks ahead of time. We send out press releases to everyone who's on our mailing list, as well as to selected newspapers, bi-weeklies, monthlys, here in Nevada. Whether or not somebody chooses to publicize the meeting, we only have limited control over, as you know, but we do go to great pains to make all of our information available to anyone who's interested, and to post it wherever we can.

The one thing that we do not do is we have not targeted individuals and gone out and done like direct mail, do you want to be on our mailing list. We do not as a federal agency do that.

COHON: We like people to come to our meetings, and we'll be happy to disseminate this information in any way that people would like to recommend within reason.

Bill Bernard?

BERNARD: Bill Board, Board staff. As many of you probably know, Frank Randall helped us in our outreach efforts to the public in disseminating information. Frank left the Board for a better position, and we do not have the funds to replace him. So we're trying to do with the staff that we have. I could have told you to look at our web site, but you wouldn't have found the agendas for these last two meetings until Friday, and I apologize for that.

COHON: She also wouldn't have found our web site. Thank you. Judy Treichel?

TREICHEL: Judy Treichel, Nuclear Waste Task Force. I'd be happy to help you with your communication stuff, too, if you want. I'll get it to you like before Friday, though. I don't want to have to do the Pony Express thing.

I have a couple of questions for John Greeves because he addressed something, had a whole viewgraph dedicated to something that I do all the time, and it's the proposed public outreach, and you mentioned the two meetings that are proposed to be here, and I wanted to know, we've had some unfortunate situations before with public meetings, and I wanted to know if the NRC is going to be willing and eager to have the public play a pretty big role in setting up the format for the meetings.

GREEVES: Judy, I'd like to talk to you and get some input on that. We're going to work with Chip Cameron. You know Chip.

TREICHEL: Yeah, I've been talking to Chip Cameron, but I wanted an assurance from you that if we wanted something that was particularly more friendly to interchange with people who come, if that would go through.

GREEVES: Judy, that's my goal.

TREICHEL: Okay.

GREEVES: So if you've got some suggestions, I'm open.

TREICHEL: Okay. And as the person that's probably going to play a big role, not the only role, but a fairly big role in getting people out and getting a wide range of people out, can you--the question I get all the time is that they don't know if it makes any difference if they go. What would you think would change? As you know from the exchange that went on here just with the Board, there's going to be some real questions and some discomfort with the proposed rule. I don't think anybody is going to be surprised with that.

Can anyone expect significant changes because maybe 80 per cent of those who interact with you at those meetings say that they believe the rule should be more stringent or say that they believe that there should be differences?

GREEVES: I'm not sure I caught the question. But we're going to come out and ask you to help us with the exchange with the people, because what we've done in the past, I don't find satisfactory. We've had meetings and we don't get a big turnout. So we've got to do better on that.

As far as impact, we do rulemakings all the time, and we listen. Things do change. And I'm sure we will, you know, hear comments about the various things we talked about today. Even the Board--Cohon was quite animated on at least one topic.

TREICHEL: Did he change anything?

GREEVES: First recognize I don't change things based on one set of comments, but what we do is we have this open period, and people who will send their comments in in writing, and we're taking an extra step to come out and sit down with key stakeholders, including you and the people out in the Valley, we don't want to just have a meeting here.

Although I will comment, and I believe, Judy, you even said that this forum right here is actually one of the most useful interactions with the stakeholders.

TREICHEL: The Board meetings, the Technical Review Board meetings?

GREEVES: These Board meetings.

TREICHEL: Oh, absolutely. Hands down, yes.

GREEVES: So that's in part why Tim McCartin was here today to go into the details, and this is part of the outreach process. And as I said, we'll come back tentatively in the March time frame, do a meeting here in Las Vegas, and out in the Valley.

