UNITED STATES

NUCLEAR WASTE TECHNICAL REVIEW BOARD

SUMMER BOARD MEETING

June 24, 1998

Crowne Plaza Hotel
4255 South Paradise Road
Las Vegas, Nevada 89109

BOARD MEMBERS PRESENT

Dr. Jared Cohon, Chair, NWTRB
Mr. John W. Arendt
Dr. Daniel B. Bullen
Dr. Norman L. Christensen, Jr.
Dr. Paul P. Craig
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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I N D E X

P R O C E E D I N G S

COHON: Good morning. My name is Jared Cohon. I'm the Chairman of the Nuclear Waste Technical Review Board. It's my pleasure to welcome you all to this summer meeting of the Board here in Las Vegas. I would begin by introducing the other members of the Board, as well as myself, each of whom serves on the Board in a part-time capacity. Every one of us has another job, usually full-time, and in some cases like mine, more than that. I am, in addition to chairing the Board, am president of Carnegie-Mellon University in Pittsburgh.

I want to start by going out of order. We usually do this in alphabetical order, but I want to welcome to the Board a new member of the Board, Don Runnells. If you could turn around so they can see you? I would ask each member to stand up when I introduce you so everybody can see you.

If the press is to be believed, and of course we invariably read the press, Don's appointment was approved just this week by the White house. We have yet to get direct communication from the White House, but we're confident that the news is true, that Don was appointed by the President in fact yesterday. Don retired five years ago from the University of Colorado in Boulder, where he had taught for 25 years. His expertise is in geochemistry, and we're delighted to have him as a new member of the Board.

Although other members are now veterans, having served for at least several months, I would nevertheless like to introduce them to you.

John Arendt, a chemical engineer, retired from Oak Ridge to form his own firm. He specializes in many aspects of the nuclear fuel cycle, of which standards and transportation are two particular examples. He chairs the Board's Panel on the Waste Management System.

Daniel Bullen is in the Mechanical Engineering Department at Iowa State University, where he specializes in nuclear engineering and, in particular, nuclear waste management. He chairs our Panel on Performance Assessment.

Norm Christensen is dean and professor at the Nichols School of Environment at Duke University and brings expertise to the Board in the areas of biology and ecology.

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

Debra Knopman is director of the Center for Innovation and the Environment in Washington. She's a former Deputy Assistant Secretary of the Department of Interior, former scientist and science manager at the USGS, and an expert in ground water hydrology. She chairs our Panel on Site Characterization.

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

Richard Parizek is professor of Hydrologic Sciences at Pennsylvania State University, and an expert in geology and ground water hydrology.

Alberto Sagüés is professor of civil and environmental engineering at the University of South Florida. He's an expert on materials and corrosion, with a 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 EPA in Sacramento. He is an expert in risk assessment and chairs our Panel on Environment, Regulation and Quality Assurance.

As you know, we're supported by a very competent and energetic professional and administrative staff, who are arrayed handsomely along the--to my left here along the side, and in the back and front of the room. I'm not going to introduce them. Many of you know them very well already. I just want to note that we rely extremely heavily on this staff, both for his wonderful expertise and its continuity.

Let me continue by thanking especially Lake Barrett and Russ Dyer, not only for being here today, but for having spent a full day, a very full day with the Board yesterday on a field trip to Yucca Mountain and Busted Butte. They and their colleagues put in a tiring, we have to acknowledge, but in the Board's view, a very productive day visiting the locations where important site characterization studies are being conducted.

I'd like to convey the Board's thanks also especially to Claudia Newberry, who's in the audience, I saw her earlier, and her colleagues for putting together the day. It was not easy with the logistics of so many people. We thank you very much for that.

As I'm sure everyone in this room knows, DOE will be publishing this fall its Viability Assessment for Yucca Mountain. And as almost everybody, if not everybody, knows already, the Board has been following this effort very closely through our meetings, both board meetings and panel meetings. We have, over the last year, been looking at studies of the unsaturated zone, the waste package, and the saturated zone especially. Today, we'll be taking a more systems view, if you will, in examining the program's activities, especially with regard to what the VA may be able to tell us about the important issues to be resolved before a suitability determination can be made. We appreciate DOE's efforts to create a coordinated set of presentations on this theme.

Lake Barrett will present an overview of the opportunities and challenges the waste management program is facing. Lake will be followed by Russ Dyer, who will talk about the safety strategy the DOE is pursuing in developing a potential repository at Yucca Mountain.

Following lake and Russ, Bob Andrews will discuss work on total systems performance assessment being prepared for VA. He will talk in particular about the sensitivity studies that are attempting to evaluate how repository performance might be affected if enhancements to the engineered system, such as drip shields, backfill and ceramic coatings, were incorporated in the repository reference design.

Following Bob, the Board will hear from Mike Voegele with assistance from Jean Younker, who will discuss plans for analyzing alternative repository designs that might be carried forward into licensing.

After lunch, Jack Bailey and then Jean Younker will make presentations on what DOE believes still must be undertaken between VA and a determination about whether Yucca Mountain is a suitable site for developing a repository.

Part of that Presidential decision on suitability will be based on an environmental impact statement. Wendy Dixon and Lee Morton will brief the Board on work being done to prepare that document, especially about the design alternatives that will be analyzed.

The day's presentations conclude with a talk by Nick Stellavato and Parviz Montazer on work being conducted independently by Nye County in the saturated zone and with respect to alternative repository designs.

We will have two opportunities for members of the public to make comments and ask questions. Now, the distributed agenda only shows one such opportunity. Let me point out that we will have a brief 15 minute public comment period just before the lunch break, so at approximately noon, and then a longer more extended one, basically an open ended one, at the conclusion of the technical presentations. The brief one at noon is intended for two purposes in response to what we've heard from members of the public after the past meetings. On the one hand, we want those members of the public who cannot stay for the whole day to have the opportunity to comment at that time.

In addition, because it is often more valuable to make comments earlier, and especially closer to when the presentation has been made, we consider that earlier opportunity somebody considered an advantage.

We ask if you're interested in making public comment that you sign up with Linda Hiatt at the rear of the room. There's a sign-up sheet. It's not essential, but it's appreciated by us if you would do so.

I'd like to make one final comment about Board members, including myself, and the comments we will make during this meeting. We're often asked do the comments made by individual members reflect Board positions. It's a question that comes up almost after every meeting, and I think it comes up because what the Board has to say matters. It matters greatly. The Board conveys its findings, conclusions and recommendations in writing in the form of formal reports, letters to Congress and/or the Secretary of DOE and/or the Director of the Program, and also in written Congressional testimony.

We attempt to run these meetings, and those of you who are veterans of them I think will agree, in an open and unconstrained manner. Board members are encouraged to ask many questions, and this set of Board members does, and to make points that they believe are relevant to the proceedings. But comments by individual members are just that. Whether they become a Board position, those individual comments, only time will tell. To ensure that a consistent message is sent from the Board to the Program after these meetings, we will continue a practice that we started about nine months ago by sending to Lake Barrett a letter summarizing what the Board as a body took away from the meeting. Anyone interested in obtaining a copy of past letters, should contact one of our staff members and we'll be happy to provide it to you.

As you know, these meetings are on the record. So I would ask all presenters to speak clearly into microphones, whether it's in the audience or up here, and in the case of commenters, members of the public who wish to ask questions, we ask that you start by telling us who you are.

Without further ado, I'm pleased to introduce to you Lake Barrett, the Acting Director of the Program, of the Office of Civilian Radioactive Waste Management.

Lake?

BARRETT: Thank you, Jared. Good morning, Board and Staff and members of the public.

First of all, the comment that I think the American people should be very grateful to the Board for putting--from 6:00 a.m. till 11:00 p.m. at night, the whole Board out there, some folks coming in with nine hour time lags from Europe. Also that was very impressive and you all asked good questions all day long. So you really are doing the job well, and as a citizen of the United States, I thank you.

Yesterday, you saw many of the things that we're doing out there. I think that will be very important as you provide good quality input to the Congress and the President. You will be hearing from members of our contractor and DOE staff later on today, and I'd like to also thank the Board for including Nye County presentation today. I think that will be very helpful to all.

What I'd like to try to do is cover a little bit of the issues that are going on around the waste management program that have impact on the waste management program, talk a little bit about the approach and what we're trying to do within the Department of Energy, and then end up talking a little bit about some of the systems points that you have in your topics and agenda.

First of all, I'll summarize a little bit about some of the Congressional actions that have been going on. Last year, the House and Senate passed bills that call for the development of interim storage facilities in Nevada with differing provisions. Due to the constrained legislative calendar, Congress chose to pursue a compromise bill in lieu of a conference committee to resolve the differences between the chambers. But in the Senate, a cloture motion to limit floor debate failed to achieve the required 60 votes. Just prior to the vote, Speaker Gingrich announced his intentions not to schedule a House vote on nuclear waste legislation this year. Consequently, this Congress is unlikely to present comprehensive nuclear waste legislation to the

President this year. The basic drivers for the legislation, however, still remain and the proponents have indicated an interest to continue their legislative efforts in the next Congress. We will all have to await and see what those future developments will entail.

On May 5, 1998, the United States Circuit Court of Appeals for the District of Columbia rejected petitions for rehearing the court's decision that the delays clause in the standard contract provides a potentially adequate remedy to the contract holders, that's the utilities, for the Department's failure to begin disposing of nuclear fuel on January 31, 1998.

The decision also denied a request from the utilities and the states to escrow Nuclear Waste Fund fees. The Department continues to explore approaches to resolving this issue in a fair and equitable manner to all parties. On May 18, 1998, the Secretary proposed a settlement with the utilities which would postpone collecting a portion of the utilities fees to offset utility costs due to the Department's delay.

The proposed settlement was not considered adequate by the utilities. As of last week, eight utilities have since filed suit against the Department in the Court of Federal Claims, seeking more than $2.7 billion in damages. The Department of Justice, on our behalf, has petitioned the

Court of Federal Claims to dismiss the utility lawsuits until administrative remedies under the standard contract have been exhausted. Regardless of the legal maneuvers, I hope that a mutual accommodation can be created by a dialogue among the parties, possibly as a follow-up to the Department's May 18th offer, or some other mechanism.

The President's Fiscal 1998 Budget seeks $380 million for the program. This funding would enable the program to continue implementing the revising program plan as refined by the information gained during the Viability Assessment work that's presently ongoing. The President's budget emphasizes the site characterization of Yucca Mountain.

The Committees in both the House and Senate have completed the mark-ups of the President's budget. The Senate Appropriations Committee proposed $375 million for the program next year, with $15 million set aside for research in advanced accelerator technologies, and approximately $5 million provided each for the State of Nevada and affected counties for oversight.

On the House side, the House Appropriations Committee proposed $350 million for the program, and did not include funding for accelerators nor the state nor the counties. They've also directed the Department to reduce support service contractor work by 10 per cent. This will have some serious negative impacts on the program, especially in areas such as the EIS, but we're working with the administration. I'll note that the President's statement on administration policy did call out the President's concern with those reductions in his response last week.

Stable funding is critical to the efficient and effective completion of the site characterization program. Over the last three years, the program has successfully implemented a focused site characterization program that has resulted in substantial progress, as you saw yesterday, toward a national decision in the geologic disposal at Yucca Mountain, despite the FY 98 budget reductions. This progress has been achieved at a significantly lower cost than previous estimates. Reliable and predictable funding is central, however, to the dynamic planning process that we use to manage an effective technical program.

Over the past year, I've appeared before this Board a number of times to discuss the status and plans of the radioactive waste management program. In those discussions, I emphasized our focus on completing the viability assessment this year. Assembling the enormous volume of data in a coherent and workable repository concept has been a significant challenge and accomplishment for the program. We're in the final states of completing this work and we expect to deliver the viability assessment for the

Secretary's review this September on schedule. The completion of the viability assessment will effectively mark the midpoint of the five-year plan to complete the site characterization under the revised program plan.

Our plan calls for a substantial effort after the VA to complete the site characterization, to continue our design activities, which we'll talk about in some more detail, and to develop and document the technical bases for a Secretarial recommendation of the Yucca Mountain site as a potential geologic repository. Supported by adequate funding, our plan should provide the sound basis for a national decision on geologic disposal in 2001. The plan includes publishing a draft environmental impact statement in '99. Wendy Dixon will discuss this in more detail this afternoon with you.

In general, the environmental impact statement will describe the environmental impacts of a Yucca Mountain repository under a bounding range of implementing alternatives. Following public hearings and consideration of comments, as required by the National Environmental Policy Act, we will publish a final environmental impact statement in 2000. Should the technical information assembled by the Program indicate that geologic disposal at Yucca Mountain is an environmentally sound approach to the management of radioactive wastes, we will complete the evaluation of the site and prepare the technical documentation necessary for a site recommendation in 2001. Should the site be designated under law, we would submit a license application to the Nuclear Regulatory Commission to construct the repository in 2002.

Yesterday, you visited a number of the ongoing technical activities. These scientific activities, coupled with our design and engineering work, and our performance assessment activities, form the core technical program that supports the site evaluation, the environmental impact statement work, and the license application work. The use of a single technical program to support all the products ensures a consistent technical basis for all the decisions that we make.

A significant portion of the work completed after the viability assessment is associated with the repository and waste package design. Your recent correspondence notes that we should develop viable alternatives to the current reference repository and waste package design, and that those alternatives should evolve over time as our understanding of the site and the interactions between the natural and engineered systems further evolve. We agree the repository and waste package designs should not be prematurely fixed, and other potential design options should not be foreclosed. These advanced design activities are an essential part of the technical work planned after the viability assessment, and will be described in detail by Mike Voegele later this afternoon.

Our basic approach has been to focus first on developing site information required to design a site-specific repository system and to be able to assess its performance. That includes the environmental performance as well as the costs for that facility. The Board's recent report emphasizes the importance of both natural and engineered barriers to repository performance. We agree, and our analyses demonstrate that the performance of the engineered and natural barriers are highly interrelated and cannot be evaluated in isolation of one another. Our efforts also indicate that advanced design work, including the meaningful evaluation of alternatives, requires an increased understanding of the site and the development of detailed process models that were previously unavailable.

We recognize performance benefits that may be achieved with design options and alternatives. We are careful, however, not to prejudge these design analyses. Systematic evaluation of design options and alternatives are inherently complex. These analyses often involve complex tradeoffs that must be carefully evaluated to understand the system performance impacts and costs. Analyses of our reference design and various design alternatives also reflect our obligation to provide defense in depth as required by Nuclear Regulatory Commission regulations. No single silver bullet can be allowed to become the sole or principal basis for the safety of the repository, because the Commission's approach to defense in depth and reasonable assurance will require us, and properly require us, to analyze the consequences of the failure of a single silver bullet.

We recognize that while enhancements may provide expectations of improved performance, they cannot provide absolute assurance of complete containment of radionuclides for many thousands of years. Such assurance is beyond what science and engineering can likely provide and defend in a licensing proceeding. It is important that knowledgeable parties, such as this Board, which I consider probably the most knowledgeable national party in this area, strive to ensure that policy makers understand the limitations of scientific predictions. Otherwise, the repository may be saddled with expectations for performance that cannot be demonstrated in a licensing proceeding for this site or any other site in the world. Such expectations could result in the rejection of an otherwise suitable site, and the de facto rejection of the geologic disposal option. Such rejection will not avoid the consequences of long-term radioactive waste management. It will simply require society to resort to a new and different and currently undefined approach that none of us really know would be.

As I mentioned earlier, the Program is approaching the midpoint of its five-year drive toward completing site characterization. Later this year, we will complete the viability assessment and submit it to Congress and the nation, and it will provide all the parties with a better appreciation of the geologic disposal option, and will provide a sound basis for the planning and implementing of the remaining technical work necessary to evaluate the site, prepare environmental impact statements, support a site recommendation, and prepare a license application if the site is determined to be suitable. With adequate funding, the program is poised to complete this work and support the national decisions regarding the Yucca Mountain site.

Thank you for the opportunity to appear before you this morning. I again thank you for your energy yesterday on that long tour. I will try to address any questions that you may have at this time.

COHON: Thank you very much, Mr. Barrett, and thank you for your kind remarks with regard to the Board.

Are there questions from members? Paul Craig?

CRAIG: Well, I certainly want to thank you, Lake, for the wonderful tour yesterday. Everybody was wonderful. It really was a great trip.

I was struck yesterday by something that struck me in the past, and I'd like to ask you to react to the following idea. When I go out to Yucca and I look at it and I listen to our geologists and your geologists talk about it, it looks pretty darned good, and in general, it seems to look better than it appears in your technical documentation. Now, Abe Van Luik properly points out that pluvial conditions change things. Nevertheless, yesterday we went to N site, and I've also been to Los Alamos, and those places are considered to be examples of places which have pluvial conditions. And even taking that into account, it still seems to me to look better than it looks in the documentation. What I'd like to ask you to do is to react to that perception.

BARRETT: Well, I believe that we all--the TSPA work we're doing, basically call those expected values. Now, one of the things that we know we're going to have to do in this country is go through a licensing procedure. I mean, whoever is proposing to go with a facility such as the Yucca Mountain repository has to be able to demonstrate to the American people and the world that this is a--thing to do, considering future generations, responsibilities, environmental protection, and all of those issues.

One of the things when you start to assemble the information as to what that would be, there is a national tension between what you really think the situation is going to be and then what you can be able to sustain and demonstrate in a licensing procedure. Our team will be called upon to demonstrate before basically Doubting Thomases who will say I don't believe that's true. You demonstrate to me that that is true. There becomes a difference there, and I think what you will see when you talk to our scientists who will be working in a particular area is--I really believe it's going to work this well, but then when it gets fed into the TSPA, some of the conservatism starts to set in a little bit. We try to keep this separate, focus between a licensing case and what has always been the value case. You will start to see in presentations whenever you see the TSPA, curves out, you'll start to see a footnote on all of those that are going to say these are our expected value cases. These are not necessarily what you can sustain in a licensing process. We're working on that footnote now that appear on all those curves, so people do not misinterpret those curves.

Now, in reality, I will need the real--it will be less than those expected value curves, for a lot of the reasons that you see as you walk around. But it's very difficult when you're looking at basically present day conditions which are dry, and then you say, well, we're going to have, when we go into the next ice ages, and that's really what drives this, is the next ice ages, then how much will it change, and none of us really know yet, and science will not give conclusive answers on this. So it's natural that you will find, I believe, that are expected values would be a little on the conservative side. If they are not a little bit on the conservative side at this stage in the game, if we are overstating the case, we will be accused of you are not telling the whole truth on this. That was biases science. You're trying to skew this toward site suitability, and then i think the whole thing starts to come apart. So I think we are extremely careful in our work that we do not show any bias for forcing this site to work. So we constantly internally caution ourselves to be cautiously conservative in our expected value numbers, because I'd rather err a little bit on the high side than trying to overstate or dismiss a theory that would say this is not going to work so well and it's not a suitable site. So we intentionally have a little bias, which I think is appropriate. So I am comforted by the fact that when I walk around and talk to our scientific community, that they feel it's going to do better, and they say you're too cautious. I would much rather be cautious and understate than overstate the ease of this that lies before us. This is not an easy endeavor.

COHON: Dan Bullen?

BULLEN: Bullen, Board.

Lake, you commented that our Board has encouraged you to carry along alternative designs and alternatives to the disposal options, but you closed your comments by saying with adequate funding, you could do these things. Is the funding adequate next year to carry the alternatives? And do you see the 350 million or 375 million, depending on which House appropriation comes through, as adequate to address all the needs necessary, including the alternatives?

BARRETT: Funding is never adequate. It is never, in this society, there is never the funds available for any particular endeavor to do what you would like to do. Our desires and our absolute necessities is where the difference is. Basically it's about the same number, usable dollars. If the money in the accelerator work out of Washington, as far as the Yucca Mountain business, I believe there is adequate funding to do the basic needs and proceed on as scheduled. It is not enough to do some of the design work and some of the things that I would like to do and I believe the Board would like to be done, but I believe with 350, we can find something--this was not my first choice, but it's one that I can live with and it would be an adequate job to proceed on to support the EIS and support the decisions. So i believe it will be not what I wanted, not what I desired, but it will probably be adequate.

COHON: Debra Knopman?

KNOPMAN: Knopman, Board. Lake, I think it might be helpful for the Board to hear a little bit more about your view of the concept of defense in depth. We all talk about a repository strategy that relies on some combination of natural and engineered barriers, but it would be helpful for us to know if you have some bounds on what that notion of defense in depth actually means in terms of relative emphasis of natural over engineered systems, and how that may change over time.

BARRETT: Okay. Just a little bit, we're all somewhat formed by our background and our previous experiences. One of the things I used to do was reactor safety engineering once upon a time in the dark ages, and I remember lots of discussion on reactor designs about the primary coolant system contains the fuel, the fuel can't melt, and then we put a containment system that assumed the primary system let go and it did melt, and that this--how much society should spend on these things, et cetera, and basically--I was in the Nuclear Regulatory Commission at the time, and we had a fairly--a defense in depth where you assumed the primary coolant systems failed and the containment worked, and then we had stylized models with those calculations, and a whole process.

Then along came Three Mile Island, number two accident, which I was involved in in response to, and I was the Director of Cleanup there for four years, and I saw what happened and I saw the melted core--and here, in a situation where the off site doses were very small in Three Mile Island, because the containment system worked very good, and thank goodness to us all that it worked very, very well, because they basically through almost an incredible scenario of man and machine and mistakes, basically melted the core.

I became very much a believer in the defense in depth concept of do not put all your eggs in one basket on anything, because something can go wrong. Now, Murphy's Law is there. So when it comes--you relate this over to where we are in the repository, I believe we should strive toward using engineering features to the best we can. Now, if that's multiple barriers and different arrangements, consolidate, not consolidate, which barrier is on the outside, inside, those things we'll work out as part of the, I hate to say the word optimization, but with the change in--work toward the best. But I am a firm believer that we should not depend on the engineered system, we could put this anywhere, because some of that stuff may go wrong for reasons we don't know thousands of years into the future.

Natural system is the same thing. You know, we should spend a lot and look at where we are in the natural system. I think the Yucca Mountain natural systems are good. I think there are other sites that have good systems too, and you don't compare, you know, compare sites. There are no best sites; no such thing. But I think we need to kind of constantly have a balanced program, balanced between our natural sciences and the engineering aspects. It is a constant thing in our budgets as we basically struggle with not our desired budget, but basically a reasonable budget; what is the proper balance. We have very spirited debates and discussions in our family, both the DOE and the contractor family, of what is that right balance. And this gets into the defense in depth of trying to have a balanced program.

So I think we do a lot of the, and you'll hear more from Bob Andrews, we do sensitivity studies, what if it's wetter, what if it's dryer, what if it's this, and what if it's that. Dr. Muniz, our Deputy Secretary, asks questions, well, I don't have a lot of faith--what if there is no outer containment, what if this, what if the packages fail at X-thousand years, et cetera, a lot of those sensitivity studies. I think we should do those, and this goes around defense in depth, present those to everybody in an open, transparent program, to see what that is. And, yes, you may find that doses are tens of millirems, hundreds of millirems, maybe thousands of millirems under some scenarios out at X-hundred thousand years, but I think it's--the process of the higher system, similar to that of the reactor plant.

Yeah, you know, the numbers may be this or that, but we are not really providing an insult to the future generations that is unreasonable, given the risk that today's society must face and future societies must face, wherever we are, and not to foreclose options in the design. Because I believe that technology will either continue forward or it will decline. It will not stay the same, in my opinion, and I think we need to compare it to either one of those future scenarios, and hopefully technology and society will continue to advance as it has, you know, for the last thousand years since the dark ages.

You know, we should be able to accommodate those sorts of things in a reasonable way as we go forward. If one looks at the changes in technology over the last 50 years, truly the last ten years, you know, we should not be technologically arrogant as we plan into the future. So I don't know if I directly addressed your question, but that's the best I can do.

COHON: Norm Christensen?

CHRISTENSEN: Thank you, Lake.

I want to first of all agree with you wholeheartedly about the, I'm not sure you put it this way, but the potential tyranny of precise expectations, and I'm wondering if in fact this doesn't call for something in the way of an explicit plan for adaptive learning management that would be driven by prioritization of key uncertainties, coupled with an understanding of assumptions that particular protocols or management options make about those uncertainties. And I wonder in fact if you see that as being a prominent part of either VA or LA. I think it's, I guess from my view, really critical, particularly given the considerable uncertainties that are likely to exist in certain areas over the next at least few years.

BARRETT: I believe we're sort of doing that. We have not explicitly laid this out in a plan per se, but I think we'll be discussing later today in some of the technical discussions. The TSPA work has been a driver and influence to where we are going, and it is a constant interaction between the natural sciences, the engineering sciences and the total system performance. You look at the entire system, and it's a complex system. And in that, we do a lot of the sensitivity studies; what if this, what if that. And these are somewhat geared to the uncertainty. How certain are we about this factor, be it natural or be it engineering, and how uncertain are we, and then we do the sensitivity studies to see what difference does it make.

We have found some cases that on a parameter, you know, we may not know what precisely for many orders of magnitude, but if you do the upper bound, it doesn't really matter. So, therefore, we don't spend vital resources much on it. So we're trying to do that, and the uncertainty is coupled into those discussions. I think there may be some dialogue and discussion on I think we call it Table 2-4, which is sort of what the various attributes of the safety strategy are and when we--you know, high, medium and low. I know the Board has discussed that, and we have as it steers the program.

So really I believe our program is responsive to the uncertainty factors as we try to balance these out, and it's very subjective. I know that our family does that as a highly qualified core of scientists and engineers who only in a dialogue together can kind of reach some of the just right temperature, not too hot, not too cold, just right, and just right balance on these things. Now, we have not put this together as sort of an overall management plan along the lines you mentioned. It's something we will consider doing.

COHON: Jeff Wong?

WONG: Lake, can you provide the Board with some comments or your views on the need for and the current status of the U. S. EPA standard?

BARRETT: The EPA standard is specified, that process is specified by statute, by law. Clearly, one of the things that is not concluded yet in the United States society is how good is good enough for how many thousands of years in the future. Basically the process is set out in the Energy Policy Act of '92, which says that the National Academy was to provide guidance. They did that in a report in '95. The next step is the EPA is to prepare an environmental standard, site specific standard for Yucca Mountain based on that guidance. It is guidance; it is not, you know, you must do that.

The EPA is in that process of developing that standard now. Once the EPA standard is completed, the Nuclear Regulatory Commission will revise their regulations to incorporate that. That will be I'm told is a new reg. within the NRC 10 CRF 63, and then that is what we will be measured against. You must demonstrate you are that good if you are to proceed with this endeavor.

So the EPA standard is really the central part of what is how good is good enough for environmental protection for X-thousand years in the future. That is under way by the EPA. They have had hearings. They have received input. They have received input from DOE, from the Board and from many others as well, and they are considering that and they are working on a standard that would be submitted to the OMB for the formal inter-agency review process, which is established under Presidential Executive orders. They have not yet done that. I know that they are working on it.

We are in dialogue with various folks as to what is the current state of technology, what technology can and cannot do, and then they will have to do the subjective, how good is good enough, protecting future generations as well as current generations to try to go forward and make those national policy judgments, and they're working on it and they're working on it diligently. Exactly when that will happen, I do not know. That is really controlled by the EPA, as it should be, and it will be submitted to inter-agency review when the EPA is ready. That's about all I can say and know.

COHON: Lake, I have a brief comment and question.

I was pleased to hear you use the word suitability so many times in your statement and referred to the necessity of that step where the Secretary may recommend to the President the site. There is a tendency, an understandable one, for the program to focus on LA as the milestone, and when that happens, there's a tendency by, I'll speak for myself, not for the whole Board here, to infer that the program is not paying sufficient attention to suitability which must be attained on the way to LA. I don't mean to make you repeat yourself, but I'm going to ask you to repeat yourself just to expand on that a bit about the importance of suitability and the necessity of passing through it on its way to LA.

BARRETT: Thank you. That's an excellent question and I'm glad you asked that.

This is--an understandable thing will happen in basing a work plan, and it goes something like this. Where I sit and live, the next important piece of business is get the EISs done. Okay? And those are really secondary, but important documents. The big issue will be implementing 10 CFR 960, which will say this is a suitable site and here is the technical basis for it. That will go to the Secretary. If the Secretary at that time believes that is done properly, the Secretary may conclude that the mountain is not suitable. Based on what I know so far scientifically, I don't see that, but it could. Okay? Especially when one doesn't know what the EPA standard is in the NRC regs, which is a determining factor in the suitability of the site, regardless of the existing 960 or proposed 960. It doesn't matter. That's still the essential part. Then if it's suitable, then there's the political process happens and then you go to the LA shortly thereafter.

Now, in planning--that's how I see it. So, the next important thing is going to be that site suitability decision. Now, if you go and talk to a scientist or an engineer who's working out here diligently at Yucca Mountain, what are they really thinking about? Well, they are looking at planning the technical work, the scientific work and the engineering work. What drives that is not an etherial thing called suitability decision. What really drives that are the technical precursors that are necessary for that. Well, what is the most important drive in one of those? It's the LA.

Because one of the parts of the site recommendation is a letter from--and this is in the statute of '82--is a letter from the Chairman of the Nuclear Regulatory Commission that says I have reviewed the technical work that the Department of Energy is ready to submit to the President, and I have concluded or I have found, I forget exactly what the word is, that the technical work is sufficient for a license application. And that's necessary in the suitability.

Now, we all know the core of this is really the scientific suitability, and that really is a judgment very heavily weighted by the Nuclear Regulatory Commission's views that that is sufficient for a license application. It will be heavily weighted by the views of this Board. It will be heavily weighted by the views of the governor of Nevada and all the various parties as well at that time. So when it comes time to really planning the work, how much engineering work, alternative work versus natural science, you know, they all look really to that LA.

So I am not disturbed when I hear all the Yucca Mountain folks never say the word suitability and say with the LA, we've got to do this or we have to do that, and the balance of this, to me that's comforting. It doesn't bother me at all. We are now, as part of the--now, the VA has been our focal point, and appropriately so, and I don't want to overload the system by saying I want you thinking about the next thing. This is sort of like, it's not football season, but I use the football analogy, we are a team in the Super Bowl running, we made the playoffs. Okay? The first game you've got to play is the wild card if you're the wild card team, and you must win that. If you don't win that, you're out. Okay? That to me is the viability assessment, is the wild card playoff.

Now, if you win that, then you go to the next game. The next game would be the division championship. That to me is the site suitability. The game after that is the conference championship. Okay? That really is the LA. And then the real Super Bowl is the construction authorization. In LA, you were successfully brought through the completion, and you cannot overlook the next game, so you cannot be looking to the LA all the time. You need to look at suitability is really the next game. So you have to kind of watch this thing and get the team on the right balance. But I don't try to influence the technical side of the house too much to say suitability is the next game, team, we are now going to start doing that, because I did not want to detract from the game right now, the viability assessment. Because if that's not a sound state of the art unbiased scientific technical document, it's over. And I believe it's going to be exactly what we've said it's going to be, and then we're going to move on. So I believe you will find more talks from the family, we'll say, a little more suitability, but not too much, but it's still the basic technical engineering work, scientific work is primarily driven by the LA work.

COHON: Thank you. That's very helpful. I'm trying to decide if the Board is the people in the striped shirts or the football.

BARRETT: When we figure that out, we'll let you know. It's the folks with the zebra shirts, if they don't make the right call, and Debra is set for the game.

COHON: We might just adopt this as our standard business.

Lake, thank you very much for a very useful and helpful presentation. We appreciate it.

BARRETT: Thank you very much.

COHON: I'm pleased to inform everybody that we now have in hand a hard copy of the White House press release announcing Dr. Runnells' appointment as a member of the Board, and we're delighted.

I now call on Russ Dyer, Project Manager. This is our first opportunity, it's our first Board meeting since Russ's appointment as Project Manager, so it gives us an opportunity to say congratulations and welcome to the job.

Russ is going to talk about repository safety strategy.

DYER: Thank you very much, Dr. Cohon.

I'm doing sort of two functions today; one is the technological guinea pig, because we're going to try something new. We're going to try an electronic power point presentation here. But in the spirit of defense in depth, we have printouts on the back table in the back.

And the second role I have is the opening act, as they say here in Las Vegas, for the project presentations to follow. What I'm going to try to do is set the context for these following presentations, and in the course of that, give a--I'm going to revisit a little old history to talk about some of the things that have gone before that led to where we are now.

As manager of the project, there's two questions that continually run through my mind, and I suggest they should run through your mind, too. Is the project focused on the right things, not just are we doing things right, but are we doing the right things? And secondly, how much is enough? And what I'm going to do is set the stage for using that as a theme or dialogue and the following talks are going to expand on that theme and try to give us a basis for a conversation and dialogue along those lines.

The management of the program priorities continues to be based on strategy to protect public health and safety. That strategy has evolved somewhat with time. I'm going to go back and revisit some of the early concepts. The framework that we're using now is the repository safety strategy, and we'll have Bob Andrews, Jack Bailey talk about that in considerably more detail than myself, but it provides a framework for the integration of site information, repository design and assessment of postclosure performance.

Now, one of the things that I want to point out is that over the course of time, and I'm going to start in 1988 with the site characterization plan, which some of you may remember, this is Volume 4 of the site characterization plan, which starts the delineation of activities that would need to be--potential activities that would test hypothesis for different parts of the natural system that would provide us information regarding the characteristics, the processes, and information that could feed into design as part of the site characterization plan.

There were tables of hypotheses in there, and although there were favored hypothesis, the testing program was laid out such that we were going to systematically go through and evaluate literally every hypothesis, every alternative hypothesis that we could as part of the testing program to make sure that we had a complete and defensible path forward as we moved into the suitability and licensing arena.

It became obvious early on that this was such an incredibly optimistic program, the resources it would take to do this were beyond what was realistically feasible, so we need to prioritize the program. This actually gets to one of Dr. Christensen's questions, how do you systematically go through and prioritize the program. In the early days, one of the first things we did was a thing called the test prioritization task force, March 1991. This was driven in large part by demands of the program to take the massive information, massive opportunities in the site characterization plan, and put some prioritization on it. And the priorities that we--what we used for filtering priorities in the testing program at that time was our evaluation using a formal decision analysis expert judgment process of the ability of tests to detect potentially unsuitable conditions for a nuclear waste repository, using the criteria of 960.

That gave way over time to something a little more structured and formal, a much more formalized decision analysis process, gave rise to the integrated test evaluation. This is from February, 1994, where again we went through rank order tests--tests, I'll emphasize that repeatedly--based on an evolving understanding of what the criteria for prioritization should be.

Now, one thing that we've consistently come up with over time is struggling with how one incorporates and includes design in this. Is design an input or an output?

And in the current repository safety strategy, it's both. And we'll let Jack Bailey and Mike Voegele talk to you about that.

The SCP strategy for allocating performance across the system elements, both natural and engineered systems, yes, we recognize that if you concentrate on a few features, you could reduce the cost of the program, but initially we thought that was perhaps not the most conservative way to go, so we started out looking very broadly across the board, but we were forced very quickly into prioritizing the program.