TREICHEL: Well, I just thought this was an unusually good opportunity to be able to ask someone, and it happens to be you because it was your presentation, but I have been told before it's really too bad, it's really a shame that there aren't more people at meetings, at Board meetings, at NRC/DOE meetings, at various other meetings. It's really too bad we don't get real people and people out, and this has been going on in Nevada for a very long time.

Yucca Mountain is nothing new. But people are not eager to take evenings or take a long time just so that they can help make a transcript. They need to feel that something changes. They also need to feel that they have the right to say no, as well as to say yes. It doesn't do anybody any good to come out on one side of the issue if it's not allowed to be on the other side.

So if there are people that come to these meetings, I would like to be able to assure them that this is just something that's been thrown out that it really is a draft, and that there could be significant changes, and that it could be changed in ways that make a big difference. And I know you probably can't tell me that, but I would like that to go back to the Commission. And the EPA is going to be another one when they come out with theirs, and DOE is changing their rules, as well. I mean, we've got rules that are in limbo across the board, and people have to respond to each of those and have to be playing with the EIS as well.

So there's just this huge plate of responsibility out there, supposedly for the public, and if they can't expect that when they take their time and effort to go to something, that it really matters, then you're just not going to see them. You wind up seeing the demonstrations and the rocks and bottles, I suppose. But in order to avoid that, that's what has to happen.

GREEVES: Well, the short response is that the track record is that these rules do change. You've followed these programs, the other rules I was talking about. They go out for comment, and most of the ones that I've been familiar with have had some change from the proposal to the final, and

I'm sure the change made some people happy and made some others not so happy. So I expect there will be some impact in the comment process, and I appreciate anything you could do to make sure we have an exchange with the people, and we'll be talking to you, and the Board, I'm sure they'll have some comments.

TREICHEL: Okay.

GREEVES: So I appreciate anything you could do to work with us. And Chip I think has probably already talked to you about this.

TREICHEL: Yes.

GREEVES: Thank you.

COHON: Thank you, Ms. Treichel. William Vasconi from Las Vegas.

VASCONI: That's close enough. I'm Bill Vasconi. I'm a construction worker. I want to first of all thank the Board for coming to our fair city. You've spoiled the weather, but I hope you enjoy your nighttimes.

The last time I've seen some of you folks, you were at Amargosa Valley, and I want to compliment you one more time. That's still the most suits that's ever been in the Amargosa Valley.

I'd also like to thank the other committees that have come into being in the last four or five years. We've got some of those folks up in Lincoln County. You've got

Esmeralda County plugged in, and naturally Nye County. Nick does one hell of a job. I'm a 35 year resident of Nevada, and I appreciate those counties getting involved, letting you folks see what some of our other Nevadans can do that aren't scientifically, politically correct. We do get involved with the public.

The other thing I'd like to say is this. I came today and I wasn't going to speak, so I hold a reservation for maybe speaking tomorrow, but a lot of conversations I've been around, whether it be with Nevadans, keep in mind that this city you're in today with probably a 1,300,000 people, 50 per cent of them have been here less than ten years. You go to Yucca Mountain, and the terminology at Yucca Mountain, there's a certain amount of mysteria that goes along with it, even though a good many of those people that have been from out of state recognize the validity of a national issue that has to be corrected, an international issue that has to be corrected, you do have support from a good many Nevadans, a good many people in the United States and other countries. Like hey, move over, the guy in the third bunk on the aircraft carrier has some more spent fuel rods to put up there. Well, it's on the submarine, just put it out the end of it and discharge it into the ocean. Well, we've only got 104 of them, we've got 15 surface vessels, hey, we've got to resolve a critical issue, an environmental issue, rather than pass it on to another generation, and we know it.

But back to Yucca. Yucca Mountain is perceived as a dump. Years ago, we tried to use the terminology stewardship. We didn't get by with it, I guess. A good many Nevadans and other Americans want to see more conversation on the fact that we're going to build Yucca Mountain with today's alloys, today's technology, today's science and safety, today's science and oversight. What's wrong with saying 300 years, leave it open? What's wrong with saying we want moisture redux, radiation redux? What's wrong with saying we want ventilation? What's wrong with saying we couldn't use that same ventilation in the heat exchange to drive air turbines to create electricity? I don't know what's wrong with that.

I don't know what's wrong with saying let's make it retrievable so people will appreciate what we're doing with it. It could damn well be a natural resource some day. You know, I've heard a lot of conversations about climatic changes and what not, so I went to the library. I looked up ice ages. Well, I'm not a scientist, but them books tell me about every 10,000 or 12,000 years, we have an ice age. Now, three or four of them have been pretty traumatic. Central Park in New York City has scars across the rocks from an ice age about 10,000 years ago.

Well, I'll tell you what, folks, them people in

Ottawa, Detroit, Pittsburgh, Pennsylvania, New York, it's going to get awful damn crowded down this way one of these days. Now, you keep talking 10,000 years. I assume then you mean all the petroleum is still going to be around in 10,000 years. All the coal is still going to be around in 10,000 years. I lay fact that our technology, and I give our educational system a lot of credit, what were we doing 300 years, what were we doing 200 years ago?

You know, even 100 years ago, there were still ten states, ten territories that weren't states. We still had Indians that were prisoners of war. 300 years from now, I give our educational system more credit, they'll know a lot better what to do with nuclear waste than we're playing with right now. It probably won't take 300. Maybe it will only take 100. But let's not bury the nuclear waste. Let's preserve it, monitor it, take care of it. Let's get back to stewardship. You'll make old country boys like me that carried slabs on saw mills and shoveled shit on farms a lot happier about this whole thing.

COHON: Thank you, Mr. Vasconi. I apologize for butchering your name earlier. I simply misread it. I should have known better.

And just to show you that the Board does listen to public comment, your remark made to us at a previous meeting about the number of suits in the Amargosa Valley made a deep impression on us. And when we go to Beatty in June, you won't see a suit.

CARROLL: I just wanted to compliment Mr. Vasconi on his coat and tie today. He looks very sharp.

COHON: Touche. Very good. Thank you. Thank you, Mr. Vasconi. We appreciate your comments.

Steve Frishman from the State of Nevada.

FRISHMAN: Contrary to my normal practice, I just have one question that I want to ask, and the reason I want to ask it is because I think the answer may be instructive to both me and to the Board. And I don't know the answer ahead of time either.

i'd like to ask the representatives from the Nuclear Regulatory Commission, given the fact that you're trying to write a site specific rule and you have now seen the extremely large reliance on the engineered side of a repository system, what's the rationale for not including ALARA in the rule?

COHON: Whoever answers it might start by translating ALARA for everybody. ALARA is as low as reasonably achievable.

GREEVES: We use that term too often. It's really a concept that gets applied to operational activities. If you've got a medical laboratory or a research laboratory, it's part of the international approach. It's one of the four things people pay attention to that we really need to reduce doses as low as we reasonably can in that practice, an operating practice.

It is difficult to think in terms of ALARA for something out 10,000 years. So, Tim, help me if I get it wrong, but on the international discussion, you don't see people talking about ALARA calculations out to thousands of years. I don't know how satisfying that is in terms of part of an answer to your question, but that's what it's about. We will do ALARA for pre-closure activities, but you won't find that language attached to post-closure activities. Tim, if I've got it wrong, tell me.

The other piece, you were referring to so much reliance on the engineered system. I saw those charts yesterday, and I was struck with the magnitude of them, and as I showed them to Tim, those results do not line up with the results that we have, and at another meeting, we will be talking to DOE about what they showed yesterday. And I really can't address it much further at this point in time.

I expect you will be at the meeting when we do discuss it though.

FRISHMAN: I expect I will, yes. Well, I think the reason it came to mind is that the container is in the 10,000 year period anyway, whether strictly by definition or not, the container is an operational device, at least within the

10,000 year period, and the Department hopes much longer than that. So the reason I raised the question is I don't think it's as easy to escape as you've tried to make it.