In the integrated test evaluation, which was focused again primarily on postclosure performance assessment, we found that there were other reasons that one would allocate resources for a particular test or program beyond just sensitivity in a total system performance assessment. Was it something that perhaps what we would call the unknown unknown, something that would help us detect the unsuitable site conditions? Was it something needed to demonstrate regulatory compliance, but it isn't captured in a TSPA model? Is it something needed to build scientific confidence, but again, it doesn't rate real high in the TSPA sensitivity analysis? Something needed to build constituent confidence, support other tests, or provide design information? And at this time, again, this was a prioritization for the testing program. We still hadn't found a good way to incorporate design efforts into the overall prioritization effort.

The repository safety strategy that we're dealing with now, and Bob Andrews will take you through the TSPA view of this vision of the system with both natural and man made components of the system, walk you through the elements of the total system performance assessment, whether they be contributions or potential contributions from either the natural elements or the man made elements. Mike Voegele will talk about some of the potential design alternatives and options that exist within the design arena, and then Jack Bailey is going to take you through the critical elements of the system attributes as broken out, and talk about in our current vision, which of these are important, which are important in the concept of sensitivity analysis, which do TSPA sensitivity runs suggest are some of the most critical variables, what's our state of knowledge and how much more do we think we need to know. That's a strong step forward toward providing a prioritization to the program.

As I cautioned earlier, though, postclosure performance assessment cannot be the only criteria for allocating resources in the program. We have other demands that must be met, such as a preclosure repository safety case must also be made. That must also be accommodated by the activities of the project.

The viability assessment, the work that we're doing in the viability assessment sets the stage for this, because this is the first time we've taken and integrated a lot of data, I'll call it, from both engineering and the science world, come up with a synthesis and evaluations of an integrated approach to a repository system, using that to identify where our strengths and weaknesses are, and the work plans that come out of the viability assessment should identify those things that need to be done to move forward, as Lake said, to the next game that we have on the schedule.

And on the schedule, moving into the site recommendation, Jean Younker will talk to you about work that is needed to complete site recommendation and the license application, and then Wendy Dixon will talk to you about the environmental impact statement, some of the precepts behind the alternatives selected for the environmental impact statement.

The schedule cannot be sacred. It's not carved in stone. But we need to have, if the schedule needs to be changed, there must be a compelling reason to change the schedule.

In summary, as Lake pointed out, there's a lot of activity going on, dialogue regarding national policy about repository program versus storage, but as that dialogue goes on and continues to evolve, Yucca Mountain project remains focused on our charter of site characterization and meeting the major program milestones, viability assessment, the environmental impact statement, the site recommendation, LA and on from there.

The focus that we have is on technical progress through sound science and engineering, developing a defensible safety strategy, that is an evolutionary process, it's not a one-time shot, and resolution of technical issues.

With that, I'm going to try to turn this off, if I can, and take any questions that you might have of me.

COHON: Thank you very much, Russ. That was a very effective introduction and a very useful way to put in context the presentations to come. We appreciate the preparation and thought that went into that. Priscilla Nelson?

NELSON: Nelson, Board. Good morning, Russ.

DYER: Good morning.

NELSON: I have a question. I tend very often to be focused towards a time period that I can immediately relate to, which is, by definition, preclosure, and I want to understand exactly what approach is being taken towards, or what criteria are being used to consider retrievability, that preclosure period? What assurance or ease of retrievability is being considered in terms of the construction aspects, the actual making of the emplacement drifts? Is there any way of characterizing that? Is it easy retrievability? What does that mean? Or is there a tradeoff analysis underway in terms of different kinds of construction components, making something more easily or more certainly retrievable?

DYER: That's one I'm going to defer probably to either Jack of mike. Retrievability of course comes in as a design in part through 10 CFR 60 requirements. But retrievability, you're absolutely right, there's a tradeoff. How easy do you want it to be and for how long? Ultimately, one can say yes, it's retrievable if you mine out the entire mountain perhaps. That's one end member of a concept for retrievability. But the other end member would be to have perpetual care underground perhaps, where it would be very easy to break things out. And there's a tradeoff in cost and scope that will be worked out as we go through design, go through the design process.

NELSON: Will that philosophy be discussed in the VA?

DYER: The design will talk about retrievability. I'm not sure to what degree Volume 2 addresses design. Can somebody help me here?

COHON: Or as an alternative, Priscilla, if it's acceptable to you, we could defer this until we get to the design discussions.

NELSON: That's fine.

DYER: Okay. Paul Harrington stood up. Paul?

HARRINGTON: Paul Harrington, DOE. Volume 2 does talk about retrievability. And to answer your earlier question, we would characterize it as fairly simple in the preclosure phase. It's just a reverse of the emplacement process, and we made the system robust enough we believe to facilitate relatively easy retrieval, if there were a VBE event of some sort like rock fall, ground support failure. We would expect to be able to go in and mine that out, retrieve the packages.

COHON: Okay. But we may pursue it again further later today. Dan Bullen?

BULLEN: Bullen, Board.

Russ, in your schedule that you showed us, you talked about the identification of design alternatives, and then less than a year, or almost a year later, the identification of the VA design alternatives versus the LA design alternatives. In light of the comments that Lake had made about budget, do you feel that your program has the flexibility to adequately evaluate those design alternatives in that time frame, and to come up with a proposed design, you know, at the end of Fiscal 2000?

DYER: We'll see how the budget plays out. What we submitted, if we get the resources that we have requested, yeah, probably so, I mean, assuming that we have no big surprises along the way.

COHON: Dick Parizek?

PARIZEK: Yeah, Parizek, Board.

I'm looking at Viewgraph 5, and it's the chain, the links of the chain, putting all these pieces together. In terms of trying to prioritize work, there's internal judgments as to how far to go with different issues in this chain. Something like constituent confidence on the other hand is sort of the perception of the outside world's view of this. How do you get the input from the outside world? Because we see considerable resistance to the whole nuclear industry, and that's constituents I would regard, and so I say how do you take the input from the public, as an example, and say that we're doing adequate work to meet their needs?

DYER: The model that was used was almost a multi-attribute analysis, and each of those factors were weighted, and we went through the panel and asked them how much should this be weighted. They were not evenly weighted. That one I would have to go back and look at the actual report. But it is obviously a variable. It changes with time and it changes with your position, whether you're inside or outside.

PARIZEK: It's a floater really, because it's dynamic?

DYER: Yes.

PARIZEK: You could have new input at any time in the future, too, for that matter.

DYER: Oh, yes. Yes.

COHON: Debra Knopman?

KNOPMAN: Knopman, Board.

Russ, could you say a little bit about when we were talking about--you talked a little bit about almost like an adaptive management strategy as well, to some extent. What would be the level of or the kind of scientific program that you would want to see maintained even as we proceed through, assuming there is a license application, and even moving beyond that to a construction authorization, what is the kind of scientific program that the program would like to see to continue to support activities at the site? Or do you envision the scientific work closing out?

DYER: I think there is--many of the activities that are carried under the umbrella of the scientific program now will come to a natural end, because they will have done the characterization, provided the data or information that's needed. There may be some--there will be some activities that must continue, some monitoring activities that will continue on. There may be, as time goes by, we may identify new uncertainties that need to be addressed. I don't know what those may be, but we've got to be flexible enough to be able to investigate to resolve those uncertainties as they arise.

KNOPMAN: So the answer is that you will maintain some core, some level of core scientific expertise even as you move past LA?

DYER: Oh, yes, there will be something in the program. It may not be--it almost certainly will not be as large as the level of effort now, and it may be much more focused on particular activities. But there will always be some level as part of the program.

COHON: Lake Barrett?

BARRETT: Lake Barrett, DOE. Let me mention something that we have under consideration in our long-term planning along the line of Debra's good question, and at some point, the Board may have a view and I'd appreciate the Board's view if they have one at some point. From the last meeting, I think it was, we talked about our plans for a monitored geologic repository. So once we've loaded it, you go into sort of a monitoring condition, and then future society will decide do you want to seal it up, or do you want to continue monitoring it to maybe address uncertainties, whatever they may be. What entity should have sort of the proper scientific expertise at that time to make that ultimate decision that we should seal it or we should continue to monitor it?

We have a vision of how that ought to go, and I believe in sort of federalism, that it really starts, you know, locally and then grows toward the national. I would submit that the best organization to probably do that would be something like if we had a Yucca Mountain repository now, this assumes everything went that way, that it would be sort of the Nevada University System in its broader sense would basically have the expertise, who is probably closest to the people in Nevada, who would most likely be involved in this, in the decision it should or should not be sealed. I mean, the people down gradient, you know, from Yucca Mountain, et cetera, who really should be the ones who have the greatest decision making on it, not somebody who rests in Washington, like it presently is at this point.

So we have worked some degree with the University System before, but as we would move into the performance confirmation, once we basically as the applicant in this case has gathered the information for the licensing case, done the verification, there should be a turnover of the scientific expertise to the University System, and the University System, if you were to look at after the last canisters are loaded, where is the majority of the scientific expertise, 90 plus per cent of that expertise I would submit should rest with the Nevadans, and they would decide at that point, as opposed today, it is 95 per cent federal and a small percentage goes to the Nevadans. But there should be a transition of the scientific expertise. We'll be hearing later from Nye County, who has a very good scientific program at this point, but that could grow and also in conjunction with the state. I believe it's a little premature at this stage of the game when the site has not been determined to be the site for a repository or not, it's premature to get into that. But there are some points we are, you know, working toward that end, toward moving that way, and it sort of is a policy philosophy type of thing that the Board may have views on that at some future time.

COHON: Thank you. I'd like to indulge myself here in some philosophy, as a matter of fact, but an important philosophical discussion, Russ. First of all, just a comment which relates to the discussion I'd like to enter into. In reviewing the sort of historical context for how the program has prioritized studies in the past, you refer to the '91 study, or approach to analyzing this, and the focus there you said was the potential of studies to detect unsuitability, which is very interesting. That's quite different from establishing suitability.

DYER: Yes.

COHON: The absence of unsuitability does not imply the existence of suitability?

DYER: Correct.

COHON: That's the philosophy part of this. We've made that shift and we're now focused on, as Lake pointed out earlier, the establishment of suitability.

Later on on your Slide 4, you referred to performance allocation, which is an interesting concept, and

I hadn't heard it put that way before. Could you elaborate on what you mean by that?

DYER: Jack Bailey is going to spend a lot of time on this. Since the days of the site characterization plan, in any system if you try to figure out which parts of the system you're going to depend on for performance, you allocate--you can allocate performance to those system elements. What makes a repository system incredibly challenging to allocate performance through is that you're only designing part of the system. There is--the entire natural part of the system is as nature made it. So what elements of performance can you really depend on the natural system to deliver to your overall system performance? And that has been the challenge that we have had, is trying to understand, and the question earlier that Lake answered so ably, trying to understand enough about the characteristics, processes, not just now but probably processes operative in the future of the natural system, and how can you competently incorporate those in an estimate of overall system performance.

We've had an ongoing effort to try to make this overall performance allocation of the repository system. This is one of the first efforts I've seen that really goes and tried to put in and merge both the engineered and the man made system and look at a repository system allocation of performance. It is an absolutely critical concept.

COHON: Agreed, and I find it very helpful. At this stage, the question before the program, and the question that the Board has discussed at length, is given limited time and limited resources, how best to invest those resources over the next two to three years so that you're in some sense the best position possible to say something definitive about Yucca Mountain and its suitability? And that raises the question of what criterion or criteria should you use to make those decisions?

Now, performance is an interesting one, and I haven't heard it put that way before. I think many members of the Board when they think about this think in terms of we know that the situation is uncertain in the formal definition of uncertainty, and it will remain so, and the question is how much can we reduce that uncertainty between now and the time you've got to make a recommendation to the Secretary, so that uncertainty reduction becomes a criterion for deciding how to allocate resources?

DYER: Absolutely.

COHON: But that sounds somewhat different from performance allocation, although the TSPA context of course gives you a way to estimate, to quantify uncertainty and contribution of any sub-system to that overall uncertainty. But it sounds to me like performance has a somewhat different connotation than uncertainty reduction.

DYER: It provides the context or framework for--I'm going to start Jack's talk here.

COHON: I didn't mean to get ahead.

DYER: No, let me go ahead and set the stage. If you take your vision or model of the system, dis-aggregate it into system elements or processes, and then partition performance, or allocate performance across those system elements--

COHON: Will performance in this sense in this case mean contributions to uncertainty?

DYER: Contributions to the overall system performance, with some uncertainty on that. There will be some uncertainty. And then you do another screen through to get to where I need to be, how much do I need to reduce the uncertainty, and given the programmatic limitations, whether they be schedule, budget or physical reality, what's the likelihood that I can meet that needed reduction on uncertainty, and if I can't, what's Plan B, what's the alternate. What's an alternate way through this? Can I restack the allocation for performance and system elements some other way and meet my end objective?

COHON: Okay. Well, we agree we've set the stage for more discussion. That's very useful. Thank you very much, Russ, and thank you for your presentation.

We'll turn now to Bob Andrews, Manager of

Performance Assessment Operations. Mr. Andrews?

ANDREWS: Okay, technical difficulty. Russ turned the machine off and we have to turn it back on again.

Just as an introductory comment, we've given this presentation, or an earlier version of it, to the PA Panel in the middle of April down in Albuquerque, and I think the PA Panel thought it was worthwhile for the whole Board to hear a walk-through of what the total system performance assessment and the viability assessment looks like, the bases for it, the results, the sensitivity studies, with a little focus on the design sensitivity options that have been evaluated as part of the viability assessment.

What I'm going to do is very quickly walk through the components of the system. I will walk even quicker through those components of the system that have been the focus of individual Board meetings. For example, last summer, the Board focused a day on the unsaturated zone hydrology, including the Expert Elicitation that was conducted for the unsaturated zone hydrology. We presented at that time the bases for what we were using in average flow through the system, and I think there was a lot of good discussion of that.

We discussed last I believe fall sometime the waste package degradation models as they existed at that time. They revised a little bit subsequent to that meeting of the

Board. I think some of the Expert Elicitation Panel members were also at that meeting with the Board, so I will walk relatively quickly through that component of the total system performance assessment.

Finally, in January, the Board had a full Board, I think a full Board meeting, not a panel meeting, had a discussion of the saturated zone. We were in Amargosa Valley and discussed the basis for the saturated zone, the current understanding of the saturated zone, where the water goes, how much water is moving, and a discussion of the bases at that time anyway for how we intended to incorporate the saturated zone models into the total system performance assessment.

Based on in part some of the expert judgments in the Expert Elicitation on the saturated zone, our saturated zone modelling changed after that particular Board meeting. So I will walk through a little bit of those changes. So let's go ahead.

That's our outline. It would be remiss for me not to say there's a lot of people involved in pulling together a total system performance assessment. There's a lot of performance assessment sort of people, and there's also a lot of designers, a lot of the scientific community who are the underpinnings for the models, assumptions, bases, et cetera, of what goes into our current understanding of the repository system and the natural system.

What I have on this slide, and we'll walk through each one of these in more detail in subsequent slides, are the individual components of the repository system. These components are divided up by the four major attributes that Russ described, plus one other attribute which relates to disruptive processes, features and events.

This table was a useful way of showing a correlation between the principal repository safety attributes which have been described earlier in DOE repository safety strategy in January, and earlier last year. That repository safety strategy is being revised as part of the viability assessment. But those four attributes remain. Those still are the key attributes. Those correlate into principal factors and model components, and those model components are the Icons, if you will, in the previous chart, and we'll walk through each one of those in some level of detail, obviously fairly quick in the time that we have.

The last column shows a correlation of those to NRC's way of how they are going to evaluate ultimately the DOE's progress in getting to a license application. Shown there are the six that have a direct correlation. There's one that's an overlying one, which is TSPA and integration, key technical issue, which is clearly all of what we're doing revolves around that. Two others relate to disruptive events, one volcanism and one seismicity, and the last one, the last NRC key technical issue relates to their development of 10 CRF, Part 63. So it doesn't, although it uses performance assessment, it's not directly correlated to the components that we're going to walk through.

Just to refresh the Board memory, I'll quickly go through this, what is the reference repository design, because this is the bases for most of the analyses in the TSPA, is the performance of the reference repository design and the uncertainty in the performance of that reference repository design.

Reference repository design is 70,000 metric tons. It's packages placed in the drift, nothing else in the drift except the packages placed on pedestals, placed on an invert.

We have three different waste package types, based on three different types of fuel and other waste that are being disposed, but the basic design is 10 centimeters of outer barrier of a carbon steel, and two centimeters of high corrosion resistant C-22.

This just shows the relationship of the different types of waste forms that we've included in the TSPA; first, the commercial spent fuel, 99 per cent of which has zircaloy cladding, then the high level waste glass, then the DOE own spent fuel, including the Naval fuel, and in addition to that, we have the plutonium, immobilized plutonium in the inventory.

So let's just walk through the system. First, we have--and I'm going to walk through it more or less as water moving through the system, because water ends up being the principal means by which the engineering system potentially is degraded and water is the principal means by which radionuclides are mobilized and water is the principal means by which they ultimately could be transported to any point down gradient. So I'll start with water. First a conceptual picture of water movement, infiltration at the surface, percolation down to the repository horizon, ultimately the potential for seepage into drifts and potentially contacting waste packages.

So we first have precipitation before we even get to infiltration. For precipitation, we recognize that there's a change, or there will be a change in average precipitation and climate as a function of time. It's quite uncertain of when and how much, but the general estimates of amount of change are about a factor of two change in present day precipitation over some time, that change would occur over the next 10,000 years, and then a change in three to very long-term central changes. We've called those changes in three super pluvials, and the changes in two, long-term average. So this is for a single realization case, which is a set of results I'll show you, the climate change and the magnitude of the climate change that's being considered. It's a stair step thing, maybe it could be gradual, you know, science isn't sure, but this is one representation of how climate could change.

Because of that, there's a change in infiltration corresponding to those three precipitations. The present day is shown in the upper left-hand corner, averages about 7 millimeters per year. That's fairly well bounded by a lot of information from neutron holes and also the percolation flux estimates at depths sort of bound that number reasonably well. Just a blow-up of that, this was presented to the Board last summer so I think I can go through it.

The long-term average, of course we have no observations of what would be the potential infiltration change as a function of time, so we've used the same representation, the same model in the present day, and this extrapolated it to changes in precipitation yielding changes in net infiltration. And the same thing for the super pluvial.

Just to give one a sense, the long-term average is kind of like Santa Fe climate, and the super pluvial is sort of like Los Alamos type climate, I think as Dr. Craig pointed out.

Once we take the infiltration, now we have to bring that water down to a repository depth. That, in the vernacular, is called percolation. So the average amount of water moving through a cross-sectional area of the repository shown here is the present day percolation flux map, and what we have done is acknowledged that it's spatially variable. These are the results coming from a model view. There is no percolation flux meter. I think it's important to point out there's a lot of ways to get at percolation flux looking at temperatures, looking at chlorides, looking at other indirect observations that lead one to an average amount of water moving through a cross-section of rock, but these are illustrating the spatial distribution of percolation flux.

One thing to point out is essentially the infiltration equals the percolation. There's a slight redistribution, but the volumes of water, there's no dramatic shedding of water away from the system once it's infiltrated into the system.

The next component is seepage. Again, there are currently no direct observations of seepage into any of the ESF drifts in the tunnel under ambient conditions. You turn off ventilation, the humidity increases in the drift, but there's still no observed seepage. The only way they can get seepage is to force water in. So what we have done is develop a model of seepage that's being driven by the fracture characteristics of the rock and being driven by the amount of water which moves through the rock, i.e.

percolation.

So just blowing up the lower left-hand corner, we have a relationship essentially between percolation flux and the average per cent of drifts or average per cent of waste packages that could be contacted by seeps. That is shown here. As you can see, it's incredibly uncertain. This is showing the range of possibilities of seepage, given a certain percolation flux.

You can see at the present day percolation flux averaging in the 7 millimeters per year range, the expected value is about 5 per cent of the packages one would expect to see seeps.

Why the wide uncertainty is because there's very uncertain fracture characteristics. We do have some fracture permeability observations, but there's no direct observations of fracture suction or fracture capillarity, and that drives this uncertainty in the seepage.

So you see here is the range of seepage. Because climate changes, because infiltration changes, because percolation changes, seepage changes as a function of time.

The same thing is true of seepage amount. So the volumetric flow of water that could contact a waste package, given that there was a seep, looks something like this. So you can see it's for the long-term average, it's on the order of 300 liters per year. That's like a drip every few minutes, just to give you a rough indication.

The next thing we have, though, is we place the packages, so we have heat. Heat drives off moisture in the fractures. Moisture can come back in through the matrix and can be driven around through those fractures for a certain period of time. Of significance to us is both the temperature and the relative humidity in the drift that is in contact with the waste package. And because I have percolation variability, I have thermal variability. And because I have variability in different heat outputs of different packages, I have thermal variability. So this is showing for one particular region of the entire system, the predicted thermal variability at the package surface. It's a little warmer, it's about 70 or 80 degrees warmer at the center of the package than it is, especially for commercial waste, which these are representing.

Humidity is shown here. So you see the humidity is low for a period of time. Critical humidity is more or less in the 70 or 80 per cent range, and that is humidity at which carbon steel would start to degrade.

Alberto, you have a question?

SAGÜÉS: What is the meaning of the different colored curves?

ANDREWS: The different colored curves on here are showing package to package variability. We modelled some high heat output commercial packages, some medium heat output commercial packages, and some low heat output defense and DOE owned spent fuel packages. So we have package to package variability of heat output along a drift segment, and this is capturing or trying to capture what is that degree of variability.

SAGÜÉS: This is along a given drift segment; not along the entire repository? So the lowest curve doesn't show the lowest possible in the entire repository, just in a chosen example?

ANDREWS: Exactly. This is one region. We had six regions. We did six regions to try to capture the variability in flux and the variability in the hydrologic processes, which also drive the variability in thermal hydrologic response of the system.

Now coming into the next major attribute of the system, the waste package lifetime, the components that drive that are first thermal hydrology, which we've already talked about, the near-field chemistry, and then the waste package degradation itself.

So given that we've already talked about the hydrology, let's talk a little bit about the chemistry. The chemistry in and around and on the package and in the drift can in fact change with time. It does change with time, or would change with time. We've looked at the chemistry in the rock above the chemistry as it contacts the concrete, which is the drift liner, the chemistry as it interacts with the waste package, which is the steel predominantly, and the chemistry of the water as it reacts with the waste form itself, because that would change the chemistry.

Shown here is just one example of chemistry change with time in one particular region of the repository. Again, because the thermal regime differs from region to region, the chemistry is slightly different from region to region. So we've used these chemistries, different chemistries as input now to first the waste package degradation, then the waste form degradation, and finally the solubility of the radionuclides. So there's a direct feed of the chemistry into those three components downstream, if you will, from the system.

Now that I have some water that got into the drift, I can start degrading the package. Of course, the mild steel, the carbon steel outer layer can start degrading under just a humid air environment, and does degrade under a humid air environment. But the C-22 inner layer generally will only degrade significantly in the presence of liquid water, i.e. in the presence of a seep or a drip.

Shown here just schematically are some of the degradation processes going on for the generally corrosion, uniform or localized corrosion of the C-22.

Shown here, I'm going to blow up that upper left-hand figure so you can see it better, because it's going to impact our results a little bit, is the fraction of packages failed. Failed now means a single breach or single opening that goes through both the mild steel and the C-22 layer. And we essentially have two types of openings; one is a very small opening, we've called those pits, and one that can be fairly large, like a few hundred square centimeters, and we've called those patches. And as you can see, the first curve is just the mild steel corrosion allowance material itself. All the other curves are both the corrosion allowance material and the corrosion resistant, the C-22.

And you can see the very first package, if you will, starts failing by corrosion processes at about 3,000 or 4,000 years. When those are failing, they're failing generally by pits, so it's very small openings through the package, and then after a little bit more than 10,000 years, they start failing by patches.

COHON: Cohon, Board. The CAM curve then does not really represent package failure; is that correct?

ANDREWS: That's correct.

COHON: Okay.

ANDREWS: The CAM is just the outer barrier, and it has to fail first before the inner barrier, in this case, C-22, is exposed and it can start degrading.

SAGÜÉS: Excuse me. Did that include the so-called juvenile failures?

ANDREWS: No. This is just the natural corrosion processes, how we expect, you know, 99.99 per cent of the packages will behave. There's some low probability I'll come to when I come to the results of an initial so-called juvenile failure that might be a very aggressive environment that's not expected at all, or improper inspection of a weld, or something like that. It's there mostly for a sensitivity study, as I'll talk about later.

Shown here is the change in the area exposed on an average waste package surface, both by patches and by pits, and it's the area exposed that will then impact the amount of water that can ultimately get into the package.

An important point here is that just because I have a single patch opening or a single pit opening through a package, that becomes important because now water can ingress into the package and ultimately egress from the package, however, the package is still mechanically intact. There's still a large fraction of the waste package surface area that is intact even at these times.

Okay, the next component is release from the waste package. There's three things that have to happen. One is whatever the waste form is, whether it's a commercial spent fuel or a glass waste form or a DOE owned spent fuel that may or may not be canisterized, in order for water to contact the waste form itself, it must contact and degrade that whatever material that waste form is in. In 99 per cent of the commercial fuel, that means zircaloy cladding. In 50 per cent of the DOE owned spent fuel, that also means zircaloy cladding. So we have to degrade that material first, and then we have to have water contact that exposed surface.

So first we have cladding--well, no, this is more of a detailed blow-up of the different components. I first have to degrade the cladding in the upper right-hand portion, and then have to have water contact the actual waste and start dissolving, if you will, the waste and transporting whatever mobile nuclides there are. The immobile nuclides it doesn't worry about.

I should back up. Let me talk about--okay, let's not try to back up again. Let's go back forward. We conducted, in addition to the three Expert Elicitations that I alluded to on one of my first slides, there were two other Expert Elicitations the Board correctly pointed out, because we documented them in their 1997 annual report. One was on waste form degradation, and the fifth and final one was on changes in the near-field environment. So changes in mass properties, changes that might be induced to very complicated coupled effects of mechanics, chemistry, hydrology, thermal.

We elicited this group, as we did with others, on a range of issues that affect long-term performance. One of those issues of course is the amount of waste form that could ultimately be exposed, and the degradation characteristics of that containment barrier, in this case, it happens to be a barrier that comes with the fuel as received and as emplaced into the waste packages. That group acknowledged that the cladding, zircaloy in particular, could be a very beneficial performance benefit to long-term waste isolation, and they also acknowledged that it's quite uncertain, and the amount of laboratory data, although there are some, and the Navy has a lot of, 30 years of testing of zircaloy, and zircaloy is a well tested material under a range of environments, they acknowledge that those environments may or may not be applicable to the environments that we expect to see in the repository horizon.

So what we have done is said from the data that we could gather, look at the degradation characteristics, both mechanical, creep, corrosion potential, of this material and come up with an estimate which ends up being a range of estimates, because it is uncertain, of the potential degradation characteristics. This is the estimate for the base case, and as we'll come to later, we acknowledge that it's uncertain, so we did a range of uncertainty analyses with these, some of which I will share with you, some of which are still in the VA document, and I didn't bring all the results with me.

Okay, given that the cladding is degraded, now I have the mobilization and transport of nuclides through the engineered barriers. It's important to point out here, and it's going to be a theme that comes back later when we look at the results, that we have a lot of nuclides that are mobile. They're highly mobile. They have very high solubilities under the types of aqueous environments we expect. Those include things like technetium and iodine, and we have a range of other nuclides that have moderate solubilities, i.e. the water can't carry that much, it's just chemically limited how much it can carry, and that includes things like neptunium. And then we have others that can move as a colloidal form.

We've modelled one of those, plutonium. It's also true of americium and curium that they could be transported in colloidal form. What we've tried to do in TSPA VA is look at one of them as a surrogate, and perhaps the most important surrogate of the other potentially colloidally migrated radionuclides from the waste form. And those colloids, just to point out, could be either naturally occurring colloids, or they could be waste form generated colloids which have been observed at Argonne in their laboratory testing.

This just shows a particular distribution of the waste form, degradation, intrinsic dissolution if you will, for those waste forms based on a lot of laboratory data from PNL primarily, and Livermore.

Okay, the last attribute is now that I have water that's degraded the package and has contacted the waste form and transported through the engineered components, now I have the natural components of transport, first through the unsaturated zone, then the saturated zone, and ultimately to the biosphere. The unsaturated zone transport, we have both fracture component and matrix component. There's some lateral diversion or potential for lateral diversion of water beneath the repository through perched water zones which have been observed, especially in the northern half of the repository block.

This shows if I dropped a mole of in this case technetium, so an unretarded species at the repository horizon and transported that mole of radionuclides down to the water table, what the arrival time distribution would look like. If you look at the present day climate, you can see that some small fraction arrives less than 1,000 years, but the 50 per cent arrival is after a few thousand years. As you go to the long-term average and super pluvial climates, you're putting much more water through the fractured system, so the velocities are higher and the travel times are correspondingly less.

Looking at the conceptualization of the saturated zone, we're going now from the base of the repository, footprint of the repository, out to 20 kilometers, which is going to be our point of locating a well and then doing our dose calculations. Again, in the saturated zone, we have some transport through the fractured tuff aquifer units and some transport through the alluvial aquifer. That distance of transport through the alluvial aquifer is uncertain, so a range has been used in the TSPA VA.

Just to indicate the general flow regime, you guys were out there yesterday, so it should be fresh in your mind, you see Highway 95 cutting across from the lower right to the upper left. That 20 kilometer point is essentially at Lathrop Wells, which is essentially the intersection of 95 and, what is that, 363 or--and the flow of ground water is essentially to the southeast and then to the south. It's a pretty busy slide so let me blow up each of the individual components and walk through it.

What we have first off is where does the water go and how do the nuclides, could the nuclides move in the saturated zone. Well, they're moving more or less with the water to the southeast and then to the south. These are the result of a homogeneous model which we have used only to define general flow directions and flow paths, and which geologic units the radionuclides would be in. We need to know which geologic units and their relative distance because the sorption characteristics of the different units are different. There's different sorption in the alluvium sediments or alluvial sediments than there is in the fracture tuffs.

What we've done from that result then is essentially a very simplistic but I think reasonably conservative approximation of saturated zone transport. We've taken the repository footprints or the nuclides that are released to the water table, and broken it up into six regions. So we're capturing all the maps and putting it into the six regions, with the volume of water that's in each of those six regions being driven by the volume of water which came through the unsaturated zone. You then do transport through each of those six regions independently, and convolve it with all the nuclides in all of the six regions by the time we get to a 20 kilometer fence line, if you will. We're capturing it all at that 20 kilometer fence line.

And then we apply--what we did get from the experts for the saturated zone is a dilution factor. They, as the Board pointed out in our meeting in January, and they documented in our Expert Elicitation, they believed the amount of dilution, the dispersive mixing that one gets--one could get in the saturated zone was being over predicted by the models that we had, and that the real amount of dispersive effects or dilution effects was significantly less from their experience than what the 3-D flow and transport models were predicting.

Therefore, we went to this--but they did believe there was some dilution. They believed there was uncertainty in that dilution within each of those streamtubes, so we've used that dilution factor going from the repository footprint out to 20 kilometers, shown here with the blue. Those correspond to an effective dispersion or dispersivity or mixing, depends on how you want to look at it, that Lynn Gelhar, one of the experts, gave and I think Dr. Gelhar presented it to the Board in January.

Then we have the biosphere. We're looking at all pathways, all potential pathways of nuclides, once they are withdrawn from the well, how they could be transported and any individuals using that water for whatever purposes, how they ultimately could get a dose. What we've used is ICRP-30 for these calculations. That's a whole body total effective dose equivalent for calculating the annual dose, and we'll just call that a dose rate and present our units in millirems per year rather than SI kind of conventions.

Okay, having walked through the system, we have for everything at its expected value, expected now being defined as mean of its input values, we come up with a dose, and we come up with our dose rate, and that changes as a function of time. I'm going to blow this one up and walk through each of these.

These results correspond to no premature, no artificial juvenile failure. So let's just walk through. Over the 10,000 year time period, I think we saw in the results that we had the initial packages failing after 3,000 or 4,000 years, and you see some dose, you know, starting to show up at 20 kilometers after 6,000, 7,000 years. The doses over this time period, every time we've run an analyses, are always dominated by the more mobile nuclides, in this case iodine and technetium.

We look at the 100,000 year results, over the first--this is now one realization, so we want to understand one realization, and then we'll come to uncertainty in this realization and what drives performance in this and other realization. We again for the first in this case 40,000 years are being dominated by iodine and technetium. After that time period, you see neptunium starting to take over as the dominant nuclide. I'm going to come back to another slide which is going to talk about the reason for that difference in more detail, but let's say right now that the very mobile nuclides, iodine and technetium, are more or less driven by the rate at which the packages fail and the rate at which the cladding fails, the rate at which the waste form is exposed to water. So it's a rate thing, and that rate changes with time. So you see little squiggles on the curve.

That's because the number of packages that fail changes as a function of time, the rate at which packages fail.

Neptunium on the other hand, being a solubility limited nuclide, is more controlled by the cumulative amount of waste that's exposed and transportable as a function of time. So it's a nice smooth curve because the cumulative amount of packages which fail as a function of time keeps increasing. So it's not surprising when we go from 50 to 100,000 years, that it's increasing, and as we continue from 100,000 years to a million years, we also see a continued increase predominantly in the neptunium contribution to the overall dose rate.

We occasionally have a few blips in there. Those blips are those climate changes, because we either have more water coming in or less water coming in, or the water table rises or the water table falls as the climate changes. You see the biggest blips, if you will, at 300,000 years, at the time of a super pluvial, and against at 700,000 years, which is the time of the next, in this realization, the next simulated super pluvial.

If I assume that there is this premature failure, so I have an undetected weld defect or a very unexpected chemical environment, such that it's much more aggressive than expected at all, then--and I just assumed that premature failure at 1,000 years, then over the 10,000 year period, and

I'm not going to blow up any of the subsequent slides because I want to get through this and offer plenty of time for questions, I see a release occurring at 3,000 years, and it peaks at about 5,000 years for that single waste package that has a small opening through it.

If I look at the 100,000 year curve or the million year curve, there's no impact of that single package. But there is an impact if I assume a single package fails early on.

The next set of slides is just to walk through the predominant things that are changing, that drive that particular curve on the left. And now I've picked the curve that includes the premature failure for illustration purposes. So let me blow up--hopefully this is going to work--first blow up the number of packages failed. So this is from this one realization, from one case, this is the number of packages that are contributing to that dose that we are predicting. We see that one juvenile failure occurring at 1,000 years, the total number of packages is about 18 if you add up those little lines, over the 10,000 year time period. Those that start failing at 4,000 years are failing by very small openings, by pits through the waste package. This is 18 out of more than 10,000 total number of packages. So it's less than a tenth of a per cent of the total number of waste packages.

The next curve shows the seepage flux, so there's going to be a theme here that hopefully you'll--maybe I should have told you the theme before I went into the results, but there will be a theme here that the amount of water makes a difference, and the distribution of that water makes a difference, and the degradation of the engineered barriers makes a difference, and they're going to work in concert either for or--generally for each other, but sometimes against each other. If I have a lot of water and that water found those holes, then my releases from neptunium are going to be greater because it's being driven by the amount of water which gets through into the system. So it's shown here first the amount of seepage into the drive, and I have two other curves, one is the amount of water which got into that prematurely failed package which had a big opening, essentially a few hundred centimeters, and that amount of water which would get into relatively small openings.

What's shown here with the gray curves are the distribution around the expected values. So there's spatial variability in here, so that's what's shown in the gray.

Finally, I'm showing the advective versus diffusive releases. At 5,000 years, remember in this one realization, there was a climate change, so the climate change meant more water got in. If more water gets in, it means more and larger advective releases, and I'm just showing technetium in this particular plot.

Doing a similar sort of exercise for the 100,000 years, this is what you have, and now I'm going to just kind of rearrange them so that it's more clear. Essentially, the number of packages failed where failure is one pit or one patch through the package is about 10 per cent at 100,000 years. So you can see I just have a wide distribution of when those packages are failing from this particular stochastic realization.

The amount of water that gets into the drift is fairly stable. It's being driven by percolation predominantly, and the percolation change as a function of time. So I see that step function. But the amount that gets into the waste packages continues to increase as they continue to degrade.

And finally this is illustrative to show why do we get those squiggles in the dose, is because we have these squiggles in the releases from the package. This is integral of all packages that have failed, and those are being driven, those squiggles again are being driven by the rate at which packages fail, which was the upper right-hand corner of your plot.

Technetium is still dominant, these are in terms of curies, it's still the dominant in terms of curies, but as we saw, neptunium is dominating in terms of dose, especially over the last tens of thousands of years on this plot, and that's being driven by the fact that neptunium has a higher dose conversion factor than does technetium.

And finally the same thing for a million years, which I think I can--by the time I get to a million years, virtually all the packages have failed. They at least have one pit or one patch through them. Shown on the lower right-hand corner is the advective and diffusive releases now of neptunium from the EBS, or from the waste package, sorry. There's other ways of plotting this, but this is a useful way of showing that from the EBS, neptunium rises and falls and, therefore, it's not so surprising that from the natural system, it also rises and falls.

Okay, having walked through the base case with an expected realization, so a single point taking all the models at their expected value, expected now in quotes, and all the parameters at their expected value, where expected is explicitly the mean of the parameter, I want to look at a range of uncertainty analyses. This is a table from the VA, so the chapter numbers reference chapter numbers in Volume 3 of the VA, which is still in review and comment response, and things that we looked at. So for each of the principal factors, in some cases, Column 1, we looked at heterogeneity, variability in the base case. So climate and infiltration were spatially variable. That was included in the expected value realization. That variability translated to variability in percolation and variability in seepage.

We had large variability in waste package degradation. So those are in that single point realization that I've already shown you. But Column 2 is looking at the uncertainty in all of the parameters that are in that base case, and I'll come to those results fast, and Column 3 is looking at, well, let's look at for each of my parameters, let's start stressing the system a little bit and see how that pushes the results, if you will, where results are now defined in terms of dose rate.

So I'm going to start with Column 3 and come back to Column 2, and I'm going to go through these relatively quickly because the main message is how much is it changing things, first off, to acknowledge that these things are uncertain and then to look at how much did it drive the results. So for infiltration rate, we see over different time periods, different effects. We looked at a factor of three higher and a factor of three lower. Those more or less drive the fifth and ninety-fifth percentiles off of our expected infiltration rate. In part, that came from the Expert Elicitation that we conducted on UZ flow that was described to the Board last summer.

We see the dominant effect is in the 100,000 year time period. That is predominantly because neptunium is being driven by the amount of water. Technetium and iodine are not that dramatically impacted by the amount of water. They have very high solubilities. They can diffuse even through a limited amount of water. So you don't see much of an impact in the 10,000 year time period, but you see a significant impact in the 100,000 year time period, and less of an impact in the million year time period.

Looking at seepage, seepage is very uncertain, as I pointed out earlier. The amount and per cent of packages that could see seeps being driven by the fracture characteristics and the percolation flux distribution is quite uncertain. All these cases are with that initial premature failure, which is not related to the amount of seepage. So you see in the 10,000 year time period, the results are--the lower curve is essentially dominated by that single waste package.

When I come to the 100,000 year time period, you see that single waste package essentially left the system. This is that single waste package, and it essentially says there is some probability, albeit low, that I have no seeps, that the fracture characteristics are such that even over the 100,000 year time period, even with increased infiltration and percolation, that there are no seeps. Therefore, if there's no seeps, the C-22 is just happy and will not degrade significantly over this time period. It does start degrading over the million year time period down here, but not over the 100,000 year time period. So seepage is quite a significant factor.

Now, the C-22 degradation rate, not surprisingly, I have several orders of magnitude here and here on the current uncertainty in degradation rate, both the mean and its distribution of degradation rates of C-22. So that will become, as you will point out, a fairly critical factor in long-term performance.

Here is one slide, we have others, of cladding degradation. The base case that I showed you back several slides ago had essentially 10 per cent of the clad degraded, or the mean of that distribution, at a million years. And what I've done, or what we've done, is move that back so it's 100 per cent degraded at a million years, or 100 per cent degraded at 100,000 years, and looked at the sensitivity.

There's another plot of taking it out entirely, you know, just removing any credit for the degradation characteristics of zircaloy cladding. That has about a factor of, I forget, 30 or 100 change in the 10,000 year time period, and not as great effect over the 100,000 year time period, and it's almost like what we already have in the million year time period.

Neptunium solubility, neptunium drives the results at the intermediate and long-terms. Now I talk as a PA person of what intermediate and long is. I suppose most people would call 10,000 long, or long enough, but if I look at the 100,000 or million year time periods, I see a factor of ten roughly effect based on the uncertainty in neptunium solubility.

Saturated zone dilution ends up being a pretty linear effect. We have a pretty tight distribution on saturated zone dilution based on that Expert Elicitation, so it's not so surprising that we have a pretty tight impact of that uncertainty on dose. The same with dose conversion factor. It's very linear. Increase the dose conversion factor, increase the dose, decrease the dose. There is uncertainty in that that we have to acknowledge, so we have a range of possible performances.

Okay, in addition to those, we have a range of multiple realization cases. These are taking the uncertainty that I have in all the parameters and just sampling it in a Monte Carlo hypercube type approach, and we get a series of curves, not just a single curve. The major drivers on that curve are seepage fraction and C-22 degradation rate over the 10,000 year time period. As I point out here, 28 of those realizations, 28 out of 100 had no waste package failures. There was either no juvenile failures, the seepage rate was low, or the C-22 degradation rate was low, such that they had no waste package failures over that time period and, therefore, no doses.

I just blew these up for better viewing, but let's go quickly through the 100,000 year. Same sort of thing, a wide range of results. In this case, there's still 20 realizations, i.e. that either have a low seepage flux, low seepage fraction, low C-22 degradation rate, such that the packages did not fail. That's just a blow-up of that.

A million year, again, a wide range of results, the dominant factors being seepage fraction, and now some other things start cropping into what was driving the performance, including the dilution factor and the dose conversion factor. Those have a linear relationship, so it's not surprising that they have a linear--you see a linear relationship to significance.

Another way of plotting that same thing is the complementary cumulative distribution functions, which just show the range or the variability in the expected result, due to the uncertainty in all of the inputs that we've given.

Now, what have we done with that? We've said let's try to identify based on all of the above, based on the one off type comparative analyses that I presented first, the fifth and ninety-fifty percentile work, based on the multiple realization work, let's try to prioritize the significance of the principal factors. The legend for this table is on the next slide. Essentially high corresponds to factors that could cause the dose rate to be more than or less than a factor of 100 from the expected value. The mediums are between a factor of 10 and 100 on average, and the lows are generally on a factor of 10 or less significance to overall performance.

And remembering that we talked about over the shorter time periods, the 10,000 years sort of time periods, and slightly higher, being driven by iodine and technetium which are being driven by waste package degradation rates, and that the longer time periods being driven by cumulative failures, cumulative amount of inventory exposed, cumulative amount of water contacting waste, i.e. neptunium, and in some cases plutonium, the colloidal plutonium.

So we see at early times, less than 10,000 years, were being driven by seepage into the drifts, which we've mentioned several times, by the integrity of the inner waste package failure, and also by the cladding. We have taken reasonable credit for cladding. If we take that credit away, as I said, those doses could increase by about a factor of 30 to 100, so we've put it as a high.

We could spend a lot of time on here, but let me continue on and in the sake of time, this will be picked up later by Jack when he walks through the prioritization of work to be done, which in part uses this and in part uses how much confidence we could get in each of these individual factors. So that's the legend.

In addition to the reference design, which was the basis of 95 per cent of what's in the VA, there are some design options that have been evaluated. They're described in Volume 2, and we've done preliminary performance assessment analyses of those in Volume 3.

The two that I'm going to talk about here are the drip shield placed over the waste package, it can be a C-22 drip shield, and a ceramic coating on the waste package. Wendy Dixon and Lee Morton will talk some more about design alternatives from an EIS perspective this afternoon, and Jack Bailey and Mike Voegele are going to talk about other design enhancement features that are described in the VA and post-VA in their talks after me. I just want to focus on two design options that are incorporated in the TSPA analyses.

First, let's start with the drip shield. That drip shield is C-22. C-22 degrades only in the presence of liquid water. That degradation rate we have used for the drip shield is essentially the same as the degradation rate as we've used for the inner waste package material. So we just applied the same model, applied the same logic, and came up with the C-22 degradation characteristics, if you will, for the drip shield.

For the first 100,000 years, the drip shield never failed. Well, the drip shield and the underlying package, I should say, never failed. Remember, I have two centimeters of drip shield C-22, an underlying package which also includes two centimeters of C-22. So this is close to a four centimeter C-22 waste package design. And there was no waste package that failed for the expected single point realization in the first 100,000 years, and so you come to the lower right-hand curve, it did start failing after 100,000 years or so, and so the doses start coming back up, and in fact start coming back to the base case after a very long time period.

The next one is the ceramic coating. Everything else--in both of these cases I should point out, if I haven't on the bullets, they included backfill with the analyses. So both the drip shield comes with a backfill, which we acquired for its emplacement and its stability, and the ceramic coating would come with a backfill to protect the ceramic coating from any rock falls or things like that.

The degradation of the ceramic coating essentially requires degradation of the underlying steel and it to blister, if you will. That can take a very long time, and in addition to that, once that's occurred, I still have the mild steel underneath it, and the C-22 layer underneath it. So it also had no packages fail in the first 100,000 years. It did start failing, some packages started failing significantly after that, and you can see some doses attributed to that particular design option starting at something greater than

400,000 years.

Okay, so in summary, we have ample time for questions, we've looked at an expected case, a single realization case, we've looked at a range of possible performances that we think reasonably bound it from that expected case, at least from a VA perspective. That's not to say that there's not additional uncertainties or additional issues that one should have to look at between VA and LA, or VA and SR and then LA, and that would be the purpose of what Jack talks about and what Mike talks about. Where are we going with additional work?

The most significant factors that came up time and time again, not that other ones weren't, but the most significant were the degradation rate of the package itself, and the seepage into the drifts. So they're very closely related. Seepage is a natural environment thing, and the degradation rate is an engineering system. But there's obviously ways to affect the impact of seepage in the drifts, i.e. drip shields, and there's ways to affect the degradation rate of the packages, i.e. ceramic coating and other design enhancement features.

So this ends up being, by the time we include two other rows, now we have the same principal factors that we started with for our reference design, and have added two rows. One is some water diversion system, whatever it may be, and there's other alternatives than drip shield, but some water diversion system, and some other type of waste package materials or ceramic coatings on the package. And these two, as are clear in my plots, end up having a high as well.

So with that, let me stop and try to entertain any questions that the Board may have.

COHON: I'm sure we have no questions at all.

ANDREWS: Thank you.

COHON: Touche. That was an excellent presentation. For the benefit of those in the audience who have not stayed on top of TSPA, one can only say that what you just saw probably seemed like--as if it was totally bewildering. The Board, however, has worked very hard to stay on top of what DOE has been up to in TSPA, as Bob referred to earlier, which meant that much of the presentation was indeed review for almost all of us, I think, and a very good review. We appreciate that.

With that, let's see if there are any questions. Debra Knopman?

KNOPMAN: Knopman, Board. It was an excellent presentation, Bob.

The Board for a while has been concerned about stability of the science as you move toward--move through VA and beyond, and I'd like to focus on this chart right here. I find it a very useful way to organize information, and while it's not cast in terms of hypotheses, it at least identifies key issues and it's a finite list.

However, the various levels of importance that you assign to these elements here are quite different than what we saw even a month ago. And I'm wondering if you can explain a little bit about why there might have been some movement. Right now, for example, just in the limited water contacting waste packages, the first grouping, I guess there are just two elements there that now have a high level of importance, the seepage into drifts and the water diversion by drip shield and backfill, whereas almost all of those elements had been considered high, of high importance a month ago. Can you explain what may have happened?

ANDREWS: Yes. In part, a lot has changed in the last month, not so much conceptually, but generating all of our results and then how do we portray in as quantitative a fashion as we feel is justifiable, some prioritization. And we did have a lot of iterations on, you know, is showing things fifth and ninety-fifth percentile, is that a reasonable way to show quantitatively what's going on? Is it based solely on regression type analyses from multiple realizations, is that the best way to show what correlated well with dose? And, in fact, we have a little bit of a mixture of those two in coming up with these highs, mediums and lows.

I think in some previous tables, even as long ago as April, we probably based those tables mostly on the multiple realization cases and what correlated most with dose rate. Which parameter or which component correlated most with the dose rate? And there, there's a lot of things that correlate reasonably well with dose rate. You don't see it on a scatter plot, but you see it when you examine the statistics. But we didn't feel that was as useful in some cases or is the only tool that we should use to help us in ranking or defining the significance of the importance of the uncertainty. So we did a lot more since even April in examining, you know, the range of results for each component separately, so these fifth and ninety-fifth percentile type results that I showed earlier.

And then we tried to figure out a way, okay, given those, how can I--some things impact one nuclide but don't impact another. In other words, I can change some things and have a dramatic impact on neptunium, like neptunium solubility clearly, but that still doesn't impact technetium and iodine. So they would form more or less a floor in the peak dose, and so we had to factor that floor into our discussion of the quantitative impact of the significance of the uncertainty. And these are really the significance of the uncertainty driving the long-term performance. So some things did change, but it was also how do you use all the different pieces of data, if you will, that we have from the results that we have to assist the project in identifying what was really driving performance.

KNOPMAN: Okay. So it's an interpretive issue here, that is, there are any number of ways in which you can summarize the data, in effect, and then assign importance to change in performance as a consequence, a change in parameter distributions.

ANDREWS: Yeah. One of the other things we did that I didn't have a chance to present here, and maybe it's not worthwhile talking about, but it's going to be in the VA, is we took out the two or three or four most significant things and then reran it in a multiple realization. And then you say okay, how much did my total variance, if you will, in my output, how much was that total variance reduced by taking out what I perceived to be, based on the initial run-through, the most significant ones. And we did that by taking out essentially seepage and C-22 degradation. Just said suppose I knew those and I knew those perfectly, then what's my variance in the total results, and then these other things start popping in. But those two things were driving the total variance in the results. They were driving the fifth and ninety-fifth percentile results. And so they pop out on this table--well, first they pop out on the earlier table I showed you, and then they pop out as highs on this.

COHON: Can I just follow up? Debra has some more questions and other members have questions. But one of mine deals specifically with this point, so I'd like to pursue it a little bit further.

Your slide 48, and I don't know if you have the capability of going back to it, but it's okay if you don't.

ANDREWS: I do, but it might take me a while.

COHON: Okay. Well, the key thing here, it's exactly on this notion you were just discussing about contribution to overall variance. The bar chart, this is the slide with the bar chart, the four colors, the horizontal axis says impact on peak dose variance, and it's got numbers that vary from zero to .18 in units, .02, and the one that has the biggest is seepage fraction. Could you give me the precise interpretation of what that axis means and those numbers mean?

ANDREWS: Yeah, that probably is slightly misworded, but it essentially is the amount of variance reduction that would occur if I took that parameter--

COHON: Just as you described before with Debra. Okay.

ANDREWS: But it's all done statistically as a post-processor to those hundred realizations, not--I didn't physically take it out and then rerun it. So it's a post-processing of the statistics.

COHON: But didn't you just say before that you did rerun the model?

ANDREWS: We also did that.

COHON: You also did that? But these results don't reflect that?

ANDREWS: That's right.

COHON: Okay. I just want to pursue this a bit more. Now that we have it, we're done with that one. Thank you. That's very helpful.

BULLEN: Bullen, Board.

COHON: Okay, go ahead.

BULLEN: This is a follow up to the same question. It seems to me that as you look at your table with Ms and Hs and Ls on it, that the clad credit is also one that has a significance and yet it is not included here. Has that analysis been completed where you gave zero clad credit and came out with how big a variance do you have on the final results?

ANDREWS: Yes.

BULLEN: And how does that look on this kind of chart?

ANDREWS: Oh, on this chart? We did not run--this is now in the mode of an alternative--you know, not alternative realization in the way we have here, but it's really an alternative conceptual model. And when I come to an alternative conceptual model, now I have to make a whole separate run.

COHON: Well, wait a minute. Cohon, Board. That's splitting hairs, I think. You can take the same conceptual model and assume sub-realization when the number happens to be zero, all of your cladding has failed the moment you emplace the waste.

ANDREWS: We did that.

COHON: Okay. Well, that's the question Dan is asking.

ANDREWS: That was that factor of 100 that I said.

COHON: Well, then why can't you--

BULLEN: The variance on your output on this bar chart--

ANDREWS: You wouldn't see it on here because it's not--although it is being sampled, it's not being sampled over that amount of the distribution. In other words, I'm not going from zero to 100 on fraction of cladding exposed in this set of realizations.

BULLEN: Have you?

ANDREWS: In multiple realizations? We have done a single realization, making it 100 per cent of the cladding failed at time zero, and that was that factor of 100.

BULLEN: Oh, factor of 100, 50 to 100.

ANDREWS: Yeah.

BULLEN: I'll come back to cladding in a minute, but I just wanted to--

COHON: Well, let's not let this one go, because I'm totally lost now. If you couldn't do it with cladding, how could you do it with these other four things.

ANDREWS: It was with cladding, but it wasn't over that broad a range.

COHON: Why didn't you do it over the broader range so you could give it--see if it stacked up with these four?

ANDREWS: We could have.

COHON: Why didn't you?

ANDREWS: Because we felt what we had was a reasonable representation, albeit uncertain and albeit bounded, that is reflected in--

COHON: Now, wait a minute. I'm completely mystified here. You present this bar chart, which any reasonable person would infer means these are the top four contributors to variance. Is that a reasonable inference?

ANDREWS: Yes, for the representative models and range thereof.

COHON: These are the top four?

ANDREWS: In these analyses.

COHON: Is it clear these are the top four, means I know what the other whatever contribute as well to variance?

ANDREWS: You could do that.

COHON: Yes, I know you could do that. Did you do that?

ANDREWS: Yeah, all the other parameters--

COHON: Including cladding?

ANDREWS: Including cladding, but with a range. In other words, I would have to show the PDF, if you will, of each of the input variables, and cladding is one of those, and that PDF is a relatively, for this base case, that PDF of cladding degradation is a relatively small range. So it is here. We've got a relatively small range of uncertainty, and that range of uncertainty increases with time for cladding.

COHON: So these top four contributors to variance as shown on this chart are for the context of certain assumptions you made about the probability distributions?

ANDREWS: Uh-huh.

COHON: And those assumptions--why wouldn't you use the whole range? Why would you make the probability distribution range smaller than it can be?

ANDREWS: Well, we were going after a reasonable range for each component. So we have each component, the aim of the VA was to look at a reasonable range, and then to push that range with separate analyses.

COHON: Okay.

DOCKERY: Bob, I think between base case, what is the base case versus what is--you know, what were the deterministic results versus the stochastic results. I think it was maybe an issue of not understanding what the base case is here.

COHON: Well, no, I do understand what the base case is. Great care has to be taken in how these results are interpreted, and I appreciate the challenge you have in setting ranges for the various parameters. I'm sorry, I don't want to take up any more time with this. Debra?

KNOPMAN: Yeah, two quick questions. One, these parameters are highly correlated with one another. So as you're trying to interpret contribution of variance of one to the other, you get weird effects by taking one thing out and--or even something like seepage fraction is so highly dependent obviously on infiltration, that that's really your driver as opposed to seepage. So I want to second the point that Dr. Cohon made about interpretation and clarity and transparency here on representations of variance. Because of the high correlations among the variables themselves, it becomes less--it's not a trivial exercise to demonstrate contributions, though it's a helpful graphic, and I don't want it to disappear, it just needs to be I think clarified a little bit more as you present this.

Also, I'd just like to comment that I think it would be very helpful for the Board to see a very short, it doesn't have to be a lengthy document, but a very short document that would explain the way you arrive at your high, mediums and lows on performance--importance on performance, that's your last chart there, Slide 58, that we see how you've gone about making those judgments, because it's not a scientific question in a sense as to what these--what the proper levels are. It's purely a judgment call sort of preference for how to present information, and that's fine. It's just it needs to be made explicit so that we can understand it and others can understand it.

ANDREWS: I agree. We tried to--when we do the analyses over different time periods, what ends up being significant or what is driving performance over those different time periods changes. And when you try to summarize it into one global set of what drove performance, in part you have to consider which time period was it that I'm considering. You know, we could have had another column that said from zero to 1,000 years, you know, what was driving performance. And in part then, that's important to the prioritization of work is how much confidence do I need over the 10,000 year period, if that's going to be the regulatory time period, and how much confidence or variance can I accept over much longer periods of time. So that also gets folded complexly into that single column. I mean, one could weight, you know, how much I want to make sure that I'm 95 per cent confident over this time period, but it's okay if I'm looking at means or medians or modes or some other statistical measure of goodness, over much longer time periods. That becomes a very complicated regulatory and licensing type issue.

COHON: Viewing it and presenting it in those three different time periods is very effective, and I congratulate you on that. Dr. Knopman's point, though, is very well taken by me, and I'm sure by you as well, and I just want to emphasize it, and that is you must make value judgments. They can't be avoided. All we're asking for is clarity on how it is you arrived at that value judgment so we know how to interpret HM&L.

Also a follow up question on her questions. In any of these runs, did you reflect the joint distributional nature of any of the parameters, these correlations between parameters that she was talking about? I'm not sure there's a basis for doing that, but I just wonder if you attempted to.

ANDREWS: I'm not sure. I'll go back. We're still writing up some of this, so I'm not sure whether we looked at that particular issue. Clearly, in part, one of the reasons seepage is important is because it drove which packages got wet. So that correlation of seepage to wetness on package was fairly significant, and it's hard to break that out from the analysis.

COHON: Right. Of course wherever water is concerned there's correlation, from rainfall to when you sink a well. But some of that jointness is so strong in the sense of joint probability distributions, which perhaps are not derivable, that's the question, whether you've attempted to reflect that in any of the runs. We'd be interesting in knowing.

ANDREWS: Okay.

COHON: Thanks. Dan Bullen?

BULLEN: Bullen, Board. At the risk of asking too much of the technology, can you change the channel to Number 24?

COHON: Dan, should we do someone else's question while he's doing that?

BULLEN: I actually have a quick question while you're changing channels, Bob. As you presented data with respect to the near-field environment and the geochemical environment base case, you cited a drop in the fugacity of oxygen as one of those pictures that was shown. Could you tell us the basis for that drop in fugacity of oxygen? I know it has an impact on the corrosion allowance barrier failure. What basis do you have for that reduction in the drop in the fugacity?

ANDREWS: In part, that's being driven--now you're getting out of my area, so I should probably, you know, defer or have someone contact you. Part of driving moisture and air out of the system for a certain period of time--

BULLEN: Right, and this actually gets back to a question that I keep asking Bill Boyle every time I see him. In the drift scale heater test, was the partial pressure of oxygen which is related to the fugacity, and yesterday on our trip, we learned that basically the composition of the air is 16 per cent relative humidity--or the composition of vapor and air is 16 per cent relative humidity, atmospheric air in the drift scale test. So the boiling front doesn't appear to drive the water away from the mountain, which is what I would have expected, but which is probably not what's expected by the equivalent continuum modelling that you've done. And so it's just a suggestion that in this case, you know, the VA is the VA and that's fine. But it's one of the areas where someone that's going to scrutinize the changes, and I don't think the change in the corrosion rate of the corrosion allowance barrier has any effect, but it's a point where you're making a claim for something that you don't have data to support, and the data were supposed to be were derived from the drift scale test, and the data are there, and it doesn't support the fugacity curve, so you might want to make sure you consider that.

ANDREWS: I'm sure we will. We realize that the VA is based on--

BULLEN: A few months ago, you didn't have the data. That's exactly right. I understand that. But we learned yesterday, and by the way, didn't you change it for today-- no, we learned yesterday that that's not the case.

Now, to get to Channel 24 here, as I mentioned, as I understand it when you were constraining and trying to determine the variance, what you're saying here is that the only variance that it had in cladding failure, for example at

10 to the fifth years, is that for the lower limit case, I don't know, 1 per cent has failed, and for the upper limit case, 3 per cent has failed. And that is based on these assumptions here?

ANDREWS: That is--well, the bases isn't described all on this slide, but the bases are correlations of degradation with C-22 degradation, corrosion degradation, and they're extrapolations of mechanical degradation effects and also looking at creep. So we had three predominant potential failure modes. Creep ends up being insignificant, very low significance. Mechanical degradation starts once the package has sufficiently degraded such that you could get mechanical degradation of the clad, and corrosion would start as soon as you could get liquid water into the package.

BULLEN: Okay. And the correlations that you make in this kind of analyses are handbook correlations, as we understand, because the data aren't there. But I have to point out something to you that you really want to make sure that you look at irradiated fuel, 60 gigawatt days per metric ton, with whatever oxide and hydrides there might be, and then I also want to point out to you that, you know, I got a draft of your TSPA VA report, and so you always hate it when people read what you write, but in this case, it does note that zirconium is susceptible to pitting from ferric chloride ions, and so I'm thinking we're probably going to have some ferric chloride ions there. So if you want to have a justification for these types of performances, some accelerated aging tests of irradiated spent nuclear fuel, taking a look at a concentration of ferric chloride ions in the range of temperature, pH and chemistry that you expect inside the waste package is what's really needed to justify this kind of correlation.

I understand that the correlation in comparing whatever you had to C-22 to un-irradiated zircaloy is the first step. But between now and LA, either if you're going to justify this variation and see that cladding has no significance, you've got to have those data to support it. Otherwise, you've got to go to zero to 100 per cent failed suggestion that Dr. Cohon mentioned.

ANDREWS: I think we agree. And Jack, when he talks about the work remaining, you know, to get from VA to LA, will bring up some of these cladding type issues and additional information that's required.

BULLEN: Okay, thank you.

COHON: Dr. Sagüés? Alberto, can you hang on one second? Lake, did you want to say something?

BARRETT: Barrett, DOE. I've heard several discussions here about the cladding. I had a difficult time understanding these 100 realizations myself. Now, first of all, I will say I hated statistics in school and I still don't understand it all, and the Monte Carlo stuff I don't understand. But I did ask them where was cladding in this? Show me the non-cladding. And I got the proper statistical answer was it's not there, you know, and you shouldn't ask that because it's non-statistical type realization. And so humor us and please run one. And they ran a run, which is probably not going to be in the VA, but if cladding was failed inside the package, take and run it, and on Page 36, you know, is the standard output of the model, which shows you know at 10,000 years, I always kind of look at where am I at 10,000 years. You know, this was in the 10 to the minus 2 millirem per year.

Now, the answer back was, you know, it's 50 to 100 times higher, so you can just take that curve and just add it, you know, it starts off when the first package fails around 3,500 years, and you can just kind of run that curve out two orders of magnitude higher, and that's in a non-statistical way to me so it's deterministic of what happens if the cladding was 100 per cent failed inside for whatever reason, what the world looked like. You know, it did not come to an end and it didn't really come out of the statistical realizations because they said, well, that's not one that is statistically going to be there. I said just humor me and run it, and we did just to get a sense of where that is. The upper left has the cladding in that model, and if you just go and add basically 50 to 100, and it runs over there, so that you end up with a dose around several millirem at 10,000 years. But that's what it would look like in a simplistic engineer, non-statistical view to me. Now, I don't know if that helps or muddies the water.

COHON: It is helpful. We do understand statistics and we also understand modelling, which is what drove our questions. And I think we've gotten good answers.

BULLEN: Just a quick follow up to Lake's comment here. In doing that calculation, did you set the upper limit of the realization at 30 per cent of the clad failed? I don't know, what is that, 10, 20--40 per cent of the clad failed? Or did you fail all of it, surface area exposed is the question. When you opened it all the way up, it looks like you've limited it here to--

ANDREWS: Oh, when I opened it all the way up, it was 100 per cent.

BULLEN: 100 per cent. Okay, thank you.

COHON: Sorry, Alberto.

SAGÜÉS: I wanted to maybe go to the other extreme of perhaps thinking, and that is that somehow when one is trying to assign numbers to bad things happening, and one is looking at it from an engineering standpoint, one may adopt the attitude of saying well, gee, let's look at the worst possible case, and at least with the one Expert Elicitation with which I'm the most familiar, which is the Waste Package Degradation, I myself found myself thinking in that sense. Has anyone looked at the possibility that some of the numbers that went into the TSPA had suffered from a perhaps too strong of a conservative bias? And has that been looked at, if that thought has come up, has that been subject to any kind of an organized or quantitative examination?

ANDREWS: That's a very good question. I mean, look at it from both sides, you know, where we think could be pushed from being non-conservative or where it could be pushed from being conservative. What we've done generally in areas of conservatism is look at what if that conservatism was not there, you know, in other words, try to put some guesstimate of more realism.

One example that we did look at is once the waste form is exposed right now, so whatever containment there was, the waste form is exposed inside the package, we assumed that the entire waste form is in contact with water. In other words, there was no trying to guess, you know, is it 1 per cent or 10 per cent or 100 per cent of the exposed waste form that's in contact with water, i.e. the internals of water movement inside a degraded waste package were just beyond what we felt we could reasonably do. So that conservatism of 100 per cent of the exposed waste form is in contact with water, we did do another one of these one off, you know, sensitivity analyses similar to what we did with cladding in the other direction, and it has about that same magnitude of effect, especially on neptunium.

It doesn't have as dramatic an effect on iodine and technetium because they're very high solubility, but it did impact neptunium. But, you know, what is the amount of per cent of waste form that could be in contact with water, you know, it's not something you're going to model. It's not something you're going to predict. You're probably always going to make a somewhat reasonably conservative assumption on that, and then show, well, what if it isn't that. So look at it from the opposite direction.

Now, on the package side itself, which I think was the source of your question, there were a range of different local chemical environments that were elicited at the corrosion allowance material, corrosion resistant material interface. It was uncertain, and that uncertainty in part drove the uncertainty and distribution of waste package failures. You know, what is the local chemistry at that contact? We looked at other alternative interpretations of those, but still honoring the Expert Elicitation, because the experts, there wasn't a bi-modal on them. They were a full distribution of what those chemistries could be. So we looked at one extreme, the 25th percentile, and the other extreme, the 75th percentile, on that chemistry.

SAGÜÉS: Yeah, what I'm saying is that the experts' estimates may have been biased. It's quite likely at least in the case of prediction of metal failures, there is a distinct possibility that the bias may have been the conservative direction.

ANDREWS: That's very possible. We had no way of quantifying how much bias they might have had, how much conservatism they themselves were giving to their own estimates. All we can look at is did it make a difference, and we see yes, it made a difference on that particular component of the model, and as we go from VA to LA, assuming that this is our basic design, which it may not be here later, but that's still to be decided, then additional data are required to really definitize as much as we can what that environment is. And I think the waste package materials people have some ongoing tests to be much more explicit about what could that--what is the expected environment at that contact of the corrosion allowance material and the corrosion resistant material to address exactly that issue, plus have a better estimate of the range of likely degradation rates to begin with. I mean, the expert distribution well encompassed the observations. They were not guessing degradation rates without information. There was some information that they had, and they had available and they reasonably captured the range of degradation rates.

SAGÜÉS: But they appear to have reasonably captured it. What I'm saying is that human bias may be playing a very--it could be playing a very important role in the overall outcome of TSPA.

COHON: I'm sorry. Before we go on, I just want to get a sense of time and where we are. Alberto, you have more questions?

SAGÜÉS: I have a couple of very specific questions.

COHON: And then Priscilla Nelson does and Dan Bullen has a very tiny, very short question.

ANDREWS: We also have, just for your information, you know, we're trying to as we go into the viability assessment and completing it, we're trying to develop ways of explaining what variant are related and the complex system, so Holly has brought along kind of a mock-up of how this might be portrayed in a more general audience. But we can either do that at the break or as time permits. But, Priscilla, please?

COHON: No, let's let Alberto finish.

SAGÜÉS: Real quickly, on the--now going into perhaps the opposite direction here, on the juvenile failures, there was 1,000 years time assigned for that. Why not one year?

ANDREWS: We could have. We just said let's pick a time, let's pick 1,000 years. Our time steps were I think 100 years, so we'd kind of be limited to 100 years.

SAGÜÉS: Because something was having an undetected manufacturing defect, such as a bad weld, say, I would expect for that to start showing difficulties just immediately; right?

ANDREWS: I mean, one of the reasons for a thousand years the time it takes seepage to restart after the thermal pulse has decayed, or is starting to decay, is on the order of a thousand years. So we said let's pin it to the amount--the timing at which you're likely to see seepage re-initiate itself. After the water has been driven away, and now it's coming back, that for the base case set of properties and parameters was occurring at in the 1,000 to 2,000 year time period, so we said let's put it there when there's water coming back.

SAGÜÉS: Okay. And the final question I have has to do with a slide to be retrieved, that will be Slide 29.

COHON: Forget it. It's gone forever. Can you ask it without the slide, do you think?

SAGÜÉS: Sure. Well, let me start it real quick. You assume a certain amount being released, and the question was whether that was released uniformly spread over the repository footprint, or whether it was a release at a given container?

ANDREWS: No, that was uniform over the repository footprint. So, in part, what you're seeing is a representation of if things were spread uniformly, some areas of the repository block have higher velocities, have higher--less travel time, if you will, to the saturated zone. Some are longer.

SAGÜÉS: If there would be a puncture in one container release and it happened to be--you happened to have the bad luck at one of the areas of fast transport, then that could move the curves dramatically to the left; right?

ANDREWS: It wouldn't move the whole curve, but that one package or one location might have been this location or it might have been one corresponding to this location. So this distribution is more or less representing the spatial variability of arrival time from different locations in the repository footprint.

SAGÜÉS: Right. Okay.

ANDREWS: So it could be anywhere on this curve, but it couldn't be to the left of that curve for the present day climate.

SAGÜÉS: Sure. It could be at the left most angle where the curve starts.

ANDREWS: Yeah, it could be here. It could be here.

COHON: Okay, point made. Thank you. Priscilla Nelson?

NELSON: I am getting closer to understanding this overall document, Bob. But I feel encouraged enough to be able to ask this question. The concentration on time is interesting, but Alberto brought up and started a point that is of interest to me, which is thinking about the spatial, source term nature in terms of you've divided the mountain, the repository block, into six areas and they have their own precipitation history, seepage history, infiltration history, and their own particle movement history through the mountain encountering or non-encountering perched zones, as I recall from the Albuquerque presentation. It occurs to me that there's probably some parts--I would like to see, if it's ever possible, the different responses, the different contributions of those areas to the term, and to wonder if there is one or more of those areas that are predominant in certain periods of time in terms of contribution to the dosage.