GREEVES: I expect we're going to get a comment or two on it. And I think what you were addressing in the ALARA concept attached to a calculation out to thousands of years. So I expect you'll make that comment, and we'll be addressing it. But I gave the answer, and, Tim, if I had it wrong--

COHON: Thank you for the question, Steve. It was very interesting.

FRISHMAN: Okay.

COHON: Jerry Szymanski, we're happy to welcome you back.

SZYMANSKI: Well, likewise, I'm very pleased to see you.

Essentially, I have a comment. It pertains to data which was obtained by the county, and you can blame Dr. Peterman for this, for me taking some time. But I would like to get across one point, that hot water is very important. That's where I started about 20 years ago. Now, what is it? What is the process?

There was a very traditional--in the United States Geological Survey. The water is coming from below. Now, obviously it does because it is hot. But what is the process? And what they are thinking about, it is a forced convection, but that's only one possibility. There's another one. It's a thermal convection. Now, why is it important? Because in the first case, we are talking about an equilibrium system. That is a system which has an attractor as a point. Now, these systems are very robust, and they are notching into perturbations. The entire DOE effort is based on this perception.

Now, when we get to another possibility, and there is no date on it, this is just pure a priori assumption that this is a forced convection, so let's consider the other possibility. It's a thermal convection. Such a system is a disequilibrium system. There is a term of disequilibrium. Its attractor is not a point. It could be a second dose, multi-dimensional dose, or it could be climatic.

There is another question, that if this is a thermal disequilibrium which is being expressed from this standpoint, there's the next question, does a level of disequilibrium remain fixed in time, or it is changing. Now, this has a question, and why? Because if we are dealing with disequilibrium system, which is in the--level of disequilibrium, at the end, we are looking at the little--I underline little--doses of radiation.

In the case of an equilibrium system, nothing will happen to it. We'll be talking about some of this very small dose. So now how are we going to find out which one of these two cases are we dealing with? Well, there are two ways to do it. One is to look at the time series of parameters which are expressed in level of equilibrium of disequilibrium. It can be temperature. It can be chemistry. It can be isotopic composition. If we find out that the parameters fluctuate in time, that is, it's not constant, we've already established that this is a thermal convection. It is not forced convection. The assumption is false.

So the next question is does the level of disequilibrium remain fixed in time. Well, again, there are two possibilities, either it does or it doesn't. If it doesn't that system once in a while operates all the way up to the ground surface and beyond. So it is very crucial to determine which one of these possibilities are we dealing with. If you are looking at the observations, we need to probably look at them for 100, maybe 200 years.

There's another possibility, that is to look at the behavior of a system over let's say for time, and that's why this calcite silica deposits are so crucial to our understanding of the dynamics and behavior of the Yucca Mountain system. And I do submit after 20 years--which I had done at Yucca Mountain, it is my very firm conclusion and belief while looking at the thermal convection, while looking at the system which was done, becomes more and more sensitive to perturbations. And let it be an earthquake, let it be a volcanic injection of very small dimensions, and that I would like the Board to understand that this would be a crucial question which we at the Attorney General's Office of the State of Nevada would be seeking a resolution of. And if we have to, we'll have to go to the judicial system.

However, the perception Dr. Peterman expressed, that is it is forced convection, has no basis whatsoever. So by proceeding with this, we may as well assume that everything will be fine, without pretense and expense.

Thank you very much.

COHON: Thank you, Dr. Szymanski.

Is there any desire to continue that particular discussion? Seeing none, any other public comment?

(No response.)

COHON: I thank you again very much for your comments. Thank you again to Paul Craig for his chairmanship, and to all who participated. We'll reconvene at 8 o'clock. Coffee at 7:15 for those who care to join us. Thank you.

(Whereupon, at 5:46 p.m., the meeting was adjourned.)