Off the top of your head, is there one particular area that is an early contributor, for example, in the first 10,000 years, for example, the northwest?

ANDREWS: We have those plots in the draft VA document, for six different regions. The arrival time distributions, I'm trying to think off the top of my head, so I should look at the figure, the arrival time distributions weren't dramatically different, but the amount of water in each of those six regions was sufficiently different so that it affected the concentrations. There's enough difference in average volumetric flow through those different regions such that that had a factor, I don't know, of two or something. It wasn't a big factor.

NELSON: It was only a factor of two.

ANDREWS: Yeah.

NELSON: So if you, for example, were to identify one of those areas as being a major early contributor and perhaps of concern for whatever reason, the prospect of actually turning off or not using that component because it happens to be a high infiltration rate or whatever the situation is, have you investigated that at all?

ANDREWS: No.

COHON: Dan Bullen?

BULLEN: Bullen, Board. Just a quick observation that when you added your sensitivity and took a look at a C-22 drip shield with its vastly improved performance of no release at 10,000 years and no release at 100,000 years, it seems to me that that sure looks like an inside out container. And so wouldn't you just want to flip the container design and not worry about the drip shield and take credit for that, or did I miss something?

ANDREWS: It's a four centimeter C-22, but if it was four centimeters C-22, what you say is more or less the case.

COHON: Dan has no problem with a four centimeter outer layer, I assure you. And you're generous, Bob, not to have said to him that is a design issue, not a TSPA issue, and I'm sure it will come up again later. So thank you.

The last word, however, is not Dan Bullen's. Don Runnells has a comment.

RUNNELLS: Runnells, newly of the Board.

I have a number of specific questions about the chemistry, and so on, and I know this is not the proper forum for that. I'll wait for a different forum to ask those questions. But the question I would like to ask of you concerns the conceptual model upon which this analysis is based, and let me describe for you a reality that we observe in mines.

Yesterday, for example, at the N Tunnel complex, which was very helpful, we went in a short distance and walked in puddles of water. There was water puddled on the floor. So I would like to ask, and I don't want you to answer yet because I'm not quite finished, but that's one main point, is how does the conceptual model you've used here take into account the possibility of a free puddling of water?

The second thing that we observe in mines is a seasonal or even an occasional flushing of the chemistry. It's called the spring flush. During the dry season of the year, the minerals which are very, very insoluble, the sulfide minerals, oxidize and produce secondary products, which when the snow melts or the spring rains come, that soluble material in the form of secondary minerals is very quickly washed out in the first two or three storms. And if we have an occasional El Nino, we see the same effect, but on a larger scale, a flushing of the dissolved metals.

That's the second part of my scenario, of my reality check on the conceptual model, so could you tell us how you incorporate or whether or not you incorporate these sort of factual observations into the conceptual model that you've described here, or that you've used here?

ANDREWS: Okay, let me take the second one first. All of the conceptual models of the unsaturated zone hydrology at Yucca Mountain would indicate what you say in the upper 50 meters, maybe even upper 100 meters, above the Paintbrush non-welded units, that you would see very dramatic transient changes that quickly propagate--hydrologic changes that quickly propagate through that upper 50 or maybe even 100 meters. But all of the assessments done so far would say that those, and all the models and all of the observations would say that underneath that Paintbrush, which is a non-welded tuff, that those transients, especially the short-term transients, are essentially damped out, so that you don't get, or the probability of getting short-term transients at the repository horizon is small. It may not be zero, and we have not analyzed the effect of short-term transients on releases from EBS. We did look at short-term transients and their effect on transport through the unsaturated zone as a sensitivity study, kind of what if study, but not in terms of how it impacts distribution or timing of seeps into EBS.

On the first part of your question, the assumption is these packages are sitting on a meter and a half of invert type material, and then another half a meter or so of steel pedestals. Eventually, those steel pedestals will degrade, with the reference design anyway, those steel pedestals will degrade just like the package degrades, so that the package will come and sit on the invert eventually, and that invert will have, conceptually anyway, will have sufficiently degraded so it looks like, you know, a crushed rock or gravel or something like that conceptually anyway, invert at long time. Any liquid water that gets in and that could get either into or around the package and sit in the invert, it is possible that it could pond, but eventually the head would be sufficient and the permeability of the rock is sufficient to take that water away. So this is a very permeable rock in the fractures anyway, and a well draining, if you will, rock.

So, yes, it's possible if I had a cement floor that I would see ponding, or if I degraded the rock in such a way that the permeability really was significantly reduced, then I could have ponding. But under even a limited head, which wouldn't take much, it would find those fractures, and that's the conceptual assumption anyway, find those fractures and be well drained.

RUNNELLS: Thank you.

COHON: Bob, thank you very much for a very good presentation, and a very good session. Thank you.

ANDREWS: Holly can walk through this visual part or--

COHON: Well, she can do that during the break, but we're not going to continue.

ANDREWS: Okay.

COHON: We're going to take a break now for five minutes, which is to say long enough for the Chair to get to the men's room and back, and we're going to reconvene.

(Whereupon, a brief break was taken.)

COHON: Could I ask the Board members please to return to their seats now?

We turn now to a presentation on repository design alternatives--could we please have quiet in the room? Thank you--by Michael Voegele, Deputy Director, to be assisted by Jean Younker. Thank you very much.

VOEGELE: Well, thank you for the opportunity to speak to you this morning about repository design alternatives.

We have described the reference design and its options, together with some features and alternatives that we're considering right now in the viability assessment. Our intention is to be able to consider a broad suite of alternative designs and eventually perform assessments of those. Our ultimate goal is to provide an acceptable repository design for the site recommendation and the license application.

We adopted an approach to derive the design features that we're going to address in the viability assessment based upon some performance related criteria. The criteria that we used generally came from the Part 60 additional design criteria, and the ones we focused on are primarily related to postclosure performance of a repository system. These were eventually supplemented by a few more closely related to worker and operational safety, and the ability to monitor important postclosure behaviors.

I'd like to make a distinction and try very hard to be consistent with that distinction as I talk to you this morning. I have a terminology problem. Being the person who wrote the last section of the viability assessment, everybody else had chosen all the good words, so I have to very carefully describe mine when I use them. I'm going to differentiate between the word design feature and the word conceptual design or alternative conceptual design, and that's deliberate because I want to draw a distinction between those particular pieces or components of the design which have the potential to enhance the performance of that design, or to make it more operationally efficient, as opposed to a different conceptual repository layout, a different drawing for the way the repository would operate. I will be sensitive to that distinction and I'll try to point it out to you at the times where it's important.

We looked at these performance related criteria and we grouped them into a number of alternatives. The alternatives that we grouped them into deal with containment within the engineered barrier system, other possible engineered enhancements. We had a group called integrated effects of thermal loading, a group related to waste package production and emplacement operations, and a group related more closely to deferred closure. You can see the performance related criteria on engineered barrier design. Orientation layout and geometry are more related to other engineered enhancements. Thermal loading and ventilation are more closely related. Worker operational safety and eventually monitoring postclosure behavior are related to production and emplacement, and safe operations and retrievability options being maintained are more related to a deferred closure, or something related to closure of the repository system.

We developed a comprehensive, I believe, list of design features for the alternative categories. These things you might recognize as things being like the principal factors that were described by Bob Andrews in his talk on performance assessment, and to tie this back to a concept that Russ introduced and that Bob used, the performance allocation concept, these are the types of things that one would be looking at if one were looking to do a different allocation of performance. If you had--relative to our reference design, there are different ways to achieve the performance that's required to meet a postclosure performance objective for a license. And so when I talk about these alternative design features, we were really trying to generate a comprehensive list of things that you could do to a repository or use to build a repository design that had a potential to make a more efficient or more cost effect or a higher performing repository.

Within the first category, the containment within the engineered barrier system, we described possibilities to look at, different waste package materials, especially one corrosion resistant material or two corrosion resistant materials, ceramics. We looked at barriers, drip shields, such as Richard's Barrier drip shields or diffusive barriers beneath the waste package, some sort of a chemical getter that we might put in the system that could prevent radionuclide migration.

We looked at internals, things like filling the waste package with some material. We looked at different emplacement modes. We were looking in particular for things like horizontal, ceramic line bore hole, a vertical bore hole. The reason that says angled or herringbone there is because if you just have a simple vertical emplacement into a--excuse me--a right angle emplacement into a horizontal drift wall, you need a quite large drift diameter to be able to accomplish that. The reason we looked at a herringbone type emplacement is so that you wouldn't have to make quite so large of a turn, which meant we were looking at trying to do it with a smaller diameter waste package.

We'd be sensitive and call your attention to the fact that I used a different color for some of these. This is another one of my terminology issues. the things that I used in the lighter color, the whiter color, are things that generally look like they could be applied to any design. They look like things that could be applied to our reference design. They look like they could be applied to a different conceptual design. The things that I have highlighted in yellow here are things that we recognized from the outset would probably require a different conceptual design layout to be able to implement that.

So the things that are, as a precursor to where I'm going, the things that are highlighted in yellow are the things that are going to result in the different design layouts that I'm going to show you later in the talk. The things that are highlighted in white are things where we're doing studies and will continue to do studies on looking on how they could enhance the performance of the reference design, or a different conceptual design. So there I'm using the term conceptual design and I try to distinguish that from the design features themselves. I won't belabor the point, but I may mention it again.

In the second category, other engineered enhancements, we looked at different ways to line the drift or not line the drift. We talked about potential for near-field rock treatment during construction to potentially impact the seepage into the excavation. We even talked about surface modifications. You recognize from some of Bob Andrews' plots that infiltration varies over the mountain, and it is a very sensitive parameter to performance of the repository, and we asked ourselves is it possible to do some surface modification that could have some impact on that.

We also looked at the integrated effects of thermal loading, and here is where we grouped most of the issues related to waste package size and spacing. We also looked at thermal load. We looked at some preclosure surface things that we could do, like aging the waste before it was emplaced, or blending it for a thermal management scheme, or for criticality. We looked at ventilation, and in particular, we looked at the potential for postclosure ventilation. We looked at waste package spacings, looking at the line loading approaches that you've heard discussions about before, and we looked at revisiting the temperature limits.

The reference design is designed to meet specific limits related to cladding credit, performance of zeolites in the rock, rock wall and surface temperatures, and we looked at what would happen if you relaxed some of those temperature limits and looked at a different approach.

We have rod consolidation on our list, potential for backfill, drift spacing and drift diameter fall in here. Once again, the ones that are highlighted in yellow are the ones that we believed took us to looking at a different layout to be able to implement these effectively.

Category four, the waste package production and emplacement operations, the design features we came up with there were the waste handling building on the surface, it's production capability and throughput capability. We looked at waste package closure technologies, in particular for those waste packages that might involve shielding materials. We looked at the fabrication processes, the emplacement modes, and the accessibility to the waste packages. Here, we were talking about subsurface accessibility where we might use a shielded waste package for personnel access, like a self-shielded waste package.

Our fifth category was the one where we looked at the relationships between retrieval period and deferred closure. We chose to link those together. They are not exactly the same thing. Deferred closure is a societal decision. If the society would decide to defer closure of the repository for extended monitoring, that's a possibility. It's very closely related to the technology related to retrieval as well, though. If you're going to demonstrate in your regulatory licensing process that you intend to maintain, for instance, a relatively easy capability to retrieve, then you'd have to also address the period of closure, because that is how long you would have to maintain the waste emplacement drifts. So we grouped those together there. So those were the list of features that we came up with.

Now, those design features that were independent of a specific alternative design, those are the lighter colored ones on the previous slides, we identified some of those in those categories, we believed that those could potentially improve the performance of the reference design, or in fact an alternative design concept as well.

We have initiated some design studies to investigate the potential for performance enhancement. I used the word performance rather generously to talk about cost benefit, all the dimensions that you would look at as you try to make a decision as to what's a reasonable alternative.

Okay, now, certain of those design features, the ones I highlighted in yellow on the previous screen, are best implemented in an alternative design concept that's feature specific. They generally reflect different layouts or a different basis for the disposal concept. Those are the ones that I am going to talk about the small number of alternative design concepts that were included in the viability assessment.

Okay, those alternative design concepts to different layouts generally address this grouping of those design features, the thermal loading grouping, which looks at area requirements, drift spacing, thermal limits like impacts on zeolites, the ground surface temperature. We looked at the near-field thermal limits, which dictate or influence the waste package size, the cladding temperature, drift diameter, waste package spacing. We looked at a ventilation approach, which dictates drift layout, drift diameter, drift spacing. and we looked at a waste emplacement mode, which looks at the waste package size, the arrangements, the spacing and the drift diameter.

I wanted to emphasize the viability assessment includes work plans for the studies and evaluations of these individual design features as well as for studies and evaluations related to the alternative design concepts that I'm going to talk about momentarily. And we believe those design studies are needed to evaluate the performance and select the reference design for the site recommendation and license application.

In response to a question that Dr. Bullen asked when Russ Dyer was speaking, that particular schedule that you were looking at, that word initial license application reference design was very carefully chosen. We believe that we are going to, given the constraints of the budget, schedule work in the next fiscal year to do these design studies, and Jean is going to talk about that momentarily. And there's a potential that we will get to that point and not be able to down select to a small number--to a single license application design, and so we would like to limit the number of options that we carry forward, but the word initial was chosen to recognize the fact that there may be still some uncertainty at that point in time relative to that design. So I think we're trying to be sensitive to that.

I put this slide up just to once again reinforce my point. We have a viability assessment reference design, and the options. There's a fair amount of evaluation of the performance of those, the postclosure performance of those that was talked about by Bob Andrews. Within the viability assessment, we've identified a number of design features and a small number of alternative design concepts that will also be looked at. And so what's going to happen now over the next year, and perhaps somewhat beyond, is we're going to do the evaluations, primarily focusing on the design features and the alternative design concepts, because we've done a fair amount of work on the reference, to lead us to that point a year from now, or so, where we can make an initial selection of our reference design for the site recommendation and license application design.

I think that what we're introducing here is an opportunity to have some interactions with the Board and the Nuclear Regulatory Commission on specific approaches that we're using to reduce--to do studies, system studies of these design features and their performance and cost, and select that initial reference design for the site recommendation. I think that could turn out to be the reference design. It could turn out to be the reference design with some modifications related to some of those design features. It could turn out to be one of the VA alternative design concepts, or it could turn out to be a concept we have not yet drawn on paper. As we do these evaluations of the design features, it may turn out that there is a design that might put some of those pieces together better than we've done any other way. So I think we're going to be sensitive to that as well.

Okay, the five alternative design concepts that I'd like to talk about this morning are, first of all, a waste specific containment design, a low thermal load design, continuous ventilation design, an enhanced access design, and a modified waste emplacement mode design. I will not take the time to go over the reference design. Bob did that. If you have any questions about it, though, I'm prepared to put the reference design back up, and we can talk to that.

Okay, the first one of these, the waste specific containment design, is a design that has a unique container for each waste type. There was a question asked earlier, it may have been Dr. Bullen that talked about--one of the Board members asked a question about if you were--would you avoid a particular area of the repository if you knew it was going to have higher infiltration. The waste specific containment design is dealing with that concept, and that is you tailor the waste containers to the specific part of the mountain that you're putting them in. So if you knew that you could not get--you could get higher performance in a particular part of the mountain for a particular waste container type, you would put it there and you would put something else in a different part of the mountain if in fact you could get better performance by doing it that way. So you would segregate the waste into particular parts of the mountain where the packages were designed to promote long-term survivability of the packages. And the surface facility for this would have to handle a different number of container types.

Okay, I'm going to have to do this because I can't put multiple slides up with the computer. I'm going to have to use both. I put up the picture of the reference design for this purpose, because our initial conceptual model, or conceptual design in our minds is something that might look a fair bit like the reference design in terms of the layout. I mentioned that we have a possible need to handle an assortment of container types and support multiple production technologies if we were using different waste container types. We think the layout could be similar to the reference design, but we also could consider a low thermal load configuration, and I'll show that one momentarily.

Within each drift, the arrangement we're conceptualizing at this point would be similar to the reference design. It would be an in drift emplacement design. And all the containers in a drift would be of the same type, and as I've mentioned, we would segregate the waste in areas, selected to match the performance characteristics.

One thing that is very obvious to a lot of people, over on the east side of the Ghost Dance Fault, there's a lower infiltration potential over there, so that might seem that we might put some of the waste over there. We might spread it out a little bit as well.

The next one I wanted to talk about is a low thermal load design. And you have seen I believe sketches of this before. This is one where we were trying to have an emplacement scheme that limited the drift rock temperature to less than 100 degrees C. What we were trying to do there was to keep the boiling fronts from coalescing in between the drifts to allow for free drainage out there, and we would modify the underground layout accordingly.

This is one where at first blush, you might conclude that a smaller waste package capacity would be used for this. That's one way of making a smaller thermal load. However, you also might be able to accomplish this by ventilation, so we don't want to close out that feature as well. The layout would encompass 2,500 acres. If you were to do the arithmetic and divide 70,000 metric tons by 25 MTUs per acre, you'd come out with 2,800 acres. However, if you take the 741 acres required for the high thermal load, which gives you--and which is at 85, that's 3.4, and you multiply those out, you'd get 2,500. So depending on how you figure your contingency, it's somewhere in the 2,500 to 2,800 acre site. It probably would require some additional site characterization. In this particular one, we've laid it out in the lower block, east of the Ghost Dance Fault, and we've over to the Jet Ridge area to take advantage of some of that area over there.

This is also conceptually thought of as an in drift emplacement scheme, and possible could, especially if we went to a smaller capacity waste package, could go to a smaller drift size than the reference design, looking at possibly reducing the maximum waste package capacity. In this particular conceptualization, we have not shielded the containers for personnel access.

Let me just go back and make my point again about the different design features that we're carrying studies along as well. Any one of those design features could result in an enhancement to the conceptualization that I'm describing here. So you have to think of these things in terms of each other. The reason there are five layout drawings in the viability assessment is because some of those design features needed a layout specific design to illustrate them. So they're not meant to limit the consideration of the design features; they're meant to illustrate how you might incorporate some of the design features.

Okay, we talked about a continuous ventilation design. Continuous ventilation design, the concept is one where we have continuous ventilation provided during the preclosure period, and that ventilation is continued after human presence in the repository is discontinued. That would be a closure concept.

This one, the surface facility could be similar to the reference design or to a low thermal load alternative, and possibly would have to have some additional air shafts to make this ventilation happen. This particular sketch I put up here, because it short of shows ventilation cells, and the designers like that concept of being able to isolate ventilation cells. It gives them some other design features as well that they can deal with, fire protection, for instance. But this one has additional ventilation shafts along the west and east mains to be able to accomplish that ventilation.

Using natural ventilation pressure, using the actual tendency of the air which has thermal currents in it to be able to self-ventilate the repository can supplement both the preclosure ventilation, and it would be the means that we would be looking at for this design to achieve postclosure ventilation.

I have some sketches here and I'll try to show you some of those things that we're talking about. This is one where we're looking at a lower thermal load in a ventilated configuration, and the difference between the previous low thermal load design that I showed you, and this one, is primarily the extra air intake shafts that would have to be made available to provide for that ventilation.

In this particular design, the exhaust mains would be placed above the emplacement area, and so you'd see there would be a fair bit of extra drifting to be able to accomplish that ventilation, and the engineers have done enough detail to have worked out a way that this could be achieved.

And in that context, the natural ventilation pressure cells in the postclosure could work sort of in a loop around, going down across the emplacement drifts, up to the central ventilation main, coming back across the performance confirmation drift, coming back down and working their way through. So you're looking at a natural ventilation circuit developing in the postclosure to provide some of that ventilation.

Okay, this is one of the models of technology. In order for you to have the same page numbers as I've got up here, I've got to put blanks in the electronic one. So sorry about that.

The enhanced access design is one where we looked at a self-shielded waste package design. It was designed to facilitate access for humans into the drifts where the wastes would be emplaced, and this one we believe eliminates most underground remote handling operations.

We're at the very early stages in trying to develop the conceptual understanding of what a design like this would look like, but at the surface, we believe there's a possibility that you would have to handle and close a thicker walled waste package if the waste package material itself provided the shielding. If you had some sort of a clam shell that fit over the outside of it, that would be a different design technology.

We're conceptually believing that this would be a smaller waste package and, therefore, a higher number of containers and that would require a higher throughout capacity. This is one where rod consolidation, as Dr. Bullen has mentioned several times, could provide some relief to that.

With this particular one, we were looking at a lower thermal load or potentially a higher thermal load if we had ventilation to provide the cooling that we would need. This would be one where we would try to keep the drifts at or below about 50 degrees C., but the combination of potentially a smaller waste package, lower thermal loading, ventilation, all look at different ways that you can approach this lower drift temperature. And this would be one where it would be designed so that the radiation level within the drift would be low enough for human access.

This is one where the container itself was self-shielded, but an ancillary benefit is that a shielded transporter would not be required for this scheme.

Okay, the last one I want to talk about is the modified waste emplacement mode design. In this one, we're looking at possibly putting the waste packages in a configuration where the repository itself could provide the shielding, either through the natural or engineered barriers. This one, we had vertical or horizontal emplacement in the floor or sidewall of the emplacement drift, and we also looked at trench emplacements in the floor.

Some of the old timers in the room are going to recognize this drawing. This is effectively the drawing that was in the site characterization plan for a vertical emplacement scheme. This was one where you would drill a hole in the floor of the waste package and set it in the floor and have a shield plug that would allow access within that drift.

This particular layout would not do much to reduce the diameter of the drift. You can reduce the diameter of the drift through horizontal emplacement. These are smaller containers that we've looked at right here, probably have to have an increase in the total number of containers. This would be a low or a moderate thermal loading for this option. I believe in the site characterization plan, we had about 57 kilowatts per acre for this type of a design. You have to ask yourself, however, what about the thermal limits if you're putting a smaller container in a small bore hole. So that's a question we're going to look at again. It's been looked at before, and we'll relook at it again.

Let me put another one up. This is the one where you can achieve the smaller drift opening by having a herringbone angle, rather than going in perpendicular. This one is shown going in perpendicular. You could put that at an angle and then you would be able to achieve a smaller diameter emplacement drift. This one is designed so that it's self-draining, and in fact we've also talked about ceramic lining of these types of bore holes to provide additional protection.

This is one we looked at, which is a small waste package in a trench. This one's a little bit difficult to achieve the smaller diameter, because you need a fair amount of concrete here, although if we went to some sort of uranium concrete or other scheme, we might get more shielding there as well. So we're conscious--this one's more difficult to achieve the smaller diameter, but we think there might be some ways to do it.

In summary, I'd like to just wrap up, and I'm going to ask Jean Younker to stand up in just a moment and give the real summary to my talk. But the viability assessment describes work that we're going to complete between the viability assessment and license application time, and we have identified alternative design features and some concepts primarily as an aid to develop our work plans between now and that point in time.

We have started work on evaluating these features, and we will continue to do that to more fully develop the design features and the alternative concepts. We'll be looking at performance predictions. We'll be looking at costs of that material. And as I said before, an initial design will be selected in May of 1999 to carry forward to support the site recommendation and the license application. This will be based on our strategies at that time for how we're dealing with defense in depth, how we're dealing with design margin. Those could also change as the regulations become more specific.

We have a Nuclear Regulatory Commission regulation coming out roughly in that time frame, an Environmental Protection Agency regulation coming out in that time frame. Both of those can impact our approach to how we allocate performance, if you'll let me use that term, what particular features and components we put our primary reliance on, how we address uncertainty, how we build our back-ups.

So, Dr. Cohon, unless--if you don't mind, I'd like Jean to finish the talk, and then either she or I will take questions. Okay?

YOUNKER: Okay, now what we have here is the rest of the story, and I'm not going to go to the high tech, just in the interest of time.

What you just saw is kind of a symbolic hand-off in a sense, because in our current M&O organization, Mike sits over in Jack Bailey's licensing directorship area, and they're the people who kind of put these strategies together. Mike chose the task force that generated the information you've just seen presented. I sit on the side that does the implementation, and so under Dan Wilkins and Collin Heath, we then accept that input, if you will, from the strategists, and we're going to go do the work. And so what I'm here to tell you is we're going to go do this work, and what we intend to do is on the slide that Mike already showed you, which is to end up with that initial SR/LA design selected in spring of next year, in May.

The way we're going to do that, just very quickly to tell you, is that we've decided to take an approach where we have an M&O program manager, someone you'll recognize, I put his name up here, Dick Snell, who used to be the underground operations manager, has been selected to coordinate all the activities related to taking this volume of information, all of the alternatives that Mike described, others that may still be added, all the design features that cut across those alternatives that potentially can be used to enhance performance. What we will then do is end up with that initial selection of the reference design. And of course given the time element and the time constraint, we felt it was really important to have one person who essentially coordinates that work across all of the engineering organizations.

Clearly, we'll take a systematic approach. The exact way we're going to do the structure, the overall framework of this evaluation is still being set up, but we'll consider the need for margin and defense in depth in the way that Mike already said.

We have some preliminary evaluation criteria that have been developed by a little working group that has kind of transitioned the results of the task force that Mike chaired over into the line organization. We understand going into this that preliminary evaluation criteria we're likely to use would be the more quantitative in numbers like preclosure and postclosure safety, ease of licensing and flexibility. The second bullet and the last bullet tend to be the ones that will be a little bit more subjective, and exactly how we're going to treat those is certainly still on the table. Schedule and cost performance clearly will have to be looked at and traded off against safety.

The selection methods under development, as I said, the way we'll go about down selection is something that we're going to pay a lot of attention to. I think that both Dan Wilkins and Collin Heath believe that there may be some of the features where we have enough information right now to in a very careful systematic way document the basis for eliminating that design feature, maybe eventually even an alternative, but at this time, we're going into this with the idea that the way in which we move from where we are right now to the selection of the SR/LA design has to be very, very systematic, very carefully documented, and you move through in a process such that we can track it from the suite we have now, any additions that we add to that final selection, initial selection, and then of course to a final selection.

What we have now is the framework. It gives us a basis. As Mike said, this is so important and so critical, we're heading into our very detailed fiscal year 99 planning, and so in order to do the evaluations that you all realize we're going to have to do to arrive at that selection of the initial design, there's some additional data we're going to need. There's certainly additional analysis that we'll need to support that evaluation. And so trying to get as far ahead of this as we can to get the right plans in place for fiscal year 99, and even to reprioritize a little bit of the work in '98, to the extent that we can, to make sure that we have the essential information to support the decisions that we will have to make.

And the last one just gives you a schedule that's in a plan that we've been working. Essentially, we'll try to get to somewhere in the October time frame having the full definition, as full as we can get, of the features and alternatives that will be evaluated, then do the evaluations and the recommendation as a milestone in our current summary schedule in May of '99.

So that was the symbolic hand-off, and hopefully that became clear to you. We thought it would work this way to let me wrap up for Mike.

COHON: Indeed it did. Thank you. Questions, Dan Bullen?

BULLEN: This is a quick one for Mike. How easy is it to put the low tech viewgraphs up? Do you have--

VOEGELE: I have a full set.

BULLEN: You have a low tech set? Could you pull your Viewgraph Number 13 and Number 21 and Number 23? They are repository layouts if you're looking through it.

Number 13 shows the ECRB cross drift as the enhanced characterization repository block, and if you put up Number 21, you have this continuous ventilation scheme which gives you that isolation that you talked about for fire protection and all that, which is really nice, and then the refinement of the mined area above the exhaust mains doesn't show me where the ECRB is on all this. And does the ECRB interfere with the potential to do that isolation for the fire protection, and does it mess up your flow patterns, if you will, for the exhaust areas above the mains? And has that been considered, and if not, maybe you'd better.

VOEGELE: That was one question; right?

BULLEN: Yeah, all at once. But what I want you to do is just look at the three pictures, and I don't see it on there, so just show me where it is, and does it hit those?

VOEGELE: Well, on this diagram, it would go right across, see roughly where it goes across there.

BULLEN: Right. So your isolation of the bottom four, or the four on the right, probably might not exist unless you do a real good job of closing them.

VOEGELE: Or we put the--we don't use a performance confirmation drift. We don't use the ECRB as a performance confirmation drift, and physically separate those two. If we're going to rely on that separation across there, we might not be able to intersect those drifts unless we're convinced we can actually build those fire walls or those ventilation walls.

BULLEN: And I agree. I guess the question that I have is in the current placement of the ECRB, is there a potential to compromise the ability to do this? And has that been evaluated?

VOEGELE: I do not believe it's been evaluated. I mean, the answer to that question has to be yes, there's a potential there because we haven't done the evaluation yet. I don't believe it will be difficult to do this at a different vertical elevation to keep them from intersecting if we were not able to convince ourselves we could have them intersect. We still have an issue in the program relative to what the performance confirmation program looks like and, therefore, what the performance confirmation drifts look like. That still is unresolved.

BULLEN: And you know me, I'd always like an ECRB that goes east/west instead of northeast/southwest, but that's just my personal preference for keeping things simple, not making them complicated.

VOEGELE: And as you and I have spoken before, the reason that drift went at the angle that it did was to be able to give us more information about the geology. It was a compromise for us as well.

BULLEN: Right. I understand.

VOEGELE: We wanted to maximize the geological information.

BULLEN: I just wanted to make sure that it's not a problem later on.

COHON: Debra Knopman?

KNOPMAN: Knopman, Board. On, Jean, one of your last slides talked about using some kind of formal decision aiding process. You talked about criteria for evaluation, which in optimization lingo is objectives. You have a multi-objective problem with at least five objectives I think, if I counted right. I'd be very interested to hear what sort of approaches to evaluating alternatives in a formalized framework you're entertaining at this point.

YOUNKER: What we've done is we've sought some advice from a couple of people. I'm sure that you would recognize names like Delafan Van Winterfelt and Steve Horra (phonetic). Both of these guys have worked in the decision analysis kind of world for some time. They're looking at where we are right now, and they're going to give us some feedback. In fact, we've talked with them once already about the approaches that we might consider taking, and so we're going to lay something out in the next couple of weeks and then talk with DOE about that to make sure that they're comfortable with the approach that we adopt. But essentially in the next couple of weeks, we'll be laying that out with some input from the right kind of folks.

COHON: Thank you. Priscilla Nelson?

NELSON: I'm must quickly follow up because Dan made his touch so gentle that it took me by surprise. And I expect it to be more forceful, so I feel compelled to enunciate I think the importance of incorporating the ECRB as a de facto opening in the mountain in all drawings that show the mountain and the repository as a fait accompli, and to make sure--there was a request longstanding I think from the Board to really have a document that shows the no impact or the evaluated impact of the ECRB on planning for future use of the mountain space. And that's what he was requesting, and I think we'd still like to have that document that shows exactly that any trade-offs or compromises that might exist in the future have been considered in choosing that location. So we still look for that.

COHON: Dick Parizek?

PARIZEK: Parizek, Board. On Figure 21 that shows the ventilator shafts, are these vertical right to the land surface? And if so, might they be like drain pipes? Because if you have the possibility of perched water up on the PTn, you can almost imagine how you could vent water downward as well as upward by a natural ventilation system.

VOEGELE: The shafts along the outside edge?

PARIZEK: Yeah, they come clear to the surface of the ground?

VOEGELE: Yes, they do. These are in fact set outside the repository area in this conceptual layout simply to prevent that direct passageway of water into the repository.

PARIZEK: But then it could also be a drain pipe intentionally engineered in in order to get rid of water that might perch above?

VOEGELE: Certainly.

PARIZEK: Has that been considered as a possibility?

VOEGELE: As I said, we have just begun the studies on these as well. Many times we have features which conceptually seem very attractive from a design perspective, but the question of demonstrating reliance upon them for long periods of time is a much more difficult issue, and often times, we back away and introduce conservatism into our analyses because we cannot determine how we could demonstrate to the Regulatory Commission, for instance, that we could rely on this for a long period of time. And so often there are things that other people believe we should be taking credit for that we can't figure out how to build a licensing argument that we could convince somebody that this would work as a drain pipe. So we typically walk away from those.

PARIZEK: A small hole in rock won't collapse and it will be a drain pipe, probably very reliable, assuming you had water to vent down that hole, which would be a PTn perched water some day in the future.

VOEGELE: I believe that. The geology is just perfect for making that happen, the dipping rocks above the repository horizon. It should work that way. The skeptical person in me would say what if pathways clog up as that water begins to move, and all of a sudden those drains become ineffective. Those are the kind of questions we ask ourselves. I don't know how to address Dr. Nelson's question that wasn't really a question, but I feel I need to say that there will be a comprehensive evaluation of all the interactions of the different components of the repository as we look at these alternatives. That has to come out of this. We have to look at how to make these things happen.

NELSON: Okay. Well, just since you responded to that, what we were looking for was during the discussions at some point in the past, we heard verbally some discussion about the selection, but it was mainly geared towards the science in terms of the orientation. The impact of what it means to have a hole in the mountain, just simply an evaluation of that and an assessment is I believe the document that we would think needs to be done.

But I also want to ask you what is a metal lined drift? I've never seen a metal lined drift on a list like this before. Are you considering metal lined drifts?

VOEGELE: This is one of those questions where I can come at it from a number of different ways. We tried to make sure that we encompass a broad range of potential ways to deal with the problem without constraining them. We did not want to say, well, you know, I've never seen a metal lined drift so we won't consider it. I have stacks of comments that high on my list of design features saying you can't do that, just throw it out of the list. And that we felt was unfair. If the problem we're dealing with is seepage into an excavation, we asked ourselves the question what are the multiple ways of keeping it, you know, some sort of grouting pretreatment, some sort of a different lining, some sort of a metal shield, you know, it's the drip shield moved up to be in contact with the rock wall. It was just a conceptual idea that I place no, in these slides, no personal prejudices or no--I'm not going to tell you whether I think it's a good idea. I'm going to tell you it's an idea that came up in our discussions, and it's one that we need to look at.

COHON: John Arendt?

ARENDT: Arendt, Board. Have you done any design work on the transport or the gantry that's going to be used? And have you done anything in regard to a failure analysis of these pieces of equipment or other equipment that may be one of a kind?

VOEGELE: You're talking about for the reference design?

ARENDT: Yes.

VOEGELE: Yeah, maybe I could ask Dan McKenzie to--I don't know how much risk analysis you've done, or how much of a failure analysis they've done on those gantries. I know they've done design analyses on them because I've asked them specific questions about why can't you do this with the gantry, and they say, well, that's because it fails this way. So he's got to have sort of an answer.

MC KENZIE: Dan McKenzie, M&O. We've done one design pass through the transporter and through the gantry, and we haven't done a whole lot of failure modes analysis. I think it's sort of inherent to do some of it when you design it, and you think about what could break on it, so you try to make it as simple as you possibly can. We haven't done those kind of analyses that would evaluate all the individuals modes of failure and the consequences of those failures. That's in the future. We're really kind of slowing down on that since we've got a fairly wide range set of alternatives that we're going to evaluate. We may end up with a set of replacement equipment that looks radically different than what we have right now.

COHON: Debra Knopman?

KNOPMAN: This is a quick follow up to Priscilla Nelson's comment, which was a follow up to Dan Bullen's comment. And I just want to go back to the ECRB and the layout because when the scientific considerations were made and you employed a fairly exhaustive process of looking at alternatives for the layout of the ECRB, what I don't think was in the mix were alternative designs for the repository. And this we are at a critical decision point, you are, in terms of proceeding with the current design for the ECRB and the northeast/southwest trend. It doesn't have to be that way. It could be changed. It's not too late to change. And since you're now starting this analysis of alternative repository designs, there needs--it seems like you may need to go back and look at ECRB designs in that light.

Now, there's obviously the Board has an interest in seeing this tunnel completed and there's a lot of scientific work that is on a critical path. On the other hand, we're all concerned, as you are hearing, about precluding some alternative designs because of a consideration that was made without those alternative designs in mind. So each of my colleagues was saying that in different ways. I just wanted to make sure we put a very fine point on this, that we hope there is a conscious decision made that this will not be then used as an argument against otherwise attractive alternative layouts or alternative repository designs.

COHON: I get the last comment and we'll close this session. I think it's very important that you consider and try to project the technologies that will be useful in the future so as to limit human presence in the repository. I think that if you don't do that, you run the risk of making I think what would be a serious mistake in terms of adding substantial cost to the design, even though it was not necessary.

Robotics technologies, and here I speak as president of a university that is very, very active in this area, robotics technologies are extremely powerful now, and if you project ahead an appropriate number of years to when a repository might open, they'll be that much more effective and more than that much more probably powerful. And, therefore, I think to fundamentally change a design to allow more human access I think is probably not wise. But to make that determination, you've got to look at the technologies.

That was one person's opinion. That's not a Board position. Whenever I say this at Board meetings, I get yelled at by my colleagues.

Thank you very much. It's a useful session. Let me make one brief announcement with regard to our schedule. Because the TSPA session went longer than we had hoped, and the representatives from DOE had hoped, we did not have time to see the public version of the TSPA presentation, if I can call it that, and it is available and we would like to see it. I think the Board members would be very interested in seeing it. We're going to aim to do that at the end of the afternoon presentations, but we will respect the schedules of members of the public who want to comment and who don't want to stay to see that slide show. So it will come later if you're especially interested in it.

Now, as promised, we have about 15 minutes available for public comment, but let me negotiate with those who would like to comment. Before you choose to comment at this time, please consider your own schedules and the schedules of everybody else. We want to keep this to 15 minutes so we can have a full 45 minutes for a lunch break, which already is abbreviated. That means in deciding whether you're going to comment now or not, please take into account your own schedule. If you can stay till later on this afternoon and not comment now, please do so. And if your comment is not particularly connected to anything you've heard this morning, that's another reason to postpone it until this afternoon if you can be here this afternoon.

Now, with that, I will tell you that three, perhaps four people signed up. Let me just make a quick check. Tom McGowan, I know he signed up. Sally Devlin, you're on the list. Judy Treichel is on the list. Joe Ziegler, did you mean to sign up to make a comment, or did you sign the wrong list?

ZIEGLER: Wrong list.

COHON: Wrong list? Okay. So I have three people who would like to comment. Is there anybody else who would like to comment now?

(No response.)

COHON: Okay. Now, for the three people on the list, do you really want to comment now and hold up 80 people who are dying of hunger? Yeah? Ms. Devlin, please do. Now, I will ask, I'm going to be very strict in keeping this to five minutes, because you'll get another crack this afternoon. Okay?

DEVLIN: I will, but I have to say something because Lake Barrett always leaves and this will be my first opportunity to get to him.

COHON: He's staying. He's staying.
DEVLIN: Are you staying?
BARRETT: I'm staying all day.
DEVLIN: All right, I'm going to be very brief.
COHON: Okay, thank you.
DEVLIN: And that is I want to thank you all for coming to Nevada. As always, we hope you have been properly welcomed, fed, housed and all the good things. But what is most important, and again I am saying with Lake, and that is I want to thank everyone for sending me all the information that I required, particularly Carlos, who gave me all the definitions of the different classifications of waste. I got some more from somebody else. I got some from UNLV. And they all rather coincided, and so this really is what I am bringing up. On Lake's report, he did something that offended me, and I'm going to say it publicly because I never say anything behind his back, and that is you used the Royal Plural we, we will, we are, we this, and as an old toastmaster, you don't use the Royal Plural in your reports. you are a group of people, and it is--I've never seen this in the Board reports. They say the Board this or whatever. I don't know who you're working with, and I would like to. But it isn't we, and it sounds like it's a done deal and I very much resent that.
The other thing is if you remember three years ago

October, I read the Congressional report that stated that the Naval spent fuel could have 10 per cent in the mountain, and everybody went, oh, we didn't know that, or oh, my God. And so this has progressed quite a way in the last three years. What is bothering me, as of course you all know that I have read all the INEL reports and I just read Lake Barrett's report, and I think the thing that bothers me the most is of course you know I pick up the phone and call everybody, and I did call Captain Carver and I spoke to him regarding the Naval spent fuel, and I said, "Why in the world do you want 300 canisters for 5,500 metric tons of spent Naval fuel," and he said, "Well, we're going to put in mixed waste." And I said, "What kind of mixed waste," and he said, "It is classified."

Well, you don't say classified to this old lady, and we have just gone through a whole bunch of things that you're going to do with the canisterization. I have attended all of those meetings. I have given you--for canisterization, and I can't figure out quite what you are doing with all this canisterization, because of the wrapping, or is it going to be copper, is it this or that, I really think you are doing this at the surface, not explaining it.

COHON: Excuse me--

DEVLIN: But I certainly don't want anything classified in my mountain and I think this needs a lot of clarifying.

COHON: Excuse me, Ms. Devlin. The answer might be lurking behind you. Did you want to respond to Ms. Devlin?

SMYDER: I'm Jim Smyder. I'm the Naval Reactor's Representative at Yucca Mountain.

Sally, first of all, the Navy has no mixed waste or no hazardous waste.

COHON: Hang on. Could you raise the mike?

SMYDER: The Navy has no hazardous material or mixed waste that we are providing to the repository. The Navy is providing 65 metric tons of spent nuclear fuel. What we are providing to the repository is identified in our spent fuel container system EIS that we issued in November of 1996 that I will provide to you later this afternoon if you'd like that. And I don't know who you spoke with, the name isn't familiar with me. Well, I'll tell you what; I'll give you a name when we leave here today, and I'll give you my name, too, but we have 65 metric tons, which is .1 per cent, less than one-tenth of 1 per cent of the total that's going into the repository. But the only thing that's classified about our material is our design, and we are closely linked, we being Naval reactors, is closely linked to the Department of Energy, both through Lake Barrett and through Dr. Dyer in incorporating our fuel into the repository. But we have, like I said, we have no mixed waste, so you've been misinformed there and we'll attempt to clarify that, and our report issues everything that we're doing.

COHON: Good. Thank you very much.

DEVLIN: But you heard classified in our design, so we're talking about lots of different waste. We've been on fissile fuel, we've been on all these things and there is a question mark as to all these different heat elements and what have you. Thank you.

COHON: Thank you. Ms. Treichel, do you want five minutes now?

MS. TREICHEL: No.

COHON: Thanks, Judy. They all want to speak with you, Lake. That's very nice. Mr. McGowan, five minutes, and I'm--your time just started.

MC GOWAN: I'll try to meet the challenge. Incidentally, off the record, I think it should be off the record, you have the same standing ovation in the lonely conceivability of the perception of many of the people here with regard to the option to leave in toto one way and permanently any time you so desire. The public is here not because we choose to be here, but because somebody better be here. But that's simple, unpaid, voluntarily. Hello, Dr. Abe.

Mr. Chairman, esteemed members of the Board, key staff, many attendees, my name is Tom McGowan. I'm an individual member of the interested and affected public residing in Las Vegas, Nevada. In preface, I commend your dedicated efforts to date, with the admonition that I expressed the same sentiment to the World Cup U. S. Soccer team prior to the defeat by Iran. It's okay to laugh once in a while.

In an agreement with Chairman Cohon occasioned during mutual visits to the coffee urn, it was determined that by noon, public comment, which is now, would not exceed substantially less than the allotted the minimum five minutes, offset by the as yet unresolved demand that my comment following alternative afternoon session prior to adjournment, may continue for an enduring term, conceivably as much as six or seven seemingly interminable minutes, or until the arrival of my ride, whichever shall occur sooner.

Thus, in the reasonable assumption of the Chairman's nod of tacit approval, I can't see for the reflection--

COHON: Yeah, your time is almost up.

MC GOWAN: This is time, incidentally, about a minute and a half a page.

COHON: Okay, I'm sorry.

MC GOWAN: Feel free, reinforced by a two-thirds majority vote of the members of the Board. Have you got two-third here? Yeah. I'll proceed unabated and forthright disclosure of the salient highlights of my late afternoon dissertation in what may be the briefest address of my entire career, and consistent with my firm hope and belief that the DOE OCRWM site suitability characterization study and licensing aberration shall require and ultimately endure in terms of scientific certainty and viability, substantially less than the total allotted public commentary time. In my opinion, you've exceeded your time constraints long ago.

Forget about budget. That's indisputable. So stated, mindful of the historical DOE pensient for exhaustive presentations, which seemingly begin with once upon a time, and proceed to where working on it, then ends summarily with happily ever after, in the highest traditions of the best of the Brothers Grimm, barely reinforced by the multi-faceted insight, suppressed by the legendary opening remarks of Director Lake Barrett, and perhaps recommendation of the Board's Congressional persuasive capability and intent, if not to spite--at least in ultimate acknowledgement of the expedient velocity of defense in depth of that which thereas and thereby and here futably self-evident, as intrinsically indefensible, I would readily assert my individual layman's opinion as--and here it comes--adamantly supportive of the scientific validity of both the Jerry Schzimanski (phonetic) and the Charles Hockenbull (phonetic) hypotheses, and of the recommendation of the scientific testing, and on the approval, or to otherwise defy the disconcerting accumenic fact of the underground hydrogeologic domain among other things throughout the vast cosmos is naturally ordered as in the state of dynamic flux, ongoing and continuing from inception to eventual decision, or in the sense of reiteration.

Thus, the fondest hyperbaric envisionments of Dr. Jared suggest honest Abe Van Luik, among other supports of evolution is not a worst yet self-induced and securely entrapped between a welded tuff, a fundamentally flawed reasoning in which we're damned if it is and damned if it isn't. But that's one day Dr. Van Luik and his apparent quasi aspect as a member of the general public, unaffiliated with DOE at this point. Have you resigned yet or been asked to? They didn't think of that. And I only have two words for them. Love ya. I think I'm going to forego the rest of this in deference to me. My throat is getting dry, and apparently--a standing ovation.

COHON: You get applause.

MC GOWAN: That's why he gets the laughs. Thank you very much for your time and interest.

COHON: Mr. McGowan, thank you. Thank you for respecting our time limits. It's nice to have you back at our meetings.

We now will take a break until 1 o'clock.

(Whereupon, the lunch recess was taken.)

AFTERNOON SESSION

COHON: Please take your seats. We begin this afternoon's session with a presentation on Post Closure Safety Case by Jack Bailey, Director for Regulatory and Licensing.

Mr. Bailey?

BAILEY: Thank you, Dr. Cohon.

COHON: Thank you.

BAILEY: Great. I appreciate the saving of the technology as a podium now, if not actually for use.

I'm going to talk today about post closure evaluations. We call this the Post Closure Safety Case. I'm going to draw heavily from Volume 4 of the Viability Assessment, which is where we talk about the license application plan. How do we get to the license application? I'm, of course, sensitive to the discussion earlier today with regard to the fact that there is a site recommendation and a license application and that they are heavily intertwined. And so you'll see throughout my presentation site recommendation and license application sometimes singly, sometimes as both. But we, of course, are sensitive to that.

The intent is to briefly discuss our approach to the SR and LA planning. You've had a full morning of what do we know, what do we learn from this assessment of the viability design and the science associated with it and discussion of alternatives which have to be considered, and somehow we have to have a path forward. So the license application plan is going to push a path forward.

Dr. Dyer identified that I'm going to talk performance allocation. This is clearly a performance allocation process. It doesn't select the license design this morning or this afternoon, but it puts us on a path to try and find means by which we can decide what's important and what's not important, what to focus on and how to put the whole sets of pieces together. And as such, it becomes a difficult presentation because you want to talk about understanding, you want to talk about defense-in-depth, you want to talk about license ability, and when you put all of those together, it gets a little touch. And so I'm going to try and keep those separate and bring them back together a little later in the presentation.

The goal is to develop a process and make choices on how to move forward. And remember that we did this on a reference design, a snapshot taken of a design we chose sometime ago. And clearly from the alternatives, and, frankly, from what we've learned about the system with our tools, the performance assessment, we rethink what goes forward. In other words, this was a snapshot. We learned from it, and now we have to move forward. And that's what the talk is about.

Hopefully, you saw a progressively improving understanding of the repository system. Over time we should be watching as this gets better and better. The natural features, we think we have a general understanding of the behavior of those features. We believe we have some reasonably bounded parameters. We certainly have uncertainly associated with them, but they're reasonably bounded, and if they aren't, then we need to work to do that or take them out of the mix if we don't know. And there's testing and data that may yet be needed to close on those items.

Once we have the natural features known, the next system, move to the engineered features. What do we do with the engineered features to take advantage of the environment that we now believe we understand inside of Yucca Mountain?

Then you have to go to the system performance, and we believe we have the tools, based on what you saw from Bob Andrews this morning, and we may have to manipulate them in some different ways to come up with some different answers, as was suggested, but we believe we have the tools now to take the natural features, blend in what's happening with the engineered, and come up with an understanding of how the whole system works. And that's what the Viability Assessment has told us, and what we want to do is use those tools to decide how to move forward.

So the VA assess the natural features, the reference design, and then the design options to show the ability to change and identify and work with new features that could have an overall effect on the results.

The LA Plan has to focus on understanding of the reference design and the options. We don't want to just lash something together and go forward with it. We want to get an understanding of each piece. Part of the reason that we had Bob Andrews break it down into a series of factors, to understand what are the primary pieces that make up the system and how well can we understand that system.

The identification and importance of the critical elements to overall performance, let's look at what's important. Let's not spend our time on things that aren't important. What are the uncertainties associated with these critical elements? How broad are they? Are we pretty confident; we know exactly what it looks like, or is it pretty broad? Is it a broad range of performance, and do we know where the central tendency is, or could it be anywhere? And can we use the performance assessment tools to grab and do sensitivities on different ranges inside of that uncertainty? And when we do that, are there tradeoffs when we have these uncertainties? Can we trade something off?

And I'll come back to that.

And finally, we have to go to the consideration of the design alternatives, which Mike Voegele talked about, and additional design features. Take what we know and put more into it to try and get to closure.

Now, Lake Barrett this morning discussed some of the potential licensing strategies, in particular defense-in-depth. I came out of pretty much the same life that he did, so I think of it in terms of lots of barriers. I'd like for them to be redundant. Actually, one is the double thick waste package is a way to look at that, or diverse, something by which it fails by means of a--has a different failure mechanism. One of the obvious interest in ceramics, it's going to fail in a different manner than is the metals. And when you can take an uncertainty of how the metal behaves and an uncertainty of how ceramic behaves, the total uncertainty in the system should be reduced.

And finally, we have to think about the detail necessary to docket the license application. What do we really have to know about these systems? To put it very simply, what you have to know about the dynamics of wind or loading on a quonset hut is a lot different than on the front end of a jet airplane. So it's how much do you have to know. We don't have to know everything about everything. We have to know enough to characterize the problem properly and have proper interactions and come up with an answer with uncertainty that we can believe. So we have to use all of those items in order to move forward for a licensing case.

On your charts, I'm afraid the arrows didn't come through on the black and white charts. The arrows didn't come through. But to try and put what I just said into a chart, you'll see over here we had attributes and hypothesis testing, the repository safety strategy that Russ Dyer talked about this morning. What do we think is the approach that we should use inside the mountain to be successful in isolating waste, and what are the major hypotheses that we have to go work on? What is the testing we need in order to get there?

We've done the bulk of that type of work, and we've moved to the next stage, and the next stage was to move to this VA assessment, whereby we picked our principal factors. And for the reference design, as it shows, we had 19 principal factors, and we had two additional principal factors that came about because of the drip shield, the ceramic coating and the backfill and those combinations. And I'll have a slide that will talk about that a little bit at the end.

But we're now focusing on what does each factor mean to us. We're refining our knowledge to move forward with each piece of this rather than standing back here at general gaining of knowledge. We believe we've closed in enough on the general knowledge so that we can focus on specifics.

Now, let's ignore this side, these two boxes for a moment, and what that means is we need to evaluate and understand the principal factors. We have to get that importance to performance, which ones are the most important. What's our quality of understanding? How comfortable are we with what we know? Do we believe it represents it, and how much uncertainty? And how much can we know? What's our projected quality of understanding? If we're moving to a license application in 2002, we have to be frank and say, how much more can we know in the next couple of years. So we have to think through what can we really know and then assign a strategy that takes advantage of what do know, what we can know, and see if we can be successful.

Now, with that, we have to consider the licensing aspects, which again are performance margin. The margin might be in the design end by making it thicker than it has to be, for example, or it might be in the performance end by establishing an artificial, if you will, or a forced margin below a proposed standard, below a standard, so that you don't approach the standard and you have some margin to deal with your uncertainties and your unknowns; and defense-in-depth where you try and look at redundancy and diversity. And defense-in-depth can happen within attributes or within factors. We have to think of it in both of those terms.

Now, if you do that with the reference design, we would go through the reference design, try and come up with a solution and move forward to an SR/LA design. Straightforward process; if we weren't going to consider anything else, we'd take everything we have in the Viability Assessment, everything that we've learned, and try to come up with a license application design.

However, as you heard and you're aware, we have design alternatives; for example, a low thermal load or a waste package emplacement mode, which change the basic configuration of the facility, or a series of features which I didn't list, but which are those things which we could add to almost any design to try and improve its performance.

And then what we have to do, and this is an important point, we have to go back and identify sets of principal factors for the new design. And what's important in today's design may not be what's important in a different design, and, in fact, it may not even be the same set of principal factors. If we factor in just the options for the reference design and we start putting alternatives and additional features, then we may shift the importance to different portions of the system, and it is a system problem that we're trying to work on. How do we get the entire system to perform?

So what our chore is and what was described earlier is to take these alternatives and work this whole process again putting all of those pieces together to come up with a design that we can move forward with for the SR and LA.

So as I said, I can't choose, I can't identify to you our SR/LA design today, but I can talk about the process and how we're going about making those selections with the recognition that as we do these developments of these areas and redo principal factors, that we're going to use basically the same process.

Now, Volume 4 is clearly under development. It's a part of the Viability Assessment. We're still discussing what it is. Some of the numbers are subject to change as we work through the system and bring all the pieces to bear. As it was said, values in the tables have changed in the last month. Some have changed more recently than the last month, and so we're constantly looking at what the system does and what we can learn about it.

Now, at this point, I revert to the old life. A slide of mine didn't make it into the presentation, I'm sorry to report, and it was put on your desk, I believe. It says "Jack Bailey" on the top of it. You don't give it back to me. It's actually for you to use. And in this I'm going to talk a little bit about what the VA was about and what the SR/LA design is about because they're different, and we've heard a lot about it today.

The VA design focus was to use expected values. What is happening in the system as best we believe it, the mean of the uncertainties? What do we think is really going to happen in the system and how is this system going to work in the way that we believe it's going to happen? And so we tended to work expected scenarios and we look to see what kind of a result we got from expected scenarios; pretty straightforward.

And you'll notice that there is a performance measure placed up above. We don't have a regulatory standard. We don't know exactly where that's going to be, and this is, of course, artificially placed. We have some planning guidance to look to, but basically we don't have that performance standard set yet, and as we said, we're dealing with expected values.

We then took a look at options, and we looked at the options to see what does the option actually do for us, and, in fact, the options provide us with some improvement. And that's what the VA design focus is, it's to learn about the system.

Now, Bob Andrews also talked a lot about different sensitivities that were run so that we have some understanding of what happens to the system as start to perturb it in a runoff situation and see which of the options or which of the factors dominate when you start doing those kind of evaluations.

For the license application, we have to run a scenario basis we believe. We have to do--

CRAIG: Could you explain--

BAILEY: Certainly, I'm sorry. This was on any given scenario, what the probability of distribution would be of the parameter, flux for example. It might range from zero to 30, and we took the central tendency here, or the expected scenario, as our likelihood of occurrence. We took the largest value.

Over here, we're dealing with time and dose rate. And again, it's for the specific scenario. It's the range or the probability distribution function of what the feature could possibly have as its potential values.

For the SR/LA, we believe we have to do a sampling of the entire range. As Bob showed you with his multi-realization charts, you sample lots of these in lots of places, and you end up with different answers that says you have this large range that it could actually appear between.

We don't know yet what the regulatory basis will be. Will it be a mean of all of those, will it be a 95th percentile of all of those? Will it be a mean with some required margin? We don't know what the answer to that is going to be, but we recognize that we're probably going to have to deal with the entire suite at this point.

Further, the defense-in-depth is going to take us into the low probability scenario, a tail of the curve, which might be either end, depending upon which is more limiting to the facility. And we're going to have to evaluate it, and it, in fact, may cause a larger perturbation. So we may have a very robust design with lots of options or features added, which is going to form a basic scenario very low, but we may take a low probability event and see what kind of a result we get for it if we took it in the deterministic manner.

And that's one way to treat defense-in-depth; not necessarily the only way to treat it, but that's one of the ways that we're thinking in terms of, of doing the runoffs with regard to the low probability event, but that low probability event having a large impact outside the repository.

So we work very hard here to get an understanding of the system, and then we have to put together a system, which likely will be more robust than the present system because it has to be evaluated in a different manner, and it has to deal with the defense-in-depth strategies.

With that, we'll look briefly at the Post Closure Safety Case that's laid out in Volume 4. And what that is, is focus on the elements, provided reasonable assurance that public health and safety will be protected.

We need a comprehensive understanding of the natural and engineered features. That's what I'm going to talk about as we go forward in this presentation. We have to understand the system, and we have to understand computationally how to work with the system.

Now, there's some pieces, which I'm not going to talk to you about today, but I want to cover quickly, and that is, as I said, we have to incorporate design margin and the defense-in-depth. There are several ways to accomplish that, but we have to do it. That may, in fact, add features to the design in order to accomplish that, which may, in fact, cause the expected case and the overall results to get better, but we have to deal with the how to add the defense-in-depth with the margin into the design.

We have to have explicit consideration of disruptive processes. It's very nice to work on the system, but if a volcano is going to take it and move it away, then, obviously, we don't want that to happen, and we are working those issues to show that from a disruptive point of view, that they will not disrupt the facility unacceptably.

We have to look at the supporting information from the natural and the manmade analogs. We have to be able to answer the question such as posed this morning of the spring flush. We have to think about what all those pieces are and make sure that we have the understanding that says this jives with how we see these things operate in nature. So we have to have that piece of credibility.

And then finally, we have to have a performance confirmation plan which demonstrates that we have the ability to measure those parameters that ultimately will identify that the facility is behaving and performing in the same manner as our analysis. All those pieces have to be done.

In addition to that, there's a lot of other work. There's a preclosure, as was discussed, and some questions have been asked. We have operations. There's emergency preparedness. A whole bunch of things have to be done to write a license application, but we're going to stick to the post closure here in this discussion.

Now, if we go back to the attributes of the system, we try to limit the waste package environment, make the waste package robust, keep it in the package as long as you can, and then reduce the concentration as it migrates. It fits fairly well with what we discovered. The majority of the radionuclides in the repository are not particularly mobile in the Yucca Mountain environment, certainly not at the time of emplacement. They're either insoluble or they sorb strongly in the local--the remainder could be transported by water movement. That's what we discovered sometime ago, certainly no news with regard to the four attributes. And the natural features are, in fact, favorable for limiting transport by water. There isn't a great deal of water movement.

And finally, the site provides a predicable and stable environment for the engineering.

Now, with those thoughts in mind, if we move to performance allocation, what do we need to know? I'm going to do this twice so you'll get a couple of chances to ask questions.

We have to understand the required performance of the system. I keep coming back to that. We have to understand what we're dealing with, and that is the four attributes. We have to understand the factors that affect the performance of the system. Those change from design to design, but we've done it for the Viability Assessment.

We have to determine the importance of those principal factors with regard to overall system performance, decide which ones we really need to work on and which ones we don't have to work as hard. We have to determine our current confidence and our understanding of what those mean. We have to understand how much do we know about this, how much don't we know, and where do we go from here.

Then we have to look at what's a potential confidence we have in the future. How much can we know? What can we reasonably expect to learn in the next year to two years, and make determinations on how to assign our resources in that regard or look for different alternatives or engineered features.

And finally--well, not finally--determine the performance allocation for LA. Make a decision of how much harder are we going to work on this. And I have some examples that I'll walk through.

And then finally we need to determine the priority of the technical work for the LA, which turns out to not be too hard once you decide how you want to allocate your performance. And Jean Younker is going to talk about some examples of the work we do and why to tie into this.

Now, this is a chart that you saw at least part of from Bob Andrews. Let's see if I can make my pointer work again. It has your system attributes, the four of those. It comes to the principal factors again. And then the importance, as determined by Bob Andrews through his sensitivity studies and which was subjective to an extent, it smears it over a very long time frame. And we recognize that there are different strategies for the first 10,000 years, different strategies for the middle 10 to 100, and perhaps different strategies for greater than 100,000 years, all decisions that have to be made as to whether we want to treat each one separately or try and treat them as a group or limit the effect.

So to a certain extent these have been smeared, but this gives you where you are and what the basic importance is. And what you find out is that your seepage from the drifts, the drift shield as an option, the integrity of your inner barrier and your ceramic waste package coating come up as highs.

Now, there's a confusion factor that I've introduced again to make the presentation go a little more quickly, so let me explain that.

The idea of the drip shield and the backfill and the ceramic coating, they are not part of the reference design. And so what you see here is the assessment of importance based upon the reference design, and you all see the assessment of importance based on sensitivity studies. This is not necessarily the importance were you to put both of these options into the system. And I have a chart that shows you that a little bit later. I'm getting some blank looks.

If you put in a drip shield and backfill, and you put in ceramics that dripping may, in fact--the dripping, the seepage that was talked about earlier may, in fact, not be as important because now I have two means of keeping it off the package, not to mention a robust package. So knowing that answer precisely may not be as important, and I may, in fact, change the importance throughout this column. And that's why I say you have to consider the entire design that you're working with when you work on the system.

So I want to point out to you that the letters that are here are not for this as a system. These are here for the reference design, and we added those aspects for the two options. And clearly, one of the tasks we have, and I tried to make the point on the earlier chart when I showed the flow, is that we have to go back and identify what are the principal factors for designs based on different options, different alternatives and different features that we place in there. And we've done some of that work, but it's preliminary, and so I chose not to show it.

Yes, Dr. Cohon?

COHON: Cohon, Board. Is there any significance to the Super Big H on the seepage?

BAILEY: No, sir, it's a function of my visual acuity in proofing these charts.

COHON: Fine.

BAILEY: I'm sorry I can't give you a better answer, but when I proofed it, it looked the same size on the paper to me.

Now, here's the rest of the chart. We had some other pieces, and they're what I told you I was going to talk about. What is our current confidence? What do we know about the system? We have our potential confidence. What do we think we can know about the system, and then a decision on how much credit or how much confidence or how much allocation do we want to provide to this system if we move forward to the license application? Can we learn something, and is learning something useful, or should there be another strategy to try and offset the uncertainties or the inability to learn that more precisely?

And then finally, pretty straightforwardly comes out the priority for future work.

I have a few examples here that I'm going to walk through. Seepage into the drifts, clearly important as Bob Andrews talked about this morning colloquially. The moisture that comes in through seepage contributes to humidity, which in the reference design affects the carbon steel outer barrier. The dripping falling on the package provides the liquid medium for the inner barrier, the C-22 barrier, to fail or to be corroded because of the presence of liquid water. And then finally, although the iodine and the technetium can move rather rapidly without flowing water, the neptunium in the longer time frames is carried by the seepage that you get into the drifts, a very important parameter.

What's our current confidence? Well, we have in situ measurements. We didn't have to guess. We have some numbers. We've used some theories for the models, the consider percolation flux and rock properties, which we believe have to do with it. So we have some data. We believe we have a fairly bounding piece here, which Bob showed you this morning, and I can't recall the specific numbers.

But what it does is it says, we know probably about how much could come in through a seep, and we have a range on it from a medium value to a very large to a very small value. We probably can't tell you where it's going to seep and when it's going to seep, but we can probably tell you that it's going to seep and there's going to be water dripping. And for that, we can be fairly confident.

Now, Bob has used a series of probabilistic methods to estimate how that works. In a licensing arena, we may have to go all the way to the top, use the top value and have it hit every package or hit every package divided by how many packages there are that use 5 percent.

So we actually have pretty good confidence. We think we have it bounded, and we believe--we recognize what we don't know, and what we don't know is that we don't know where and we don't know how often. And in the projected confidence, we don't believe we can run tests that will ever tell us just exactly how much where or when. We probably can never get to that answer and know it for sure. We can bound it, but we can't ever know it.

And as such, we better only put a moderate importance on it for post closure performance. Even though it has a high impact, we can bound it, but we probably can't get the exact answer. And if we depend on knowing how much, where and when, then we're going to be unsuccessful in this process. And if we're going to bound it, then we know enough to bound it. And the question is, do we design to accommodate it, and it would suggest right now, based on the charts that you've seen, that even the C-22 material does corrode in the face of this. So maybe we need some other design mechanism. I'm not committing to one, but the fact of the matter is, is that we'll never know how much, where and when, and so we have to take a bounding-type condition on that.

And so we look at this as let's see if we can put it back to a moderate understanding; in other words, we know enough, and see if we can either design away from that issue or design into that issue to deal with it. And as such, the work on this is a fairly low priority. Now, let me say here that a low priority doesn't mean that there isn't anything to be done. Clearly, there's work to be done; clearly. I mean, we have models, we have codes, we have data that we're gathering. We can sharpen it a bit and make sure that we really have it bounded so that we can defend it. So low doesn't mean we're closing the door and walking away from it. There's still work to be done.

But this would recommend, and that's what it is, a recommendation, that we don't try and go the next step and try and figure out how much, where and when. But instead, we take a strategy that moves us into a different approach.

I believe the question was asked this morning about performance allocation, and that's what we're doing here. We're stating that we're going to live with what we have. We're going to clean it up, obviously, but we're not going to base our case on being able to know everything there is to know about this. We have to do a design and a system. We have to have a system. And when I say design, I'm talking about the entire system. I can't change the mountain, but I can take advantage of its finer attributes.

And so when we do our design and we choose the system, we choose not to try and place tremendous reliance on exact knowledge of this parameter.

Now, I took another one here, and this is an option, the water diversion by a drip shield and the backfill. And as I said, this is an interesting one because if you're trying to keep seepage off of a package and want to keep it in a diffusive regime, you want to keep it out of advective flow, you want to keep it in humidity, well, here's an answer that obviate the seepage into the drifts and make it so that what we do understand about it in a bounding condition and every place, that if we can demonstrate this works, a performance allocation of high, then this can take away the uncertainties associated with the natural feature, which we probably can't develop fully.

So what do we know about it? Well, we have good information on the longevity of ceramics and tuff gravels. So you could have a ceramic drip shield, you could have a ceramic and a metallic drip shield. And I talk about C-22 in a minute; that's why it isn't on here. We know pretty much what happens there, whether it goes away or it doesn't, and we can work that.

We have limited information on flow through backfill, not something that's been studied heavily. And the feasibility of construction, how to actually install this backfill and place a drip shield either in contact with the package or suspended above the package. And the drip shield in this case is not necessarily just a thicker package. The idea here is to try and get a diffusive flow regime onto the package itself, although you could probably do that with a drip shield and some different types of barriers there; maybe throw sand over it or something. But the idea is we need to figure out how to construct one of these reliably so that we can test it and demonstrate that it's going to work.

We currently have a moderate current confidence. This is standard engineering type stuff. It just hasn't been looked at over the time frames that we're talking about, and we haven't looked at it in this particular setting.

Our potential confidence, well, we can do some testing on the flow and the backfill. I mean, it can't be hard to make a dummy and put it in there and make some backfill and drip water in various places and measure. We can do that. We can find out the theory of backfill flow, and we can even make a proof of principles as a prototype. We can make the dummy put the drip shield in, do the measurements.

So we can learn quite a bit about this. In a short term, we can learn quite a bit about it and how it's going to behave, and we believe we can have a fairly high projected confidence. That high confidence has to be weighed by our ability to deal with the materials involved, but we believe we can get to a high confidence to where we believe we understand how it works, and as such, we would give it a high importance to post closure performance. We can learn something about this particular feature.

Now, if we go to--which is the integrity of the inner barrier, we currently have a moderate confidence. We have some pretty good ideas. There's been some testing. We've met with the experts. It's been suggested that--another expert suggests maybe we're being a little bit too conservative. I'm sure someone else will be we're not conservative enough.

We have limited experience in testing of the C-22.

There's no doubt of that. It's a newly defined metal. There has been some very aggressive testing over which we are then trying to project very long periods. But we have had the experts who have given us some ranges, and with those ranges, it appears to be a very robust material. The experts believe that it will work very well in that time frame.

We've considered a large number of effects. We've looked at the dry conditions, the wet conditions, stress corrosion cracking, microbiological effects, radiation effects. We've looked at it fairly comprehensively, and we believe we probably have a moderate current confidence. We think we understand about how this works.

Now, we can do a lot of testing to improve our confidence. We can do some very focused and very localized testing and learn a lot more about the material and get a high projected confidence. And as such, we believe that we could have a high importance to the post closure performance. Again, we can learn a lot about it in a short period of time.

And it shouldn't be surprising, now that we understand the conditions of the mountain, that we're engineering inside of those conditions and can develop and do the test programs focused on what we believe we want to see, and that the most rapid gains and understanding are probably an engineered area because we can control the heterogeneity, we can control the processes by which it goes in place, and we can run testing that now is bounded by what we believe is going to happen inside the mountain.

I will on this one take a half step back and point out that from my previous light, we certainly found new ways for metals to fail. Just because we tested it and tested it and tested it didn't mean that 20 years later it didn't find some mechanism that we just didn't find in the short term. There is no question of that, and we are alert to that fact. And once again, you go back to your defense-in-depth argument. How do you deal with your known unknowns; you can do that I think with margin. How do you deal with unknown unknowns; you deal with defense-in-depth to a certain extent.

And so having a super excellent material is probably not enough in the licensing sense, and it's probably not enough in the generic sense. It's probably not the right approach to have one silver bullet, I believe Mr. Barrett explained this morning, and one thing in there that you're absolutely dependent on. It's the same argument I used as to why we shouldn't chase seepage real hard. You can't have something that you absolutely depend on.

And I picked on here which isn't high importance, but it was a different one, and that's transport through and out of the waste package. And Bob Andrews went back through this pretty quick. And basically, well, we know how data moves through granular and iron materials. I mean, we understand diffusion around those kinds of things. There's little data specifically on transport through these assemblies or the surface of the internal components inside this waste package. I mean, it is a very difficult situation to begin with, and then as it degrades, you have really odd conditions.

We have theoretical knowledge of the small opening transport, which is what we're interested in, and that is when you have your pinhole, how does it get in and how does it get out through the pinhole. And we feel fairly comfortable with that from a theoretical basis. But other than that, we have pretty much a low current confidence in exactly what's happening inside, and, in fact, we bound it on the upper end. Bob Andrews bounds it on the upper end.

Now, that gives us a low current confidence, and because of the fact that we're not even going to go look at the lower bound, we pretty much say we're not going to spend a lot of time studying this or trying to learn the preciseness of what happens. We just want to prove to ourselves and to the NRC that the values we use are, in fact, bounded.

And so we'll probably have a low confidence on understanding the entire mechanism that happens here when we're done, and it will have a low potential confidence and probably have a low--we need to make it so it has a low importance to performance. If it, in fact, does have an importance piece to performance, then we're going to have to go back and work it some more.

But basically, we basically are going to make a rough assumption. It doesn't buy us a lot of time, and the likelihood of it actually limiting the dose and release for the actual transport mechanisms, it isn't the place that we should spend our resources to move forward.

This was provided as the whole chart. You saw those where I broke it down by attributes, and you'll notice that I talked about it in terms of attributes. And that's one of the things that we are, frankly, working through, is what is the right basis to look at these? Do you look at them independently, or do you look at them in terms of the attributes and what you're trying to accomplish. And that's why you see something like a drip shield in limiting water on a package because you're keeping the water away, keeping the diffusive regime as opposed to an extra robust package or ceramics because now you're trying to put something into containing the waste.

So we're trying to get an orderly thought process of what can we do in each one of the attributes to offset what we don't know about that particular attribute and consider what its interface is on its next point in the transmission of the water, which is the big issue here.

So I've provided you with the whole chart so that you could have that for information. And if you want to just ask questions about that, I'll do my best during the question session.

I then went to an example performance allocation for the design options; I said I'd do that. And this is, as you'll notice, that we have the VA reference design, and again, I have a big H, and it looks like I'm missing a couple lines. So my proofing is--it's on my paper version, but not on this one. Interesting.

You'll see that I took out the drip shield and the backfill, and you can see how the reference design was actually graded by Bob Andrews with regard to importance of the principal factors.

I then moved over and said, well, let's go to the VA reference design and put on the drip shield and the backfill. And when you do that, you'll notice that, as I suggested, seepage into the drifts isn't quite as important because we can account for the seepage into the drift and the maximum number, the maximum amount, the locale, and take those particular parameters out of the calculation significantly, if we can place the dependents down here onto the drip shield and the backfill.

If you go and do it again for ceramics, you find out that ceramics has about the same effect, and that is, is it takes the seeps and the transport again out of the mix. And if you put both of them in, and this is an example--get my disclaimer in, we have an example--but if you do that, what you'll find is that you have three fairly robust barriers, three fairly robust ones in terms of the drip shield and the backfill to keep water off of the package. You make an extremely robust package by means of ceramics, which has a different failure mechanism that the metals beneath it and perhaps has a different failure mechanism than the metals above it in the drip shield.

So by doing that, you may even be able to take the rest of the parameters out, and we may have more than enough knowledge, if you will, to be able to move forward with a design like that.

Now, I have to temper my answer because you have to look, and I guess you saw the charts with a million years with the ceramics, or 10,000 years or 100,000 years with the ceramics. We have to look at those numbers, and we have to spend the time to make sure those are with moderate confidence ceramics and moderate confidence C-22. We have to go back and really do the math.

But this is the approach that we're using to determine what's important and decide where we should really put our emphasis. Now, you can argue that we've placed three silver bullets. Well, the three is a whole lot better than one, and if you can make them out of different materials with different failure mechanisms, then you have a pretty good argument. And if you don't, we can come back and add and look at additional features or go back and look and try and take better credit for some of the site features. I place greater reliance on those site features.

And I have one more chart. I see the questions getting ready. I have one more chart, and it's an example again, and the example principal factors for alternatives. This is not defining new principal factors for the alternatives. As I said, we've done some preliminary work on that. There might be as many as 25 or 27 parameters if you start looking at what the alternatives do for you. We're not prepared to discuss that at length, but this suggests that these are the areas where the other features or the alternatives that we're looking at may, in fact, be able to enter into a principal factor to provide a different or a greater reliance than we currently have.

And the easy one on top, surface modifications covering the mountain with alluvial or putting drainage up there so that we can move it in some manner so the percolation flux itself is lower is another way to control the water contact in the waste package just like a drip shield does. So there's other means by which we can do that.

Now, the decision process of this is performance, it's cost, it's feasibility, it's all of those kinds of things, and I think there's some decision theory work looking at how to make the best set of decisions. But this is the process that we're going through to try and make those choices, and our recommendation in the LA plan is going to include where we believe we should spend some work--spend our work and our resources to try and move forward.

Clearly, we have an action with regard to the alternatives and the features in the May time frame to move and make those decisions and build lots of those charts that I showed with regard to the features for every design. We, in fact, have built 17 of those to date using the design options, various design options and a few of the features to try and build what are the things that are most important to us. So it's a systematic approach to choosing our pieces.

COHON: Thank you, Mr. Bailey. Alberto Sagüés? Yes, sir.

SAGÜÉS: I'm surprised at the high rating that ceramic coatings for the waste package seems to be getting in needs for future investigation. That particular option, as far as I know, has been looked at quite unfavorably by the expert elicitation on waste package materials and also in other meetings by other bodies that have been looking at the area.

Can you, or would you be able to indicate maybe if there is additional information or additional issues that help--that have taken this to such a prominence?

BAILEY: Well, yes, the waste package expert elicitation group is focused very heavily on the metals, and the metals have a failure mechanism. In keeping alive the spirit of defense-in-depth, diverse failure mechanisms, and having other options available to us, we need to look very hard at the ceramic alternative. It doesn't take a lot of money to find out if we can apply it, to find out what its failure mechanism is and to see if it really buys us the time and the isolation that we believe it does. We're going to give it a good thorough going over to see if, in fact, we can make it useful.

I understand that the expert elicitation has not been strong in support of it, but there are--there is belief that it could possibly be successful. There are applications in ceramics in many places where they've been good for wear. They are not susceptible to caustic environments, and the question is one of application and proof.

And like I said, it's a process which we can test fairly readily without a great deal of expense. So we're going to move forward and take a look at it. Or, it may not pan out, but it's something that we want--remember what I'm doing in the license application plan, I'm trying to identify what is the future work, what do I need to look at to make sure I can move forward. And right now we haven't taken ceramics off the table.

SAGÜÉS: The biggest problem is not just ceramics, but it is ceramics in intimate contact with metals. And so there is a marriage there of the two materials which creates a lot of compatibility problems. And from that standpoint is that the experts usually were quite frankly against that concept.

BAILEY: I understand, and we have to go back and prove that to ourselves.

COHON: Paul Craig.

CRAIG: Craig, Board. I'd like to explore what seemed to be an interesting consequence of what you told us. On Page 15 and 16, you bring your priorities. Don't bring it up, I'll just say what it was. That's where you summarized everything. And I looked through them, and all of the high priority items are engineered elements. It looks like there's four or five of them.

Now, in Albuquerque and partially here, too, it became clear that particularly under the pluvial and super pluvial conditions, the transport times through the saturated layer were of the order of a few thousand years, first arrival, and the unsaturated zone now seems to have transport times of a few thousand years also, according to the model that we've worked out today. And what that seems to say to me is that the entire protection of the mountain now lies in the engineered barrier system, and in recognition of that, that's where you're going to put all of your effort.

So my question is, if you're now going to rely completely, essentially completely on the engineered barrier for protection, all protection beyond the period of a few thousand years, what difference does it make whether it's at Yucca? Why can't it be anywhere?

BAILEY: I don't believe--I would disagree with you that the entire protection of the waste is based upon the engineered system. A great deal of the waste is not mobile in the mountain, even if the packages are breached. The amount of water won't carry it forward. So a good deal of it is, in fact, held up by the mountain itself.

Second, the mountain provides us with the limited environment and the limited water flow and a predicable environment that appears to be stable for very long periods. It's an excellent location in which to optimize the entire system design using the engineering. It's not a belief that the mountain does nothing for us. We believe we have characterized the mountain to an extent where we understand how the mountain looks, and a great deal of time trying to narrow the uncertainties is probably not necessary when it's looked at as a system response in conjunction with the engineering. So it is, in fact, the entire system that's of interest.

Our focus right now, as I tried to say earlier, is that now that we clearly understand we believe what the mountain looks like and have it within bounds, now we can expand some real effort on the engineering to take advantage of the mountain's environment.

COHON: Dick Parizek.

PARIZEK: Yeah, Parizek, Board. In terms of drip shields, assuming it's not a ceramic coating, but a separate item that's somehow suspended in backfill, it has to be material that's as good or better than the waste package in order to last long and give you protection. So what sort of material would you make it out of, ceramic by itself? And how does one test something like that in a short time period that remains to make sure that it has its own performance that's going to act as a shield?

BAILEY: Yes, the way that Bob Andrews did it, as he explained this morning, is he used C-22 again. He used the same material that we're using in the waste package because we believe we have an understanding of how the material corrodes. And you might use a ceramic with it, you might not use a ceramic with it. You might use a titanium type material. And what you do is you can either suspend it or you can attach it, depending on--you know, there's engineering ways to accomplish that to try and avoid the interaction between the packages.

And again, you're into the test program that says how do I make sure that this lasts long enough? You've hit exactly on what the question is, and if you can do--I believe Dr. Bullen this morning said you make the waste package bigger. Well, that accomplishes it as well as far as providing the robustness of the design. If you can separate it into a different design, then you have the ability to try and get that entire diffusive regime below the package as opposed to expose the package to everything that drips. And that was the intent.

And again, you have to have a long life--you have to have a long life. It has to go through the same kind of a test program that the package does. It would be desirable to make the dependent portion of that material different than C-22, since you're not subject to the unknown failure that we're likely to see.

PARIZEK: So the listing is really a working recommendation of high, medium and low at this time until you really go on through those tests. Then you could say in the final analysis high is high, and you feel better about it?

BAILEY: That's right. Again, this list is to identify how do we think we would allocate it at this point in time based on what we know and what we believe we can learn and try and make that allocation to focus the work that we have to do for the future. If that work doesn't pan out, then we have to go back and use something else.

And remember that I'm doing this for the reference design alone. I haven't factored into this the different alternatives and the different features, but could very easily change what it is that we have to go work on. But because we're doing the VA and we're trying to identify where we go from the VA, then we've chosen these are the places that we believe that we need to go, and that they are compatible and consistent with just about any design that we might move forward with. And the alternatives and additional features work that we do will identify new work that we have to do in order to make this allocation work.

COHON: Jeff Wong?

WONG: Unlike Dan Bullen's questions, which his single question probably represents a convolution of a thousand other questions, my questions are simple.

BULLEN: Thanks, Jeff.

WONG: Any time, buddy.

I'm trying to understand--I listened to Bob Andrews' presentation, and I looked at yours, and I'm looking at these H and the Ms and the Ls. And as I listened to Bob Andrews, he talks about significance of uncertainty on post closure performance. And maybe I understand uncertainty from his point of view being that the value is, or the parameter value is unknown, and, therefore, the potential range of that value is large, therefore, having a potentially large effect on the end calculated value.

And then I listened some more, and then I think I'm hearing a discussion of sensitivity, meaning that a small change in a parameter value leads to a large change in the end result.

And then I look at your charts and I see potential importance, then moving on to confidence and then performance allocation. And so I don't exactly understand how to move from Bob Andrews' explanations to your use of those terms H, M and L.

And the other part that is confusing to me is that just from I'm not a hydrologist, I look at the part on limited water contacting the waste packages, and you end up with Ls all the way down in terms of the priority, and yet the DOE has a big effort going on at Busted Butte to deal with infiltration.

And so I'm trying to understand the H and the M and the Ls, how do these transition, and then ultimately, what do you do with that value when you make that priority, and then how is that translated into actual work?

BAILEY: Okay. Well, there are a couple of questions, I think. Bob did talk about his uncertainties, which is important because it tells us what we don't know. What we were interested in learning is what's really important, whether it has the large uncertainty or not. The original approach to this was, in fact, let's run from either end of the probability distribution function 5 percent to 95 percent and say, how much does it change? How much of an impact does it have? Does it cause less than 10? Does it cause a factor of 10? Does it cause a factor of 100 change? How important is it?

And that was how we tried to put this chart together, but then we took into account some of the pieces of smushing three distinct time frames into place, three distinct different types of transport that we had to put into place, and we lost a little bit of that I think. But we tried to stick with it as what it is that ultimately is important to us, and I think Bob will nod his head that these are the things that are important when you look. These are the things, and this is their relative importance.

I mean, H, M and L was chosen as a gradation. We all understand high, medium and low, and I mean, is medium here, is it here, is it here? I can't possibly get into that. It's trying to get a gradation that says what really sticks out, what's in about the same ball park and what does it matter? And you'll notice there's no lows on the list. There used to be some lows when we originally started this and started changing the list.

With regard to the work in limited water, I may have to have some help there with regard to the program. As I said, there clearly is work that has to be done to close these items out. And trying to run the program to come up with a new conceptual model and a completely new approach to what we're doing, that for the most part isn't our approach at this point in time based on this chart.

Now, the chart is relatively new, and this is what's going to guide our program for the next year. And when we resolve that, if this is the agreement, then I guess some of the testing program has to come under further scrutiny.

COHON: Dan, can I insert myself, here?

BULLEN: Be my guest, Jerry.

COHON: Okay, thanks. Cohon, Board. My questions deal with the same matter that Jeff's does. Could you put up Number 11?

BAILEY: Which chart is it?

COHON: It's the seepage in the drifts highlight.

BAILEY: Okay.

COHON: First let me make the observation about looking at the large table, one notices that one of the major drivers in what the rating is in the last column, the fifth column, is the difference between Columns 2 and 4, and that's quite appropriate. That is, if we can't know much more than we know now, then why invest a lot in it?

BAILEY: That's correct.

COHON: And I think the way you're proceeding here makes a lot of sense, and I find this very helpful. What I'm stuck on is the middle column. And I asked the question when Russ Dyer first used the term this morning, and I have to say this didn't help me any. I'm still confused.

BAILEY: Let me--

COHON: I choose this example because it illustrates very well the problem I'm having with the concept. It's actually just a clue to my problem because I'm having trouble articulating my problem.

Follow me here. If you look at the first column, and I have to tell you, I need a magnifying glass to read this, but potential importance to post closure performance, right?

BAILEY: Yes.

COHON: You write that in H?

BAILEY: Yes.

COHON: And that's largely on the basis of TSPA?

BAILEY: That's based on the TSPA and the big impact it has in a variety of ways.

COHON: Right. Now, the third column, you give it an M?

BAILEY: Yes.

COHON: And the reason you give--the only reason you cite for giving it an M in your chart is moderate importance to post closure performance, but you just got done saying it has high importance to post closure performance.

BAILEY: Yes, sir.

COHON: All right. So help me here. If you can explain that apparent inconsistency, I might understand performance allocation.

BAILEY: The performance allocation is a choice we make, and the choice was that we didn't want to have a high reliance on that.

COHON: So you're going to--you're going to try to, through the use of design alternatives, reduce its importance to--

BAILEY: That's correct.

COHON: --performance allocation.

BAILEY: We're going to choose whether or not it is the bumper, the dual redundant break system, the seatbelt or the air bag that's going to protect us from being hurt when we walked into something in an automobile. We're going to choose which one of those we want to use and try and focus on in terms of knowledge, certainty, argument to the NRC, and not play something like that into the forefront as this is the only way that we can get to the answer. If we have to know how much, where and when seepage occurs precisely, this can't be done. So we have to take it out of being knowing all of those things and move it back.

COHON: I'm not done on this, but Alberto is--do you want to talk to this particular point?

SAGÜÉS: Yeah, on this particular point. I think--well, you're choosing things, whether you're using the bumper, but you're choosing whether you're going to collide with a SUV or with a VW car, right? I mean, because that's not a protection item. The seepage in the drift is an aggressive item.

BAILEY: It's actually prevention. I've mixed mitigation with prevention, you're correct. There is prevention type issues, which is what this is, and there is mitigation type efforts where you're trying to catch what happens. But the concept is the same, and that is, is we're making the choice because we have another choice. We can put alluvium on top of the mountain and plant trees. Just demonstrate that it will be there for 10,000 years. We're trying to make those choices, and if we have several things that do that, then I don't have to play this greater reliance, and I don't have to understand as completely each one of them, and that's where we're trying to take this allocation.

COHON: Right. Just in the name of my understanding your methodology, the factors then that then go into the determination in the last column, the fifth column--

BAILEY: Yes.

THE COURT: --are Columns 2, 3 and 4 and basically not 1.

BAILEY: That's correct. That's correct.

COHON: And what drives it is the difference between 2 and 4 and then conditioned by what you've chosen in Number 3?

BAILEY: By the choice that we've made, that's correct. The first column, and let me--

COHON: I've got it. I've got it.

BAILEY: --explain. I'll say it back to you. The first column tells us what we should be looking at and how important it potentially is to the analysis at hand, what we know about it right now. The fourth column says how well do I know it right now, and the other says how much more can I learn about it in the two years or so before the license application. And then I say how much do I want to depend on this? How precisely do I have to know it?

You know, it's the old question of when I drop this, is it going to hit the floor? The answer to that is pretty much yes. But if I ask how, if I have to know how, I've got real problems. If I have to, then I have a lot of math to do and a lot of studying to do to get to that answer.

So if I can take it back to hitting the floor is what I need to know, then because I can use different aspects of the system, be they engineer or natural, if I can use those aspects, then I can reduce the preciseness of the calculation.

COHON: Okay.

BAILEY: And I want to do that.

COHON: Okay.

BAILEY: And then the final column, just to close, the final column says in order to go from here to there, how much energy do I have to spend?

COHON: Dan Bullen.

BULLEN: Bullen, Board. Just another follow-up on that one.

As you take a look at the performance allocation--and actually I want to compliment you on putting these tables together because it helps with the logical train of thought of prioritizing thing.

BAILEY: Thank you.

BULLEN: But the concern that I have is that as you do--and let me see if I get the words right. This is potential importance to post closure performance. That means you've taken a look at some kind of evaluation using TSPA.

And as we saw this morning, and this is the concern that I have, if you have some aspect of that that may be masking the other performance, you have to make sure that you're doing a valid evaluation. For example, your performance allocation for transport through and out of the waste package has very low--I guess medium potential impact, but that's only because the cladding is so good, that only at most 3 percent of it are ever going to see any waste. And so if you had no cladding and did the same type of analysis, you may not end up with an M there, you may end up with an H, and then we'd really have to understand how the water gets in and gets out.

And so I guess the caution that I have for you is that even as you try to do the bounding calculations, you may not have gotten outside the complete bounds. And I know you want to set a bound and ignore it, but be cautious that you may ignore something that will jump up and bite you later.

BAILEY: I understand your concern, and we have to be very alert to that, I agree.

COHON: Debra Knopman.

KNOPMAN: Knopman, Board. I, too, want to thank you for putting these tables together because they're helpful, and they show us how you are thinking about things.

But I want to go back to this Column 3 again, the performance allocation because in some ways this is now, it seems to me, an expression of what you all mean by defense-in-depth, that you don't want to rely on any one feature in sort of a disproportionate way, and if something is--if a particular feature happens to be difficult to characterize in great detail, you want to find a way to get that out of your critical path in a sense.

The question, however, is that it seems to me if that's your philosophy with the performance allocation, then you'd kind of want Ms or Ls all down that line. You don't want anything with an H?

BAILEY: Yes.

KNOPMAN: But you have three things with an H.

BAILEY: That's correct.

KNOPMAN: And that's the drip shield and backfill and the ceramic waste package and the integrity of the inner corrosion resistant materials. So now you've got this weighting toward the materials evaluation, and not just materials, but sort of our ability to engineer them in a way and apply them in a way that will have a high degree of reliability.

So you've made a tradeoff. I just want to make it very explicit that you've made the tradeoff here. And I'm not saying it's right or wrong, I just want to highlight it, that you're now placing a great deal of importance on being able to prove that you've got--you're going to get performance out of the ceramic waste package coating or the drip shield and backfill. You've introduced a new set of unknowns because these are currently items for which there is not a lot of information, at least that I'm aware of, and trying then to fill in, leaving some other things possibly behind.

But, I mean and this is the point here, if you're really going to do a serious look at design alternatives--

BAILEY: Yes.

KNOPMAN: --then you may not want to be going down this path here.

So that seems to me to suggest that you've got to really get a move on your design alternative evaluation to focus your work in this time between now and a site recommendation.

BAILEY: I agree with you on your second statement. I want to go back to the first. If you go back to the example performance allocations, we could potentially allocate a lot of mediums into that last column instead of a lot of lows.

There was a question earlier today on the quantitative nature of how we do this. This has not been quantitized at this point in time. We frankly didn't have all the data that we needed at the time to go do that. We found ourselves subject to a great deal of expert judgment to do that, and so rather than try and quantify expert judgment into numbers, we quantified this as subjective evaluations at this time.

We could conceivably go back and work these and use a lot of Ms and have no Hs, and I agree with your assessment. If we can have all Ms and Ls so that we are not dependent significantly on knowing everything there is to know about something, or come back to my argument on material and metals, then that's highly desirable. But if I can have three materials that all fail in different manners, at different times for different reasons, then when you put those together, I'll have a high likelihood of success, which is the approach we're trying to take right here.

But it could be, exactly as you say, a different allocation. These are examples. We have all the alternatives to do, and we have to come up with that final strategy. Here we were trying to decide what work do we have to do for the coming year, and to us, it only--it makes sense in these recommendations, draft yet, but it makes sense to go look at some of these engineered features to see if we can make some rapid progress that we can apply to this.

COHON: Just, by the way, just as a note on the internal consistency of the methodology they've used, if you identify drip shield as the way you take some natural feature and reduce it to an M from an H, then that drip shield better remain an H in your performance allocation.

PARIZEK: And it better work.

COHON: And that's what the H says. I mean, we're pinning a lot on--

BAILEY: That's correct. That's what we have to defend.

COHON: Priscilla Nelson.

BAILEY: Yes, Priscilla?

NELSON: Well, I'd just like to request that generally that--at some point you used the term smushing for the time intervals.

BAILEY: Yes.

NELSON: And the question about the time, I could see some of these things being more important in certain time intervals than in others--

BAILEY: Yes.

NELSON: --and that some of them may be high importance if your focus is on the first 10,000 years and low importance in longer term. And I guess for me to feel like I understand what you're communicating, that sense is important to see on these drawings, on these tables because that's sort of my dipstick on whether I understand what you think the issues are. So I encourage you to work through this.

BAILEY: Unsmushed, yes.

NELSON: We could make it unsmushed and as a consistent kind of a definition and a presentation to that made by TSPA, by Bob Andrews, so we don't get ourselves confused like this.

BAILEY: Well, yes, I agree with you that the preciseness is desirable. In trying to decide what work we have to go do for the future, we tried to look at the three time frames together, which is why seepage is interesting in how your fail the package, and it's interesting in the very long term for transporting neptunium, but perhaps not--and so we left it at high for the whole sets of periods. But I agree with you. I agree with you.

COHON: Notice how responsive the Board is to the metaphors that you use. Priscilla just referred to the dipstick.

I have one last question for you.

BAILEY: Yes.

COHON: Your slide Number 5, which is the performance allocation process, the box with flow--

BAILEY: Yes.

COHON: I'm not sure it's fully intended, but perhaps it is. But this says basically, we know what we know about the natural system, and we're not going to try to find out too much more because you've got the two boxes on the right, which deal with design alternatives. There should be another set of boxes on the left, sort of a parallel path, which is further exploration understanding of the natural system.

Now, the words you use in describing this didn't jive with the picture; that is, you said things like, we've got to treat this as a system and understand it's a system, and the natural system is a major part of that overall system.

BAILEY: Yes.

COHON: Yet there's no provision here in this diagram for further study of the natural system. Where is it?

BAILEY: It's in the principal factors. It's in the original. That was my intent. I understand your comment of slighting the natural system. The intent was, is that as you work through--

COHON: No, no, wait a minute.

BAILEY: --here, that's where it would--

COHON: No, that doesn't work.

BAILEY: It's implicit, in my mind.

COHON: Well, it's very implicit.

BAILEY: In my mind.

COHON: No, the principal factors--

BAILEY: I understand.

COHON: No, okay. Well, you understand, but I'm not satisfied with the response because the design alternatives, those two boxes on the right, represent actions you're going to take.

BAILEY: Yes.

COHON: The principal factors do not--

BAILEY: Are actions being taken, yes.

COHON: They're actions you're going to take?

BAILEY: Our actions we've taken.

COHON: You've taken, right.

BAILEY: Yes.

COHON: So that's why the missing boxes on the left are important.

Paul Craig.

CRAIG: Craig, Board. Yeah, I want to jump in here, too, because this is exactly the point I was trying to raise at the conclusion. You're proposing to do practically nothing about the transportation through the water. All your effort, all your important effort is on the engineered barrier, which means you don't expect any improvement in the transportation through the water in the natural system. And since we now know from your previous briefings that the natural system does not provide much in the way of delay, that means that the successful working of the system relies almost entirely on engineered barriers. And that's quite a new result, a very important result it seems to me, and it needs to be noted. Maybe there's nothing that can be done about it, but at least it needs to be noted.

BAILEY: There's still work going on in the natural system. As I said--doesn't mean nothing has happened. But it is a system response, and there's clearly a reliance being placed on the engineering. I agree with you.

COHON: Well, thank you very much; very helpful.

Paul, in the future, bring the mike up to your mouth. They're having trouble picking you up.

Sorry to run on so long, but that was a very important presentation, and we appreciate all the good information you gave us.

Jean Younker is now going to speak about work remaining to complete the site recommendation and license application.

YOUNKER: While he's setting me up here, let me mention to Dr. Craig, we do have--if you notice at the end of mine as I walk through the allocations, we have moderate performance on both UZ and SZ transport. So you'll see that, in fact--I mean, the moderate means that you're going to make sure that you've got the right work going in order to get what additional information you can.

So I don't think that it's quite as extreme a view as what you were portraying, just to say what I'm going to say again after I get set up here.

CRAIG: Well, I was trying to provoke a response.

YOUNKER: Got one.

COHON: But, Jean, I'll give you another response.

YOUNKER: Okay.

COHON: That slide that I flagged, Number 5, without the boxes on the left, I mean that leaves nothing open to interpretation. That says we're emphasizing greatly on design, and I mean, taken totally by itself, it would say we're going to do nothing in the natural system. Now, we know that's not the case, but there's something in blue and white that is hard to get around.

YOUNKER: The one that I like to think about is that--

and I'll say this again, too, at the end of my talk, but the environmental conditions that we have to design a waste package and a repository system to sit in are pretty well understood. Now, I mean, we're starting to close on it. There are still some uncertainties for sure, and we think we have a pretty good handle on where the important ones are. And so it's now time to start focusing in on that design, and I think that's more the way I'm looking at it than it is quite as extreme that the whole reliance is shifting to the engineered system. It's simply time to begin to really spend your money and your effort to get the right engineered system for these conditions.

Well, given what you've heard from Jack, and I think that was exactly the discussion that we were hoping to have with you about the method because I think the method is one that we have in the Viability Assessment, Volume 4. The M&O has spent an awful lot of time putting it together with as good explanation as we can get for the columns, for the entries in the columns.

As Jack said, we would have liked it to be a little more quantitative and a little bit more basis for each entry in the column, but at this point in time, given that we've only evaluated the options--you know, we have the base case evaluation. Everything that goes into that in terms of the process models for the natural barriers, natural system components and the engineered system, together with the options that we've looked at in terms of drip shield, backfill and ceramic coating, you know, we can take a look right now, get the best case we can for prioritizing the future work coming up next year and then our multi-year plan.

Clearly though, as many of you have pointed out, depending on how these alternative concepts and the features that cut across the concepts are put into our reference design as we head out into the next year to two years, some of these allocations are going to have to be looked at. We'll have to update them and make sure that we're not closing out some work that has some reasonable chance of needing to be, you know, put back into the system in terms of an allocation to that component.

So that's, I think, the balancing act we're playing. We clearly can't keep on doing work on everything. We have a constrained budget. We have to get the best program to find that we can for the Department. And so, you know, our job, I think, between Jack's department, between Dan Wilkins and Colin Heath, the M&O is going to go to DOE with our best set of recommendations.

Now, what I'm presenting in no way is locked in. You know, what you see right now is in a draft that's going into DOE review for concurrence. What finally comes out in September very likely will have some substantial changes.

So this is work in progress. It should be viewed that way, and I think it's a good time for you to see it to have some input into how well we can explain it, as well as seeing the directions that we're heading.

Well, everything is organized in my talk as well around the attributes of the repository safety strategy, and Jack tried to explain to you how we stepped from the original set of hypothesis now into these principal factors that give us a way of really talking about the components of the system as reflected through the performance assessment.

And the table again--what I'm going to focus on completely is how to use the pointer. There is a little pointer here, and I'm going to bring him down. I haven't used this before, excuse me, but that should look interesting in the minutes, whatever that noise was--the priority for the technical work.

And the way I'm going to talk is taking what we've just told you as being the full sensitivity results coming out of PA together, including the reference design and the options. I'm going to make the assumption that that is the way we should drive our program. That is what is in the text right now, and I'm going to walk you through the kind of priority we'll place on the technical work and then just give you kind of an amino synopsis of where we think we would be at the time of SR/LA if this is the direction we go.

So it's just kind of walk this method now to completion with the scenario that we've laid out for you, not in any way, you know, saying where we will finally go, given that we will consider the broader side of alternatives.

So if I do that, if I take the first attribute, which is the limited water contacting the waste package--and if I find my arrow again, there he is. If we take the high--I may have to give up on this. I'll be too slow. If we take the water diversion by drip shield, which is our high--I will come back to the moderate, but I was doing our high first--Jack has already basically summarized while he was speaking what the information needs are. We'd have to get at the flow properties of backfill, since any time we talk about water diversion by a drip shield, we assume that we would protect that drip shield with backfill.

The feasibility of the design and emplacement of that, of course, is a concern. And so in terms of an information need, that would be something that we would focus some immediate work on to see what kind of information we can obtain in the relatively short time frame, and likewise, the longevity of that system. How long we'll be able to rely on it being in place in the way that we put it in there is, of course, a question that we're going to have to answer in the licensing arena and to ourselves before we allocate--take this allocation of performance into our licensing basis.

For tests and analyses that are currently on the table being looked at as a part of potential FY-99, fiscal year '99 planning, as well as longer term for many of these tests, obviously getting at the backfill and drip shield flow properties, making sure that we determine and ask what kind of material would you use for the drip shield, well, if we continue with C-22 as our primary corrosion resistant material, then much of the work going out on that C-22 to some extent translates to the drip shield behavior and long term corrosion performance.

If we look at other materials, like ceramic, we may also be looking at that as a coating anyway, so that information should translate.

So we have some potential for some feedback among the various studies. Feasibility studies, getting at design and emplacement are going to be very important, and we do have some--a proposal at least on the table to begin very soon looking at an actual prototype where we can begin to get immediate feedback on whether the kinds of concepts we have will work.

One of the concerns that comes in from the PA side of the house, and, of course, you would recognize if you put a drip shield in, does it act as a little cap that causes condensation and you drip water right back onto your package? Well, that's something that has to be looked at. What can you do to avoid that? There's certainly engineering solutions we think that will allow you to design a drip shield that doesn't cause condensation and immediate dripping back onto the package.

And then, of course, in this area, getting out and making sure we cover the natural and manmade analogs that are available to bring in information. This is one I think the Board has told us we should pay attention to, and certainly the TSPA Peer Review Panel has made a real point that there are some natural analogs that we should be looking at.

Okay. Let me go up to the moderate now, and this one is the effects of heat and excavation on flow. In this case, the information needs, moisture redistribution during the thermal pulse, the effect of that redistribution on flow, meaning if we close fractures, open fractures, cause precipitation and dissolution and re-precipitation so that we change the permeability and the fracture characteristics in the near field and that alternation through mineral deposition.

Question on this, I think in general TSPA Peer Review Panel, for example, has commented that this is an area that we haven't looked at enough to satisfy them. On the other hand, I think our general view right now is that we have to look at it, and we will look at it to some extent, but our overall intuition is pretty strong that this area is

--that the changes will not be significant. The major reason for that is because we're in such a fractured system anyway, that any amount of change that you produce probably isn't going to fundamentally change flow properties in the near field, giving you the bottom line here rather than waiting for the last slide.

But the kinds of tests and analyses that we'll get at some improvement in this area, of course, from our in situ drift scale heater tests and the natural analog studies should be helpful here as well from the standpoint of looking at geothermal systems, is at least one place that we've looked. Modeling and testing mineral alteration, that's work that's been ongoing for a long time. Some very focused work can be done we think. And finally, then, updating our draft scale flow models. This is one area that I think from a performance assessment perspective we know we need to put some attention to.

If we move down to the long waste package lifetime, the high here, which we've spent some time talking about, is the performance of the integrity of the inner corrosion-resistant waste package barrier. And this is an area where those of you who follow this closely know that we've had a lot of input from our expert panels, as well as from our Total System Performance Assessment Panel. The corrosion rates in crevices, the thickness of the oxide layer and what happens to it through time, what kind of phase transitions we get near grain boundaries are just key information needs. And I think we now believe we have a program set up that in a relatively short time frame with some fairly aggressive testing we can get at some of these information needs, looking at phase stability, as well as some models for localized corrosion and phase stability.

I'll come back to each one of these with a snapshot of where we think we'll be, given that we know these information needs are the key focus, or should be the key focus of our work, and that we have some tests and analyses planned into the '99 plan to go after this, '99 and out year plan.

All right. For the ceramic waste package coating, this is our other high, and this--I lost my arrow again. This is our other high, and from the standpoint of information needs for this, I will go through very quickly because I think in conversation, Jack in discussion has reviewed most of these: The longevity of the coating, stability against phase transitions, long-term continuity of the coating. I think that Dr. Sagüés mentioned that this is an area where there has been a lot of critical comment about whether or not the kinds of ceramic coatings that we're proposing really can be put in place; spray coated, whether you get some effects on the underlying barrier and interactions between the ceramic coating and the underlying metal material, metallic material, that cause you some problems, and then the effectiveness of the backfill as a protective barrier for the ceramics.

Kinds of tests and analyses, we have been told, and we are looking seriously at reviewing a range of industrial experience that is out there in using spray-coated ceramics. There's some testing that we have proposed in the fiscal '99 year plan to get at the adhesive strength of coating and the effects of thermal and handling loads--yes, thermal and handling loads, sorry, and measuring the permeability and density of the coatings.

I know there's been a lot of question about whether we could get a really homogeneous coating sprayed on and get something with very, very low permeability because people were concerned about low porous spots where water would actually pass through the ceramic coating and get to the metal more quickly than what you would originally have thought. And then corrosion tests on the ceramic has a function of thickness, structure and composition.

So these are tests and analyses that our design team and materials team are putting into the plan. We're coming up with proposals for where, how they can be done, what kind of times. Some of these can be done in an accelerated manner, such that even in a year, we'll be able to get a pretty good handle on these.

Okay. Now, we're into the repository system attribute for slow release of radionuclides from the breached waste package, and this is where we do start looking at a moderate importance priority for the technical work for radionuclide-bearing colloids, driving our work in this area; information needs, such as colloid stability under the expected environmental conditions, what kinds of sorption/desorption, irreversible reactions or reversible actions can we anticipate, and then what kinds of solubility constraints on colloid formation can we come up with in a relatively short time.

Now, the tests and analyses to do these, I'll mention in a minute. But overall, this is an area where we have a really nice integrated program, where we have a team working from kind of the formation of the colloid out to the transport of the colloid, four national labs working together with our PA team to attempt to put together a really integrated look at colloid stability from inception to transport in the natural barriers.

And then as I said earlier, we do have moderate importance priority on the technical work for transport through the unsaturated zone and transport through the saturated zone. This diagrams walks us through the information needs for transport. We're now, by the way, down in the attribute on radionuclide concentration reduction during transport from the waste packages. So we're now--once we have some material that is able to be mobilized, we can look--during unsaturated zone transport, we can look at lab tests. We know we have the information needs related to the reversibility of the sorption of colloids and other radionuclides, for that matter.

Filtration effects for the colloids is something that we believe we can get at in a relatively short time frame. The whole area of advective versus diffusive transport characteristics is one that the performance assessment modeling side has been hit on that we have to have a better way of representing or more confidence about the way we represent our transport. And better representation of fault zones and spatial variability within our models, another information need, kind of driving from the modeling analytical into the information needs spectrum.

From the tests and analyses standpoint, laboratory tests going on in that integrated team that I mentioned, as well as the field tests at Busted Butte, should give us some useful information about colloid transport. Also, the evaluation of transport from other DOE facilities where we're getting at some kind of information, like from the plutonium transport on the Nevada test site. And finally, once again, from an analytical viewpoint, updating the transport models to reflect any new field data that we're able to get our hands on.

From the standpoint of flow and transport in the saturated zone, we're talking large scale bulk flow characteristics. As an information need, toward the end of our TSPA/VA, it became very clear to us that we needed to take a hard look at the way in which our saturated zone site scale and our regional scale models are talking to each other; refine those models, so that's an information need driving out into the process modeling and the data acquisition areas; and then some aspect of flux and particle velocity, such that we can get a little bit better handle on what is happening to the contaminate plume when it's in the 15--10 to 20 kilometer distance.

So tests and analyses that will help us with that: The cross-hole tests that are in the plan right now or at least in the recommended plan. Aquifer parameters in alluvial and tuff aquifers, here we should be getting some help from some of the work that you're going to hear about a little bit later from Nye County. The local regional model interface I mentioned already. Here also, the test wells in the carbonate aquifer downgradient.

Our people believe that this is a fair bit of hydrochemistry and some other types of hydrologic data out there that can be easily--relatively easily used to calibrate our flow models a little bit better.

So in this area, there's quite a bit we can do with what we already have, I think, when you look at the spectrum of information that we've pulled together to update the model for transport in the saturated zone.

All right. Let me just shift over for just a minute to the alternative design and the design features. And all I really want to say here is this is just a repeat of what we've already said. And you've heard that we are moving this into the mainstream. It will become the way in which we move forward to select the initial reference design for site recommendation/license application.

What the team that Mike Vogele headed up has given us is a relatively long list of related information, information needs. Some of it is truly information--or data that we will need to try to get our hands on. Some of it is analytical. Some of it is just general information.

And we have lists of these. I just chose one from the enhanced access design concept. And on this list, you can just take a look at it and see parameters related to shielding, performance that have shielding as corrosion allowance material, general pit and crevice corrosion. There's a long list that the team that worked with Mike put together for us to make sure that we have at least a first set of potential information needs to look at as we go into our detailed planning for next year.

And so if you look in the back of your handout, I think what you'll find--we gave you three pages from the Viability Assessment that gives you the list of related information, think of it as information needs, that accompany each of the alternative concepts.

And you'll also find one for the design features, such that it just gives you some idea of the details so far that have been handed to us to look at as we head into our detailed planning because as we've already talked, we have to be very careful as we go through this kind of a method that we are considering any of these information needs that drive an alternative evaluation or a feature evaluation. If it's one that has a high probability of needing to be looked at in the next year, we can't have low priority on gaining that information. So this really is going to be a difficult balancing act.

Now, where will we be at SR/LA? Once again, I've racked these out in terms of each of the attributes in the repository safety strategy.

If we look at the performance of drip shield and backfills, and there is a little arrow on this slide, that first subset there, performance of ceramic coating, really should say performance of whatever material we end up selecting for the drip shield and/or backfill.

But the key things that we think we can get at with some of the tests that we're planning in the very short term would be sensitivity to the uncertainty in the hydrologic properties of the backfill. There is really some potentially good performance characteristics of the backfill in that.

For example, we speculate as you get evaporation, you might get salt deposition in the backfill rather than on the surface of the waste package once you have actual liquid water advective flow coming back into the drift. Well, that's great. However, there are other kind of balancing parameters that are not as potentially good for us, and so we have to make sure that we look at both the positive and negative benefits of backfill. For example, the heat, the thermal effect on the cladding is one that we've talked about with you before, and then how stable this material will be over time, whatever we choose for both the drip shield and the backfill.

For the effects of heat and excavation on flow, which was our moderate priority data deed within limiting water, contacting the waste package attribute, the improved models for heat and excavation effects on flow, we really think we'll have a pretty good handle on this one. I already mentioned that, you know, our general sense on this one is that this will not end up being a major impact on the overall--the near field environment. And so we do think we'll have in a year, a couple of years, a pretty good handle on redistribution of moisture, boiling/recondensation, and the change in flow properties in terms of the way the fracture permeability changes above and below.

Now, when we were talking about what kinds of tests will continue and where we'll get confirmatory information, I think this is one where people point out that some of these kinds of changes are going to be only really recognized over much longer term tests results, so that these would be some where the thermal test in the east/west drift or the large scale heater tests probably, these are results that you might begin to see well out into the performance confirmation period rather than anything you're going to get a real good handle on immediately in the next couple of years.

For the integrity of the inner corrosion resistant barrier under long waste package lifetime, this was one of the allocations that was high or one of the priorities that was high, where we think we get within the next year to two years is define the range of environmental conditions for the waste packages, select the appropriate waste package material, the context of the overall allocation.

And we certainly have some work set up and some of it ongoing, some of it ready to go that will get at thermal stability, confirming our models for predictions of crevice chemistry as a function of time. This is an area where I think some of our external review panels have given us a lot of feedback that this was work that needed to be done. We've really, I think, accelerated, put a lot of attention on this.

Increased confidence in the behavior of the passive films under the range of environmental conditions that we expect to see on the waste package surface, and the potential for repassivation. I think that the people working in this area have some pretty high confidence that within a year to two years we can get a lot of good information with carefully designed tests.

For the ceramic waste package coating, again this one is at a high priority under the current allocation, carrying this in.

We believe we could get a basis for claiming the waste packages can be reliably coated, some confidence of the ceramic coated packages can be handled safely, confirmation of the permeability or impermeability, which I think our view right now is that you really can probably create a pretty impermeable ceramic coating and an adequate basis for predicting corrosion and behavior, particularly getting a handle on the effect of any defects that are present.

Okay. Now, moving into the release of radionuclides from the waste package, a moderate was placed on the colloid transport. And here I mentioned that we have a very well-defined set of work going with an integrated team approach that gets out the effects of secondary phases and corrosion products in the environment where the colloids are forming, effects of concrete degradation products being in that environment; then moves out and attempts to look at sorption/desorption ratios, and also any kind of solubility constraints on the formation of the colloids.

And likewise, when you get into the transport system now in the unsaturated zone, we have work ongoing to help us understand the transport characteristics for the radionuclides and the colloids and hopefully get an improved representation of the advective/diffusive transport, which I mentioned in the earlier slide.

For the saturated zone, I think I already said this, we'll get some improvement in our bulk flow characteristics, some improved interface between our regional and our local models, using some of the work that Nye County will do in the downgradient area, and then additional confidence on our flux and velocity estimates, so we'd get a good, better handle on the calculations for the doses.

So the status at SR/LA, to give you kind of a synopsis then, and I think I said this in the beginning, but I'll run through it again, basically I think we're of the opinion that the site processes and conditions will be characterized well enough and, you know, are well enough now to give us the ability to focus in on the right work in the next couple of years to--we could establish those environmental conditions, including their ranges, to give that information to the repository and waste package design element of the program. And that repository and waste package designs then can be developed that are tailored to those environmental conditions in the way that we've talked about using the performance allocation approach that Jack just described for you.

And given where we are with TSPA and the sensitivity results that you saw today, I think with the improvements that we've noted, we can explicitly then address where the remaining uncertainties are, which is then what allows you to go back and look at your allocation to see whether you need to change anything, given, you know, once you've come through this process that we've just described for you.

The last slides are just the back-up that have the list of potential information needs tabulated for you.

Okay. So that's it. Thank you.

COHON: Thank you, Jean. In your current thinking and planning, when is SR/LA, when is that milestone? And sort of backing out from that, when do you have to fix these priorities so that you can get on with the work and meet that deadline?

YOUNKER: Well, I think--let's see, I'd have to ask somebody to give me the exact dates for it. I don't know, Jack, do you have them in your head, or if somebody can give me the--

BAILEY: July, 01.

YOUNKER: July 01 is the site recommendation, and then in March, 02--March of 02?

BAILEY: Right.

YOUNKER: March of 02 is our LA date. And what we're assuming, though, is, you know, that initial selection next May of the SR/LA design, you know, we certainly would like to have been through this process once and be pretty certain that we've got the right alternatives and features included in that design, and that, of course, feeds back to what kind of a performance allocation we've performed in the meantime to include any reliance on natural barriers, additional natural barriers.

COHON: Do you have a date in mind when you want to fix these priorities? In other words, declare as final that--the ratings for the various things to come?

YOUNKER: Well, from a licensing strategy perspective, there are some dates that we have where we say we're going to freeze our licensing strategy. In a sense at least--I mean, I'm kind of the person who listens to the licensing people tell me when it is they need to have the information backed off from when we'll write our site recommendation supporting information, when we'll write our license application text. So I turn to Jack because they set the schedules for us essentially.

COHON: Well, let me restate it in a way that might be more productive and easier to answer. My guess is the Board will be eager to comment on these rankings that you have. When would you need our comments by? That's the real question.

YOUNKER: Well--

COHON: Well, maybe you could let us know. I mean, you don't have to say it right now.

YOUNKER: Yeah, I was just going to say, well, you know, what you heard me present will be--some form of that will be in the Viability Assessment product that comes out in September. And so I assume that you all will be in some manner commenting on the Viability Assessment. So I think at least that's one venue. There may be others as well.

COHON: I assume, though, that you'll want to get on with a lot of the work. I mean, you are already.

YOUNKER: That's right.

COHON: But you'd like to--you know, so if you'd let us know what would be a good date to comment on this.

BARRETT: Well, maybe I can add a little on that at this point. Let me just make a general comment on this issue of temperature, not too hot, not too cold. We've been discussing here, and there has been very good dialogue, the balance between natural barriers and engineered barriers and stuff like the yin and yang discussion. You go back and forth. There is no right, and there is no wrong.

Now, this topic was a Board-chosen topic, an excellent topic, and in our classic way, you know, we want to be full and open and discuss it, and the contractor team has views, as I think you've gotten the impression it is weighted toward engineering. Some might think too much, some might think too little, depending on your point of view.

DOE, Russ Dyer and myself, have not decided yet what we're going to do.

All right. Now, back to dates and times. The work plans are signed by Dr. Dyer and signed by me on October 1 basically, based on the contractors' recommendations to us. They are in the middle of doing that now as we're getting our budget guidance from the Congress. Also, we are preparing the Viability Assessment, which includes the licensing plan and the cost estimates per the statute for the work to be done between now and LA. So to do that, we need to--what is in that as our plan.

Now, that plan will be presented to the secretary for the secretary's review in September so that can correspond basically with our work plan. So they kind of go together.

So feedback from the Board is very valuable to the contractor and also to Dr. Dyer and myself on this. There is no right, and there is no wrong.

So the sooner, the better. I mean, just to comment, and the dialogue here I will say is helpful to me, and I think it's helpful to our team as we discuss these things.

Once we have published the Viability Assessment, the Nuclear Regulatory Commission will provide their views. Now, when it comes to is this the proper set of work between now and the license applications, their views will be most important. Your views will also be important. I think one thing we need to be careful with, that there is no misunderstandings regarding the next major step, which is not the license application, is the site suitability as we talked this morning. And the work is driven primarily by the license application.

But just because we talk a lot about the engineering aspects and different barriers and different materials and different approaches, we still have site suitability, and I think as Dr. Craig mentioned, you know, just because you don't hear that every other word doesn't mean that's not important because it will be a balanced program of natural and engineered. That's what I want and Dr. Dyer wants, and your views will be helpful to us.

But I mean, clearly, we are not engineering a bad site, and the siting is an important part of this, but then I think the engineering can compliment any natural site. And it does matter very much if you're in saturated or unsaturated and all those kinds of things. Even though we're kind of shifting toward squiggly curves out to a million years doesn't mean we still aren't caring about the basics to what we have, and it can easily get lost. And noise can get into the system, especially from such an important body as the Board, who will write to the President and will write to the Congress.

And I would like to have the opportunity, as I'm sure you will afford us the opportunity, to have the Board's views when the Board has a view. I mean, the different members--as you said, Dr. Cohon, in the very beginning, members have views. Contractors and individuals and DOE have views as well, and it's not necessarily ours until we sign it.

So the earlier, the better. And then when the Board does have a view, or even individual members have views, as we hear them, we will try to accommodate. But clearly, the Board's views are most important, and before there is noise in the system, in the upper--in the Congress and the White House, I would like the opportunity to try to address it to find a win/win way before we get into that type of thing. And I'm sure you will attempt to allow us to do that.

COHON: Understood. Thank you.

Well, we'll go this way, Paul, Debra--

CRAIG: Craig, Board. I will try to speak into the microphone. Yeah, it really is a fascinating and difficult time in the history of this project, and it is real important to remember that there's life after LA. And we did see a bunch of experiments up on the mountain yesterday where the results won't be in for 10 years, and those are important experiments. They are really important experiments.

Nevertheless, here is Craig's view, which as our Chairman always says, may or may not be on the--for having anything to do with what the Board thinks. But I've been following the engineered barrier and corrosion research pretty intently in the last some months, and I've got to say that given where you are today, it is absolutely proper to rely on engineered barriers for a lot, and there are a whole set of really important questions, many of which probably can be answered in the next year if you have the right technical program.

So I personally like the research priorities that emerged here. I wish you weren't in this position, but you are. Given that you are, I think it's a good set of research priorities, and what I would love to see next would be the specific details on just exactly what research programs you intend to run because those are critical, and they can be done right or wrong. I'd sure like to have an opportunity to--

YOUNKER: Yeah, the detailed planning is under way. We've just kind of completed the mid level and are ready to roll with some interactions with the DOE to make sure that we have kind of their thoughts incorporated. So detailed planning for '99 is about to go.

COHON: Debra Knopman.

KNOPMAN: Knopman, Board. Jean, would you clarify a statement you made quickly in talking about flow and transport in the saturated zone? It was your Slide 11. You seem to suggest that you sort of have the tools in place already to glean additional information, and it sounded like in combination with the drilling program of Nye County that you'd probably get what you felt you needed by LA.

But I'd like you to clarify now for us what the status is on the second set of--second well complex that we had heard about. There's some confusion on our part as to whether that is proceeding in a time frame that would be relevant to LA, and if you're not doing that, what exactly are you going to do with the C-Wells Complex? And if you can't answer this question entirely now, we really want to get some more detail on this.

YOUNKER: I did ask to have people here who could respond to that question because I'm not familiar with exactly where we are on it. But I think probably from the M&O side, Ron Smith, do you know the status on the C-Well planning? And then maybe let Ron comment, and then see if Dennis or someone from DOE wants to add anything.

SMITH: C-Well Complex is--

YOUNKER: Oh, Ron Smith from the M&O.

SMITH: I'm sorry, Ron Smith, M&O will continue into the next year. All we've recognized is we've seen the program that Nye County has proposed, and we see in it a real opportunity to piggyback the work that the M&O is doing with that of Nye County.

So I think Second Testing Complex, or STC is probably--we are looking in the planning now to try to find a way to integrate the two programs to work with Nye County. We'll see their complex of boreholes as Nye County presents their results, and I think that presents us with an opportunity to do that work in a place we really need it, which is in the alluvial area and down in the paleozoics.

KNOPMAN: But their wells are different than the ones that we had been talking about before for a Second Testing Complex. There was one that was just south of the C-Well Complex that I had understood would be in some deeper units, and you'd be looking at trying to get aquifer properties extended over a larger spatial area.

And, you know, there was testing that was done at the C-Well Complex that was cut short or important--this is a data poor area is what I'm saying, and one can do more model development, but it's not going to get you very far in the absence of some increased data collection.

So we just need more detail on what your data collection activities are going to be from now and through the next two or three years.

DYER: Okay. We can give you more detail, but again, the C-Well Complex will continue, and there is, again, more extended test in the Prow Pass and the Bullfrog, which are the places we were missing data. Hydrologic tests are going on now. There will be tracer tests going on.

But again, I think--we're looking at two other locations for the STC. We believe the more productive area is to look down south in the area where Nye County is working. But we can get you that information.

COHON: Priscilla Nelson.

NELSON: Okay. My question here relates to I guess the fact that a lot of the focus of these is towards natural and engineered barriers in terms of understanding their properties or data for input. We've also got some processes themselves that are available for consideration to determine whether they can be improved, or whether they're correct or not or alternative models need to be developed.

So that's one comment. The second comment that came up, and it's certainly not my field, but it's something I've always wondered about, deals with neptunium solubility, and that it has changed fairly radically in what has been done with that. And here we see it as L, for low. It's my understanding that that's not because there's no impact on dose because it's a fairly significant component of the long-term dose calculations.

So I'm wondering about what the L means in this context, and does it mean that the process that's involved is known very well so no additional data is required, or does it mean that it's not known very well, but you can't get it any better, reasonable?

YOUNKER: Yeah, I think that's one that has been raised as one that we need to look at. I know that people have been talking about it in the last week or so. But I think if you look at Bob Andrews' plat, the sensitivity at the end of it to that, I think it's less an order of magnitude, isn't it, Bob, or about an order of magnitude?

So I mean, it's one that's on the margin. You would consider the cost of that work. If you thought you were going to get a better handle on solubility, and potentially it was lower than what you're assuming in your PA calculations, you'd have to balance that off against--

NELSON: Well, maybe Bob can tell--how much was it varied in order to observe one order of magnitude difference? I mean, it has moved several orders of magnitude over the past recent years.

YOUNKER: Yes, it did.

NELSON: And so you've selected some amount of variation that you're going to consider for sensitivity, and I don't know how much that is.

ANDREWS: Yeah, let me try to--this is Bob Andrews at the M&O. We didn't talk about neptunium solubility, the details this morning, but there's a wide range of data on neptunium solubility, some of it from over saturation. Those are not believed to be stable for long-term prediction uses, at least from modeling studies. And there's a number from laboratory observations of water in contact with spent fuel. Those are very much lower, several orders of magnitude lower. It's quite an extensive range. The total range that we used is between those two N members, if you will. It encompasses about three orders of magnitude of neptunium solubility. So the ones that were very high are not stable for long term, and the ones that are very low are also probably not stable for long term. It might be true for the first thousands or even tens of thousands of years, but not for long term predictions.

One of the things that is going to go on is to better examine these secondary phases which do control the soluble neptunium concentration on the waste form surface and to re-look at some of the Argonne data, that testing data that they have on the formation of those secondary phases and correlate those to natural analogs of secondary phases in that form when UO2 alters in the presence of oxygen and water.

So our total range was three order of magnitude, and that's what drove it to have--

YOUNKER: In the solubility of--

ANDREWS: In the solubility.

YOUNKER: Okay.

COHON: But you don't sound like a man with high confidence in our current knowledge of neptunium solubility.

ANDREWS: That's why we have three orders of magnitude range on neptunium solubility.

COHON: No, no, I know. Our current confidence is judged to be high in this table.

YOUNKER: But we could--

ANDREWS: We've reasonably bounded that uncertainty.

YOUNKER: That's right. We could be high confidence that that's the right range to use and that we won't do much better. I mean, that could be the answer to the question. I'm not saying it is, but that would be a reasonable answer given the method we're using, that I will accept that bound, I believe I can defend it, and I will move forward with that range of solubility in my modeling.

NELSON: I'd like to defer just to Don, if he has any follow-up questions, because he was the source of some of the discussion there about neptunium.

RUNNELLS: The question you raised, Priscilla--Don Runnells, Board--is one of the detailed questions that I mentioned this morning that I probably addressed with Bob or someone else individually.

But the change in solubility does have profound effects on that ultimate dose, and the average change in solubility, if you'd like, is about two orders of magnitude, but the total range is probably, if you take the highest value and the lowest value, about six orders of magnitude.

NELSON: Yeah, it was higher.

RUNNELS: And the question I ask you, Bob, about the secondary phases, the secondary minerals, was directed really at that question specifically. As MPO2 dissolves, if that's the proper phrase--and my friend Dan says he's not convinced that MPO2 is, in fact, the starting material, the proper starting material. As that dissolves and produces a whole sweep of secondary minerals alteration products, that's when I was leading into the spring flush, if you like, how will those behave when they see additional water.

Now, I was happy to hear you just a moment ago, Jean, say that there's an ongoing or a good program in studying secondary mineralogy and the solubility of the secondary mineralogy. I guess I would say simply that from the data that I've looked at, the three orders of magnitude variation solubility is not perhaps as conservative as I would like. In fact, I might go with five orders of magnitude and say that would encompass the uncertainty.

Priscilla, does that address--

NELSON: Yes, thank you.

RUNNELLS: Okay.

COHON: Richard Parizek.

PARIZEK: Parizek, Board. You've got Slide 22, which is the unsaturated zone, and Slide 23, the saturated zone.

COHON: Go ahead.

PARIZEK: Yeah, of the two slides, 22 and 23, they concern some of those study needs in the unsaturated zone and the saturated zone. And I can see an aggressive program underway and continuing with the unsaturated zone, with the niche studies that are ongoing, the planned new niche studies. There's the drift scale heater experiments underway. We've heard of new heater experiments on a smaller scale being planned in the future. So there's a lot happening there, plus the Busted Butte work. And so that's aggressive, and so Paul Craig ought to feel happy about it, and he's aware of that.

The saturated zone we're still a little bit vague about, and I know Nye County is going to give us a presentation. Perhaps we ought to wait until we hear what their drilling plan is all about, maybe the testing that they're planning there.

But it seems like from what Ron Smith said, that you will maybe use some of those realms to do studies. What kind of studies? Will it be pumping tests? Will it geochemical sampling? Will it be isotopic work? Will the drilling be done in a way that the quality of the data you collect is meaningful, or will it be contaminated by the drilling process? There's a whole series of questions of that type that I'll wait until later to hear what's being planned.

YOUNKER: And that's part of that collaboration that Ron Smith was talking about. We really want to make sure that we're going to be able to use their information, and they likewise share that concern. So we'll be working together on that.

PARIZEK: Right. So that's a happy situation.

In terms of the regional modeling again, some update as to where that's leading, as well as the geochemistry updates because there's a lot of analog value in geochemistry, the patterns of flow and water quality is kind of validating flow models and maybe getting at dilution dispersion.

But I still feel strongly that the transient time period with heading toward pluvials means more recharge, which also means change in groundwater flow details, which gives you dilution and mixing. And you really should get credit for dilution mixing if there's going to be any. It seems like we backed away from it for reasons that you need to get on with VA, but at the same time, there's value there. And I'm sure you could probably give us some further information of how you're going to handle future modeling efforts or revisions in them.

YOUNKER: Yeah. Not answering the specific questions because I think it's probably--probably some other people would have to answer the specifics, but I think this is one area where, just like we talked about, you know, under a constrained program, you have a certain amount of budget, that the kind of work that you're talking about in the UZ clearly has some high value to us, and there's some of it that we will want to continue.

If the allocation that DOE accepts is to shift a certain amount of work and spend a certain amount of work on some of the engineered system characterization that we're talking about, then some of the materials work that we've been told we have definitely not put proper priority on by a number of folks, then I think some of that work you're talking about will have to be looked at. And that's what this is--that's when Lake is talking about the balancing act between the money that we spend.

I mean, when you look at the discretionary dollars that you have to spend in a program like this, you know, you do end up doing some very difficult tradeoffs. And it comes down for the most part, if your infrastructure costs and the costs of doing business are as well constrained, as efficient as they can be, then it does come down to tradeoffs between some of the scientific work and some of the engineering work.

So, you know, it's a very difficult balancing act. And I think, like Lake said, you know, in no way do we know exactly what balance we'll have going into FY-99 at this point. But, you know, we're putting our best information together and on the table, and we'll work with DOE to try to determine, you know, whether that kind of program that you're talking about is the one that should be supporting the kind of priorities that we think we need to have moving toward LA.

COHON: Dan Bullen.

BULLEN: Bullen, Board. I, again, want to compliment you on the performance allocation development, but now I want to ask the follow-on really tough question. The really tough question deals with as you gather more information and you do the tests and analyses, and the one that jumps off the page at me, obviously, is the materials test.

When you learn about the phase stability, the drain bound region and the as-welded region of C-22, if you decide that it's important that you understand its performance, and you think that that's where you're going to put a great deal of your effort to evaluate and to take credit for performance, how much of the other performance of the system are you willing to trade off, or sacrifice, to ensure that you know that that performance is, indeed, occurring? And, obviously, this leads into why don't you do post-weld heat treat because then you wouldn't have to worry about secondary phases near the drain boundaries, and it will be there in a situation that you know will exist.

YOUNKER: You're talking about the exact kinds of discussions that we have to have in terms of allocation.

BULLEN: Right. And I guess the question is, how do you do that? That's kind of--I mean, it's an example that you knew I would make, but how do you make that? Cladding credit is high. C-22 credit is high. Now, if we do something to make the C-22 more--excuse me, less uncertain, then do we sacrifice something else? And how do you do that? That's a tough call.

YOUNKER: Exactly right.

BULLEN: I just would like to know what your thoughts are.

YOUNKER: I agree it's a tough call, and those are exactly--it's the reason we have developed the method, so we can be as explicit as possible about the decisions we're making. I mean, I think that's all you can do, is get it down on paper so you can focus on what decisions are driving your priorities.

BARRETT: Barrett, DOE. Dr. Knopman asked a good question earlier, and I'm not sure she got a direct answer on the Southern Tracer Complex, on exactly what our intentions are regarding the Southern Tracer Complex. Let me back up a little bit.

In '98, I had a $30 million hit, okay, and we absorbed that, I think, reasonably well. I'm looking basically at a $20 million hit here in '99, thereabouts. I basically committed virtually all our reserves to build a, let's see, northeast to southwest drift, at very strong influence on our decision from this Board.

Okay. So now we are somewhat living with that because we committed pretty much all the reserves to do desirable things. I believe if we didn't do any of the things we've been--if we didn't do much of the things that we've been talking about here today, we'd still have an adequate base program, but not one that we would like to have at all.

So now we've got some really hard choices to make regarding are we going to do this on the Tracer Complex, which is very valuable and we would certainly like to do, but right now that is swinging in the wind, all right, versus engineering that we've talked about, versus solubility work we've talked about. And I'll bet there are a dozen other items that we haven't talked about that are very important to us all as very positive, desirable things that we should do.

But it's getting very closely--we've got to get soon, in the next couple of months, we're going to give direction to the contractor to go. And all we can do at this point is do the most thoughtful balancing of these competing goods, as it's been described, and choose the best ones for this program and this nation. And that's what we're trying to do.

So the dialogue is good, but it is not clear. I mean, I'm unclear, the Southern Tracer Complex, I don't know. We'd love to do it. We hope that the Nye County work, we can work that, and that can be adequate and enough, but we just don't know, and that's part of where we are. We did commit those reserves, and that was it. And we said in the hearing process, the budget process, we have no money left now for contingencies and new issues. We absorbed an awful lot of this, and we can't absorb much more.

So it's getting down to nice-to-do versus necessary-to-do in the dialogues. And I think Steve or Dennis had something.

YOUNKER: Dr. Cohon, would it be okay for--

COHON: Well, you guys sort yourself out.

WILLIAMS: Do you want me to say something?

YOUNKER: Please, Dennis Williams.

COHON: Dennis Williams, DOE.

WILLIAMS: Regarding the Southern Tracer Complex, I think one of the things we lose sight of is what the particular objectives of that complex were, and they had to do with things such as scaling to get us a larger area to do hydrologic and tracer tests on, also to look at the potential interference from faults that may be in the area in an area that's in the downgraded area.

Although we do have some difficulties right now trying to configure this test, we are looking at what we can do with possible spacing out the C-Well Complex, wider with extra drill holes. Of course, we have the opportunities now that Nick Stellavato and Nye County has offered us to possibly do some things with some of his drill holes to get a larger scaling effect to look at the influence of faults, those types of things.

So just to say that maybe the Souther Tracer Complex as originally envisioned may not be on our screen because of some difficulties in funding, but we still have some of those objectives in mind and trying to get those objectives incorporated into existing programs that we can hopefully field in the next year or two.

BROCOUM: I just want to make a comment on the performance allocation.

YOUNKER: Steve Brocoum, DOE.

BROCOUM: Steve Brocoum, DOE. I want to make a comment on the performance allocation, which is so important. You've had a lot of questions about the high, the mediums and the lows. I have to say from my perspective of managing the completion of the VA, that area has been the most difficult for us to manage. When you get the VA, make sure you read Section 2 of Volume 4. That is where the logic and the explanation will be for the actual performance allocation. We're getting that in next week for the DOE management review. So there may be some changes from what you've seen today, so this is work in progress. In fact, when I look at the tables today, they've changed since last week. Some of the mediums and highs have changed.

So this is work in progress, and we're presenting to you work in progress, and that's the point I want to make. We have not fully embraced it at DOE yet. We realize it has to be done, and it's a very important activity, and it's very difficult to do, as you can imagine.

COHON: Thank you. Alberto Sagüés has the last question.

SAGÜÉS: And a short one at that. Things such as inside of package, like C-22 outside and carbon still inside, or the dual corrosion system package, are those issues that are not to be looked at or they're not--or they would be investigated under a different heading?

YOUNKER: As a part of the alternatives that would be looked at, I think both of those--I think there's no question both of those will be entered into that list that gets looked at as we head into the selection of the reference design.

So you're talking about having the CRM on the outside?

SAGÜÉS: Right, right.

YOUNKER: Yeah, and the structural material on the inside?

SAGÜÉS: Is that a different list from this list that you are showing in here?

YOUNKER: Is that one on the alternatives list? Yes, it's on our list. It's on our list already. It will be considered, as also the dual CRM.

SAGÜÉS: I see, thank you.

COHON: Thank you very much, Jean.

We will now take a break for 10 minutes.

(Whereupon, a break was taken.)

COHON: Our next session is on Environmental Impact Statement alternatives, to be presented by Wendy Dixon, Assistant Manager for Environment, Safety and Health, and she will be assisted by Lee Morton.

Wendy?

DIXON: Okay. The discussion elements in the presentation this afternoon include as it relates to the implementing design alternatives, Nuclear Waste Policy Act considerations, the overall goals of the Environmental Impact Statement construct, some information on the background on the selection of thermal load as the foundation for the EIS implementing alternatives, and finally, and this part of the presentation will be presented by Lee Morton, a discussion of the analysis of design features and their integration into the Environmental Impact Statement.

Let's start out with Nuclear Waste Policy Act considerations. This is basically a refresher. We talked a little bit about this in January. The EIS is intended, as you know, to support a secretarial recommendation to the President on the development of Yucca Mountain as a repository. And as you know, the approach to alternatives in the Environmental Impact Statement was developed based on what we term the Nuclear Waste Policy Act's road map.

In the Nuclear Waste Policy Act, Congress told us that we did not need to consider in this EIS the need for a repository, alternatives to geologic disposal, alternative sites to Yucca Mountain. In essence, Congress made these decisions for us and directed the Department to streamline its evaluations in the EIS. If Congress had not done so, these may have been major alternatives that would have had to be considered in the EIS.

Thus, the proposed action for this EIS is to construct, to operate and monitor, and to eventually close a repository for the disposal of spent nuclear fuel and high-level radioactive waste at Yucca Mountain. The really key alternatives for this EIS are whether or not to recommend the site to the President. That is from a NEPA point of view the key alternatives.

With respect to the goals of the EIS construct, there's really two very major goals, and under them some subset goals. The first one is to focus on significant environmental issues, and this ties back to the CEQ guidance that basically says that we need to focus on those issues that are important to the decision maker and not to spend time amassing a bunch of needless detail. So as a sub-element of a goal we need to provide information on issues that are important to the decision maker, and, obviously, one of those is the long term repository performance, tied to human health and safety.

We want to as part of our overall EIS construct preserve engineering flexibility and the ability to accommodate eventual LA design. We're not at LA design now, that's some time in the future, and we want to preserve the flexibility to deal with and accommodate whatever that LA design might eventually be.

We do not anticipate decisions on these implementing alternatives. These decisions, as it relates to design issues, will be made as a part of the evolutionary design process. And I think it's probably important to underscore the fact that EISs normally deal with the conceptual level of design. They don't deal with the really detailed design issues. Those are left as you move forward to optimal design, to final design, and then as you move forward and you move down that path, you deal with your value engineering studies, your tradeoff studies and so forth. Those are dealing with your more final designs. EISs typically deal with conceptual designs.

We need to also recognize the need to take advantage of all the previous engineering and site characterization work that's been going on. We're not going to reinvent the wheel. We have 15 years of data out there, and we're going to make use of this data. And we need to recognize uncertainties in the continued evolution of the reference design, both performance-related, which we term the long-term impacts, as well as the operational aspects, which are the short-term aspects.

And finally, as a major goal for this EIS, what we're trying to do is reasonably represent the range of environmental impacts from the proposed action. This is an important point, and I'd like to say it again. One of our main goals is to reasonably represent the range of environmental impacts from the proposed action.

Okay. This sort of ties to where we were going on the EIS construct, and what we wanted was a tool to do what I just said, to valuate the range of impacts and implement, and alternatives is one of the words that we claim to do just that.

We originally looked at all kinds of design features that might serve in that capacity, and what you see on this particular chart is just a very small sub-element of the list of design features that we tried to consider to determine which kinds of features or, you know, implementing alternatives would best bound and be, you know, multi-dimensional, the greatest number of potential impacts.

We looked at the types of disposal containers and materials. We looked at drift size and spacing. We looked at waste emplacement schemes. We looked at canisters versus the uncanistered fuels and surface facilities sizing and capabilities; again, to name a few. There was a large list.

And as we were going through this process, we realized that there were almost limitless possibilities in the numbers of design elements you could end up considering. We also recognized that as you looked at these various features, that they really could be put into basically two categories. And one was are they performance-related, i.e., long-term impacts, or operational related, i.e., short-term impacts.

Through our analyses, again looking at these various design features that we were considering, we found a lot of them couldn't look at a very broad range of impacts, but there were a set which we have coined the term tied to thermal load, which probably is perhaps better said aerial mass loading. That was the lowest common denominator. It influenced the greatest number of things.

For example, as it relates to long-term performance, thermal load influences the corrosion of your waste package, influences groundwater flow, which leads to the transport of radionuclides, and it also influences a number of your operational or short-term features through the course of your analyses.

Again, what we were looking for was the ability to evaluate a full range of environmental impacts through these thermal load implementing alternatives and the types of things that can be evaluated using thermal load. And I just have some on here for purposes of examples, includes such things as, you know, start out with operational or short-term impacts land use.

There's a difference in the amount of land use from low thermal load to high thermal load. There's a difference in the amount of muck that you're going to generate from your excavations. There's a difference in air quality because in the low thermal load, I have more equipment and more tunnelling. Safety issues, that ties to it, too; number of workers, amount of tunnelling that might need to be done; ecosystems, amount of land disturbed; socioeconomics, number of workers that would be employed; waste management, the differing amounts of hazardous materials that might be generated from your activities, and, obviously, utilities would fall in that category as well.

I have another slide that takes utilities down to the next level of evaluation that you could go to for the EIS, and I'll get to that in a minute because first I'd like to mention that, obviously, it also deals with long-term related impacts, those important as it relates to radiological impacts to the public, and finally, the potential for impacts for ecosystems as it relates to high thermal load.

Okay. I mentioned that we take a look at utilities. Again, this is just for example. But if we pulled the utilities off the other slide, and you broke it into its lower component sub-parts, utilities would include electrical power, your potable and construction water use, your sanitary sewer, your communications, and these are all on the upper level bounded by your low thermal load case, which requires a greater number of work force, greater excavation, larger number of tunnel boring machines, more conveyers, more ventilation fans, more waste transporters, and the list goes on.

This is also just for presentation purposes, but we're trying to get across the fact that as you look at from an operational standpoint thermal load as a potential implementing alternative, it does cover a number of different areas for evaluation in the Environmental Impact Statement; extent of excavation, worker size, support facility layout, dust generation. We've mentioned a number of these before, but it's a fairly extensive listing.

As a result of our analyses on high, intermediate and low thermal load, as well as a number of the other features that we mentioned to you earlier, and the list, as I said, goes beyond that, we did end up selecting thermal load, the three thermal load implementing alternatives, to bound the long-term performance impacts of any likely LA design variations and recognize that there were a number of short-term operational impacts that were also bounded by using thermal load as your implementing design alternative.

We recognized through our evaluation that this did not cover the full range of impacts and there were additional analyses necessary, so we picked up two other options for evaluation, again as tools to understand the full range of impacts from the proposed program. And these included both packaging options and transportation options.

And on the packaging side of the house, we have as a scenario the fuel other being canistered or uncanistered, and, obviously, the upper bound for impacts is the uncanistered fuel, where all the fuel to the maximum extent possible would come in on canistered. You would have to deal with the handling operations. You would have a bigger waste-handling facility, more land used, more workers involved, greater health and safety impacts from potential worker dose. And these are the kinds of things that would be--again, these lists aren't all inclusive, but they're examples of things that can be evaluated and would be evaluated by looking at packaging and transportation options as well.

I've been using the word bounding now for awhile, and I thought it was by this time in the presentation appropriate to, you know, spend a moment on what we're talking about and what we're really focusing on as part of our evaluations. And that focus really is to represent the upper case environmental impacts from a particular feature or combination of features.

The consideration of lower environmental impacts really ties into the equation when the impacts are deemed significant. And I guess I also would like to add that the significant environmental impacts that would come out from our analyses as it related to design features and alternatives--and we're working on an analysis of design features and alternatives to make sure that we have adequately bounded impacts. Should analyses show that any of these impacts are significant, we'll factor them into the work that Mike Vogele is doing, you heard about earlier, and their criteria and evaluation for, you know, ultimate decisions on what they might do at some point in time for the LA design.

This, again, is just an effort to try to explain what we're saying when we talk about impacts bounded. We'll feel we're successful if the analyses in the EIS provides for us that outer circle. And when the LA design is complete and when LA, you know, moves forward, the LA impacts from that design are within the overall umbrella of what we've encompassed in the Environmental Impact Statement, i.e., it's okay if performance gets better. We want to make sure that we've done the higher upper bound in the Environmental Impact Statement. If we find out on the other hand that impacts weren't bounded and the impacts that come out of the LA design are outside of the circle that we've evaluated, we'll have to go back and do supplemental analyses to determine if those impacts aren't fact significant.

This doesn't show up very well on this picture, but this was intended to be sort of the overall, you know, diagram of what we're considering at it relates to the EIS and our analysis of a full range of impacts for the EIS.

Again, the major alternatives and ultimate decisions are whether or not to recommend the Yucca Mountain site to the President, which equates to in real short terms our "go, "no go" alternatives, and they tie down to the tools we're using to analyze impacts.

And on the design side of the house, we have our implementing design alternatives, which equate to high, intermediate and low thermal load.

On the transportation side of the house, we've attempted to bound those impacts by on the upper side using our legal weight trucks, and--to the maximum extent possible, there are a couple of exceptions we need to recognize. And on the lower side, on the rail, intermodal implementing alternatives in the state of Nevada, we have a few more scenarios because there isn't, as we mentioned before, a rail line that goes all the way to the site, and we need to look at potential impacts there as well.

And again, completing the picture was the evaluation of the spent nuclear fuel packaging options; again, trying to bound it from all the fuel coming in uncanistered versus canistered.

But this is the picture that the presentation has been attempting to describe.

In conclusion, our analyses to date show that the combination of implementing alternatives that we've described, together with the packaging options and the transportation options, produces a full range of reasonably foreseeable environmental impacts.

However, and "howevers" are always in these discussions, we do need to recognize the need to continue to assess the potential impacts of engineered design features on this construct. And, as I mentioned at the beginning of this presentation, Lee Morton will be providing you with the information on how we're doing that and what we're doing and how that will tie into the environmental impact statement.

MORTON: Once again, my name is Lee Morton. I'm with the M&O here. I want to talk to you real briefly about how the EIS is going about incorporating the design related features that we've been talking about most of today and how we're going to address that within the EIS.

The list that was presented earlier is the same list that we're going to be using in EIS. We're going to remain constant with them. We're tracking with them as closely as we can to make sure that we continue to maintain the correct list. I'm not going to go through all these options and features. These are the same lists that Mike Voegele presented at the beginning of the day, and this it the same list that's being picked up for the EIS, design features in a couple of different categories, and then the project design alternatives which are the combination features. These are the same things that we're doing.

The EIS continues to study design features, in addition to implementing alternatives. As Wendy explained earlier, this is important to us and we're looking at not only project design alternatives, but we're looking at those things that are coming out of, for instance, the Board concerns, any engineering enhancements that might get picked up at a later date. We're also looking at potential mitigations to environmental impacts. We look at these because they're important to insure that the current EIS construct, the implementing alternatives with the options, is a correct construct; that it reasonably represents the full range of impacts. We are not looking at these features for the purposes of selecting design details as a function of the EIS, but it does provide decision makers information for the environmental side of these issues. We are not looking at using these as EIS alternatives. We do recognize significant environmental impacts of a design feature are not enveloped by this EIS analysis. The EIS construct may need to be changed. If we find something outside of what Wendy's ball that she showed you earlier, we have to go back and fix something in the EIS.

The process that we're following. We're basing everything off of the reference design, started out with an areal mass load even 85 MTHM/acre. This is our high-thermal load. We've added to that. We've added two additional thermal loads, areal mass loadings of intermediate and low-thermal load. Intermediate is represented by a point load of 60 MTHM/acre and low-thermal load is represented by the 25 MTHM/acre. We are evaluating engineering alternatives/ enhancements features--again, we have the same language problem that everybody else has--in context of the reference design; what do they change off of the reference design to determine whether thermal loads envelope the operating conditions and potential long-term impacts? We also recognize if these alternatives or enhancements offer significant improvements for the project, there is a potential that they may be added as time goes on to the reference design and they will be picked up in the EIS if that occurs.

The process that we're following. We're going through and gathering data on each one of these features. The first one is to get a good, strong definition of what that design feature represents. We also need to understand why is the program considering this feature and develop a qualitative or quantitative description of the benefit to the program. From there, we will look at the expected changes to both short-term and long-term environmental impacts if the program was to place this feature into the program. From that, we will make a judgment on whether or not we need to do a continued study in the EIS.

Now, I brought two examples of our preliminary assessment to date on these, and I know that it's probably real difficult to read from there where you're sitting. I'm trying to follow everybody else's course and you've got to put up some real complex stuff. The first one that we're going to put up here is a--again, I want to stress continuously that this is preliminary. Jean Younker explained to you how they are going through their process, that they hope to have their report available next May. We're going to track along with that and continue to update our information for incorporation into the EIS as we go. When we issue the draft EIS, it will contain the best available information at that time and, as the program continues to evolve this information, we'll update it for the final, as necessary.

Waste package corrosion resistant materials. This feature involves the use of alternative waste package resistant materials that might provide enhanced long-term performance for the waste package. Related to the EIS from a short-term operational impact type of consideration, we look at surface, we look at subsurface, and we look at waste package.

From a surface point of view, we recognize that the waste handling building may need to be modified to seal packages constructed of these new materials. We don't currently foresee that any of these new materials would represent a significant technological advance and/or change to the environmental impacts that are currently governed by the existing waste package. So, we think that our current reference design adequately covers this issue.

Subsurface considerations. We don't expect to see operation or design of the subsurface changed just by adding a change in the design of the waste package corrosion material. Once again, waste package not expected to result in significant changes to the concept of the waste package design, only to the materials of the waste package. If a material is selected for this analysis that represents a significant burden on the world supply of a material, we will pick up that analysis in EIS. But, in general, we're not talking about any important things here.

Long-term performance consideration. There might be some improvement to performance from changing the corrosion resistant materials. We recognize that any such improvements are still to be quantified and we're going to be tracking to quantify those, but we believe that any improvements will be bounded with the EIS analysis or the reference waste package. Again, we don't think that we're going to incorporate this if it makes performance worse. We've bounded it on the high end on what our worst--I don't want to use the term "worst case"--what our performance should be. This would just enhance the performance, shift the release curve to the right in time.

Conclusions relative to waste package corrosion resistant materials. At this preliminary stage, we don't see any issues that concern us in relationship to our belief that our construct adequately bounds this design feature.

The second one I want to talk real briefly about is pre-closure ventilation. We talked a little bit earlier about pre-closure ventilation. This is providing continuous ventilation through the waste emplacement drift to help keep the temperatures down. The intent here is you can keep the temperatures down, that affects corrosion, it affects moisture in the tunnel.

Short-term performance considerations relative to the EIS. Obviously, we'd have to add some additional ventilation capacity on the surface. We understand by doing the difference between high-thermal load and a low-thermal load in the EIS what the difference of adding additional ventilation shafts already is. So, we know what that delta impact is, so we understand what those impacts might be.

From a subsurface consideration, as Mike showed you earlier, it does change the underground layout represented by the need for additional drifting. We understand how much additional drifting might be required by looking at the difference between the high-thermal load which requires a lower amount of drifting, then a low-thermal load where we end up having to do extensive drifting. We understand the differences in the delta of impact from the difference in drifting.

Waste package considerations. Directly, this doesn't affect the waste package design.

Long-term performance, again all this needs to be quantified, but the removal of the heat and moisture through ventilation may result in a shift to the impacts off to the right in time to a later date, but again we feel that the way we construct our EIS, that's adequately bounded within the EIS.

Once again, the conclusions are that the EIS adequately bounds this design feature.

Now, we're gone through all of the list on a very preliminary basis today and we're going to continue to track along and participate in the other studies. What tools are we using to do this? The sensitivity studies that were being preformed from VA and beyond, the currently planned FY-99 study that Jean Younker's people will be heading up. We continue to hold qualitative discussions and workshops with project scientists and engineers who we can understand not only what is a change to a physical design, but what is a change to potentially operational type of aspects. And, we're reviewing historical project records to see if what's been studied in the past related to these.

Once we have this done, how do we integrate this into the EIS? We've got two points of integration. We've got to get it into the draft EIS, we've got to again get it into the final. We'll use the best available information possible at the time of the draft because they're studies are running a little bit later than what our timing is in order to get the thing through review cycles.

But, we do plan on creating several reference documents to support the EIS, the first one being an analysis of the design features, the continued accumulation of these discussions that I just went over again affecting all features. We're also going to develop a document called the evolution of the reference design which will be available as a reference to the EIS. This will describe the historical basis of how the project reached the level in the reference design; whereas, the other document describes those other things that are still being considered by the project.

Depending on the design feature, these things can be incorporated into the EIS in a number of locations. They could be included in a discussion of responsible opposing views. Those are views from outside the agency that the Department is or is not currently considering. They could be included under mitigations which are possible performance improvers to known potential impacts or they could be included as part of a description of proposed action in implementing alternatives. We haven't locked in on each one of these features where they're going to be plugged int the EIS. That still needs to be determined based on the results of the studies that we're going to be conducting.

In closing and this comes back off what Wendy said earlier, thermal load implementing alternatives and transportation and packaging options were selected to ensure that a full range of reasonably foreseeable environmental impacts are considered. The additional analysis of design features is important to validate this statement and validate that we chose the right construct. Once again, if significant environmental impacts of a design feature are identified, we will attempt to go back, as necessary, and fix the EIS so that we are indeed bounding and we have all that information for the decision maker.

COHON: Thank you. Questions? Debra Knopman?

KNOPMAN: I'm interested in the--it's just really a two-way street that you've got going here between the EIS analysis and the alternative design and conceptual alternative features and alternative conceptual design process going on as part of consideration or moving toward an LA design. The list of preliminary evaluation criteria that Jean Younker presented in her talk did not identify EIS or environmental impacts as among the evaluation criteria for alternatives. There's the mention of improving safety, ease of licensing, schedule performance, cost, flexibility to adapt to new information, but environmental impact in a broad sense is not included in this evaluation criteria. So, I'm wondering how the information generated in Wendy's activities feed back into the alternative design analysis.

DIXON: I think, as Jean said in her presentation, that that was a partial list and fairly quickly put together for the presentation. It is a partial list. We have talked to Mike Voegele and the environmental impacts will be included as part of what they will do. It was not on the chart this morning, but it will end up being that.

KNOPMAN: So that means in terms of scheduling, you've got to stay up with, keep pace with what's going on with Jean's schedule of evaluating alternatives. They need to come to some closure on that by May of next year if I wrote that down correctly. May '99 was the time that you want to have your decision made so you've got to be in a position to feed into that.

DIXON: We're working, as Lee was saying, lockstep with what they're doing. We have done our initial evaluations, and as they go back and they presented to you that between now and May they're going to be doing additional sensitivity analyses and studies, we will be tied into and tracking those together. So, this is not problematic. This is a good thing.

KNOPMAN: No, I'm happy to see the coordination. I just wanted to make sure it was a fact that you were going to be feeding into their effort.

DIXON: Yes.

CHRISTENSEN: First of all, thank you. I think I understand better than I have in any previous presentation, first of all, the rationale for the thermal loading and also a bit more about the alternatives for some of the other issues. The one thing you didn't refer to and I just want to be sure that it remains either the same or that I understand the rationale for it is the no-action alternative in the EIS. Does it remain the same as you presented it in January and could you just say a little bit about that?

DIXON: The reason why I didn't discuss the no-action analysis in today's presentation was it was--the topic is really the thermal load implementing alternatives and I wanted to make sure everyone walked away with a good feeling on this. So, it was really focus for that reason alone. As we speak today, we're still out where we were before. We're in preliminary stage of this EIS. So, I can't confirm to you on anything that we're presenting at this stage of the game that things won't change, but at this point in time, I cannot tell you that there has been any changes because there haven't been. So, you're pretty much up to speed from the over-arching approach from where we left it, and again if things do change, we'll make sure that you know; not just on that, but on any other part of the analyses that we're doing.

CHRISTENSEN: Let me ask just one additional question on that. What will be the basis for choice of a no-action alternative? Is there something embedded either in the legislation or in current policy that will--it seems to me, first of all, I think you might agree that there's sort of an infinite range of choices that have to do with what might constitute a no-action alternative, each of which have an entirely different set of technical ramifications. Is there something that will provide the guidance for deciding exactly what to focus on?

DIXON: If you're asking for that magic decoder ring that gives us the answer, I wish it were quite that clear because you could set up and argue that you didn't have to deal with no-action, at all, because the road map, you could argue, did because it's in the CEQ regulations. You can argue that it needed to be equal with and provide an appropriate baseline tied to the status quo. You could argue that 10,000 years is speculative. I could argue 10,000 years is speculative for the repository. There isn't a magic answer in a book that you can turn to and say, you know, here is the ultimate answer. There's probably, as you said, different ways to approach the problem with defenses for all of them. In the end, as is legally the most defensible position, has not yet been tried.

CHRISTENSEN: So, I guess in a sense you're answering my question and saying that legal defensibility really may be the baseline for selecting--

DIXON: It is certainly an incredibly important decision, yes.

CHRISTENSEN: Yeah.

CRAIG: I want to pick up on a seemingly small point, but one that, nevertheless, has some relevance. Wendy, on your Graph #5, you used the phrase "issues that are important to the decision maker", and then Lee also used the term "decision maker". My recollection of the origin of the Environmental Impact Statement process which I think goes back to Caldwell, as I remember it decades ago, he was interested and ever since people have been using Environmental Impact Statements in order to help the public understand issues. Now, admittedly, in our democratic society, the public is the ultimate decision maker. Nevertheless, in a document that comes from Department of Energy, decision maker tends not to be thought about that way. Among other things, it seems to leave out the concept of stakeholder. So, at a minimum, I would encourage you to say stakeholders and decision makers or something along that line. That distinction, I think, is going to turn out to be quite important as you become increasingly involved in the process of communicating Yucca Mountain to the public. I think it's also going to become exceedingly important when we think about what it is going to happen to radioactive waste should the no-action alternative turn out to be, in fact, U.S. policy. So, there is a connection there, also. But, my specific point is that I picked up immediately on the usage of the word "decision maker", as you used it here, as being too constrained and I suspect others will also.

DIXON: Well, let me--was that a question or was that a State matter?

CRAIG: Only an opinion.

DIXON: Okay, thank you. Then, I accept it as an opinion.

COHON: That seems wise. Are there other questions or opinions or comments?

RUNNELLS: Paul offered an opportunity for me to ask a question that I've been waiting for an opportunity to ask all day. That concerns communication. Being new on the Board, I almost understand how DOE and the Board communicate. I'm getting close to understanding that. What I don't understand yet is how the public communicates with DOE and who listens? As a citizen, if I wanted to have an input into a very important decision that may affect me as a citizen, what mechanism, if any, exists for my input into the decision making process of DOE? Now, I understand the formal structure of an EIS and the public input period for that. I presume that will apply here.

DIXON: It will and has. We started out with scoping before we initiated the process.

RUNNELLS: Okay. So, that part of the EIS process has been followed.

DIXON: Yes.

RUNNELLS: In a more general sense then, how does the public communicate on these important issues with DOE? What opportunity exists?

DIXON: You're talking outside of the EIS process?

RUNNELLS: I'm talking outside the EIS process and I thank Paul for introducing the subject of communication. I'd like to talk about it generally.

DIXON: Lake, do you want to take that one or do you want me to take it?

BARRETT: Okay. An important part of the program is to have the public understand what we're doing, the societal choices that are being made by their elected representatives in the process, and they're invited in through, say, the formal EIS process. There will be public hearings, etcetera, in the EIS process. Now, that is necessary, but probably insufficient for the endeavor that lies before us in this matter. This was understood in the statute back in 1982 when they discussed this, and there are words in the statute about public information being provided by the Department to the general public.

Also, monies were provided--and a complicated issue--but to the State of Nevada and to the counties, to affected governments, which the counties are affected governments, to keep citizens informed. Maybe, most involved in this, for example, are citizens of Nevada. This has been a complicated issue of much debate in Congress, but nonetheless, it is in the statute and we've asked for that money to be given. So, that happens with the States and affected counties.

Also, we've maintained a public information center here in Las Vegas working with the state and local governments and trying to get information out. We'd like to really do more in the area, but you know, with the constraints in the budget, we've had to focus on the most vital parts, you know, on the science. But, we still try to maintain that at a level that I'm proud of. You know, get things out to the people and try to get not in a marketing sense, but to get real information out that people can use.

Also, we will have in the Act that says that we will have in the site suitability decision and the recommendation, there will be public hearings in Nevada. We are going to put those together when it comes time. It's not time for that yet, but we will do that and we will try to do that in the spirit of the law and try to make sure that is done very well.

We also have been refining our communication skills internally to try to be able to communicate on what does the VA mean to all different audiences which range from PTAs--we have a speakers' bureau that we use for that type of thing--Chamber of Commerces, and any group that would like to hear from us, as well as through the formal presentations. We have formulated a communications working group that reports to me to try to work on that. We are bringing in a risk assessment communicating specialist that I know our staff has talked to your staff on as a recommendation, I believe, from the Board back some time ago. We have a nationally renowned person coming that is going to teach us all how to try to communicate these conflict issues to the public, as well as to policy makers. So, basically, those who will be on the front line are going to take that course. I'm going to take it plus Mike Voegele is going to be there. We are trying to prepare ourselves to be able to communicate so that we connect through the receiver and the receiver can be the grandmothers and the receiver can be a scientific community that can be as sophisticated as the Board.

So, we are working to try to communicate this in an objective non-biased manner so people can understand what we are about and what the societal choices are, what the impacts are, both good and bad, of various decisions that are from this. And, the no-action alternative will be one of those that we will need to communicate in the process that goes forward under the EIS.

So, we're working on it. It's difficult because we're dealing with fairly complex matters that go to what does the average citizen understand about a million years versus whatever. That's very hard to do. I mean, a very effective ad was run a few years ago, I believe, by some of the--I don't know if it was Greenpeace or somebody that is was all the generations--you know, how long plutonium in a 24,000 year half-life, how long 24,000 years was in half-lives. I mean, it was generation, generations, and a whole page of paper, a very effective communication. You can communicate fear very effectively. It is very difficult to communicate the whole story, okay, and we are working on it. I certainly would appreciate any views the Board might have as to how the establishment, let me say, and I will include that Board in that, as well, how do we communicate to our citizens who we all serve to what we're about.

RUNNELLS: Thank you, that helps. But, you talked, Mr. Lake, about how DOE communicates with the public. Part of my question was how does the public communicate with DOE? Now, certainly, the public hearings that will go with the EIS and the period of public comment will help, but those are attached to the EIS process.

BARRETT: Dr. Dyer is going to help me out here at the microphone.

DYER: Thank you. Exactly, communications works two ways; information goes out, information comes back. Trying to find venues forums that are effective means of getting communications in is very difficult. One of the ways that seems to be effective right now is the electronic media. If you to go our home page, it's possible to send in comments to DOE through the home page through e-mail and get a response back within days. It gets routed to an appropriate individual who considers the comment or question and responds to the commenter. If it is a potentially significant comment, it gets elevated to the appropriate level. Information that comes in the written letter gets the same individual response back.

RUNNELLS: Thank you.

WONG: Easy question. Ecosystem impacts, can you give some comments as to what you intend to cover in ecosystem impacts? Is it just going to be those things that crawl in on the surface or are you going to consider environmental compartments that are below the surface? I'm specifically interested in will the EIS deal with the degradation of the groundwater basin between 20 kilometers and away to the repository?

DIXON: We are definitely focusing a lot of our analysis as it relates to impacts on the surface, you know, the amount of land disturbed, what will you lose, what are the species, is there anything there that is endangered or sensitive or whatever the case might be. With respect to the latter part of your question, the analysis will certainly look at whether or not--and that ties to long-term performance and other impacts as they go out. You know, we would address, as an example, could there potentially be a problem at Devil's Hole or Ash Meadows or whatever the case might be, and those analyses will tie to the understanding that we get from the science side of the house as to whether or not there is a potential connection and whether or not there could be a release, and if there was a release, how big would it be? So, yes, they will be included from that perspective.

COHON: Any further questions or comments?

(No response.)

COHON: Thank you both.

We turn now to an update on the Nye County Early Warning Drilling Program and also a presentation on alternative repository design. This will be presented by Nick Stellavato with the assistance of Parviz Montazer.

Mr. Stellavato?

STELLAVATO: Let me confirm the rumor that Nye County has developed a drilling program and this program is downgradient of Yucca Mountain and is called the Early Warning Drilling program called EWDP; we've got our acronym. Les Bradshaw who was the manager of the Nuclear Waste Office and I talked about this program in '94, but we didn't propose anything at that time. We wanted to see how much data was going to be taken because one of our major concerns for Yucca Mountain was the amount of scientific data being collected to go into the models.

So, the last year, we decided we'd propose this program again and this is also a joint effort of Inyo County, California. This program is a series of 21 wells. And, a quick update where we are, we've been in the field and we've got many inputs in this program. Believe me, when someone sees someone drill the well downgradient of Yucca Mountain, we get all the input we ever needed. So, we've got input from a wide range of project and associated project people. So, we've used that to evaluate where we wanted to locate our wells, along with Parviz and Tom Bugo who are hydrology consultants who were looking at our modeling and evaluating the Yucca Mountain model, the regional model, and the NTS model. So, we developed this program based on their input, also.

Right now, we've located eight wells. We staked those wells in the field and with use of the GPS--with Jim Pace's USGS GPS unit which we'll have and we located those wells with the GPS. We've also included a well called the Washburn Well and I'll show you the location on a map in a minute. This well is an old 1958 water well drilled by someone who was going to try to move in there and lay a re-entry and create a farm. The reason we included this, because this well went to 815 feet and didn't hit water. When I show the location, it's a normally--because just to the southeast of there towards Cowboy Joe's at Lathrop Wells and the brothel, they have allowed 300 feet to water. So, we can't understand why it's 800 feet. We're going to clean this well out if we can, go back in, re-enter, and see where the water is.

We also are going to complete the Felderhoff 25-1 well. That well was drilled a couple of years ago. It's an oil and gas test south of I-95 into the deep carbonate. So, you have two deep carbonate wells right now; P-1 at Yucca Mountain and then the 25-1 well. Then, the last one, I'll show you in a minute, we located an 8S well. We have since moved that well over and I'll show you the location and we call it 8D.

This is a map I got from Jim Pace. He's USGS. He was out and he GPS'd our wells and these are locations of the first eight wells that we located in the field. You can see 8S well right here. We have since moved that well--and I'll show you another map in a minute--and that well is located right in there. The first well is the 1D well and that is the paleodischarge site that we want to look at that site and then we'll core in the top part of that well and then drill down through the fault that's projected in there. Then, moving over into Fortymile Wash, we've got this 2 well, the 4 well, and the 5 and these are all on the outside of the NTS boundary.

What we've done, we've looked at the gravity of mag and the seismic work using P-1 and the Felderhoff well and there's a major structure that runs this way and the Rock Valley Fault runs that way. We want to locate these wells in these up and downs and the major--that shows the gravity of mag up and down the seismic. So, we've located those.

This is a map of all the wells again. You can see here's the 1D coming across. This is on the western splay of Fortymile Wash, as you can see on the aerial photograph. It splays out here. We want one right on the western edge. Then, the 4D and the 5S. The D and S are deep and shallow. Although it turns out after we look at the gravity mag and whatever structural data that we may be able to hit carbonates in many of these shallow wells because it's very shallow in certain areas and the carbonates in Felderhoff well was at 2200 feet and they were overturned. So, we're probably going to hit carbonates in most all these wells. So, that's what we're shooting for is good water wells into the alluvium, the volcanics, and then the carbonate.

So, this is the entire three year period. The red wells are the wells that are in already. JF-3, J-12, and J-13 for the location of Yucca Mountain, and then the other red wells here or the open circles are out year wells. But, the blue ones are the ones we're looking to evaluate and for inclusion into our drilling program starting October '99.

Finally, just a little bit of progress where we are. We've begun our permitting process. We're going to have to get the BLM permits and we're in the process of setting up with the BLM and setting up the permitting process with the BLM. Our testing program, we're in the process of developing that. But, we know we have the first year's wells fairly well-located. Then, we've reserved the right in the future after we do the wells this year, we can move the wells around for the next year so we can get the maximum use of our drilling program and the maximum data that we can get out of it.

It's an aggressive program, but it's part of our independent scientific investigation program for Nye County and we want to make sure we have enough data to evaluate what goes to the license application. All this data is posted and will be posted every month on our website like we do now with all of our data that Parvis is going to talk about. So, you can get all of our datasets on our website; NyeCounty.com. All of our data is there since Day 1; we post it every month. So, that's what we'll be doing with this. But, right now, we haven't got the complete testing worked out, but we're working on it right now.

COHON: Should we invite questions on this part of the presentation or would you prefer that we wait? They seem to be two distinct--

STELLAVATO: Yeah, they are two separate. So, you can ask some questions on this and--

KNOPMAN: It would be helpful to us, Nick, if you could tell us a little bit about what you're going to do when you drill one of these new wells. What sort of analyses will be done? Are you going to run pump tests? What information are you going to generate and how do you intend to use it in terms of feeding into your own modeling or other regional modelings?

STELLAVATO: Yeah. We'll do this hole very similar to what we did in the ONC-1 well up at Yucca Mountain. That was our first well that we drilled up there. We'll be doing these with reverse circulation to the wall, very similar to what we did there. We'll be taking cuttings. We'll take spot core if we need to like on the paleodischarge sites. We'll probably take the spot core in there, but mainly cuttings. Then, once we're finished with the hole, we will go in and log it with the complete suite of geophysical logs just like, you know, every other hole we've done. Then, we will do complete pump tests on these. Any details, Parvis can talk about that. We'll do the pump testing on it. We'll do the complete suite of geochemistry water samples. We're being supported depending upon funding by the--Center and Todd Stetsenbach to do his rare earth or heavy metal work. So, we have that and the isotopic work. So, we'll be getting our complete suite and the GS will be sampling these wells, also.

KNOPMAN: Okay. So, that establishes another question. Zell Peterman, his team will be poked into this?

STELLAVATO: Right. Yes, Zell Peterman and Jim Pace and them will be getting their samples, and when we do the pump tests, anybody is welcome. We'll get the samples. They can come up and get samples at the same time. These are to get the most amount of data that you can get out of these wells and not just to put them in and, you know, we'll get the data in a vacuum, no. These will be put out to anybody that wants to get some data. Once we're done with the pump testing and the wells are set, we will go in with the west phase and do multiple completions so we can look at the head relationships between the carbonates, volcanics, and the alluvium because we don't know what the flow is down here. You've got a well here, here, and 13. There's nothing until you get to Powderhorn. So, that's a big void and I don't know how you can model the regional flow without knowing what happens in here. So, we will complete these so that we can see the relationships and see what happens to the flows with the carbonates, the relationship of the carbonates as you go south.

KNOPMAN: These are single well pump tests?

STELLAVATO: Single well pump tests. Some of these are located--will be close enough we can do some off the well.

MONTAZER: One of the wells--we haven't decided which one, but one of the wells, we're going to leave as a relatively large producing well so that we can do basically a pumping test with observation.

STELLAVATO: Yeah, this well right here, this 8D, we've located down here because we also have this Rock Valley Fault system. We've got somewhere around 16,000 acre feet that's coming down from the NTS side which merges in here somewhere. That's just 8D. We've got this green water rift zone that runs north-south and this truncates into it. We don't know the relationship here. We want to see what's happening at this intersection. In looking at the gravity mag data and this Felderhoff 5-1 well, we've got some major structure in through here.

PARIZEK: Are you going to drill dry or with fluids? How do you plan to do your drilling?

STELLAVATO: Dry to the water and then we'll follow up and use air foam so that we can clean it up real good after we're done.

PARIZEK: All right. So, the chemistry won't be compromised by the drilling process?

STELLAVATO: Just aerate the foam so we can lift the water because we expect to get a lot of water in some of these.

PARIZEK: Some of these wells are definitely designed to hit the carbonate, the deep carbonate system?

STELLAVATO: Well, we'll try to hit it all in all of them if it's not too deep. We've located them based on the gravity mag and we may be able to locate the carbonates in most of them.

PARIZEK: So, by deep and shallow at this point, it's sort of informal because you may find carbonates quite shallow in which case that's a shallow well or deep well? If you hit carbonate, is that deep or shallow?

STELLAVATO: Well, the shallow wells are 500 to 1,000 foot planned; the deep wells are 2,000 to 3,000 foot planned. With the Felderhoff carbonates at 2200 or so and D1 up here heading to 5800 feet, we've got a wide range of where those carbonates are in here.

PARIZEK: And, the wells seem somewhat far apart and yet they're not that far apart for an artesian kind of response. So, with only one well for a long-term pumping test, you really could do more pumping tests to get regional interferences. So, how do you do this testing? You drill them, test it, go drill the next one, and test it, or are you going to do all the drilling and then plan how to do your testing?

STELLAVATO: Do a lot of drilling and--and we'll have the plan done. We'll do a lot of drilling and then do the pump testing. And, also, remember, we have 700 wells sitting right down in here that we can make use of also. When they go in as far as part of irrigating the fields, they'll pump it into those wells at 1200 or 1500 gallons a minute. You know, we're also going to be looking at the effect on neighboring wells down here in Amargosa as part of our program, too. So, we've got 700 wells here, zero wells up here, and then, remember now, we'll drill seven holes the first year. We have the right to go back in and move some of these wells if we need to. If the data need shows that we--and Parvis says modeling thinks that we need to move some of these wells, we can move them.

PARIZEK: If you pace off alluvium and then you go into, say, volcanic rocks and then hit carbonate rocks, are you going to leave the hole open to both volcanic rocks and carbonate rocks to get mixing in which case the chemistry is goofed up?

STELLAVATO: No, that's one of the things we want to eliminate. We want to pump from specific zones. So, we'll go in there with a company that does packer straddle tests and we'll straddle off all these zones so we can see the chemistry in the specific zones because when we complete them for the long term, we're going to complete five to 10 completions per well so we can look at the specific heads and the chemistries in the specific zones. Right now, everything you have is pump positive well heads up here and I don't think composite heads will get it. I'd like to see specific zones.

PARIZEK: Well, the Westbay is the only act in town that will be very detailed in this respect for both sampling, as well as for distribution. You can pick the spacing that you intend to complete Westbay's at and what sort of spacings are you thinking about vertical separations for port locations?

STELLAVATO: Well, right now, I don't know. Parvis--

PARIZEK: They won't sell you as many as you would like.

STELLAVATO: We've got 17 packers in one well, right now.

PARIZEK: Westbay is permanent installation which once you have it in, you can decide what the port spacing should be.

MONTAZER: Presently, we're planning to put 10 intervals in the deep holes and five intervals in the shallow holes, but that's a general thing for planning purposes. The first year is going to be basically learning the hydrogeology. We don't know anything about the hydrogeology. We don't even know the geology of that area. So, the first year is going to be a learning experience, and then based on that, we're going to have to plan in detail what we're going to do in the second and third year.

PARIZEK: You have some geophysics that suggest that there's a fault zone up along the paleospring deposit. So, this is a test on the geophysics, as well, then.

MONTAZER: That's correct.

PARIZEK: It's a multi-purpose study that you have going?

MONTAZER: That's correct.

STELLAVATO: Yeah, we can calibrate the geophysics and the gravity of mag with these holes once we get them in the ground. Right now, you've only got the geomag calibrated on P-1 and I don't think everybody even did that. So, we're calibrating on P-1 and the Felderhoff well right now and then we'll go in, and when we drill these wells, we can confirm and then recalibrate based on when we get the tops on all the units as we drill each one of these wells. That will help calibrate the gravity of mag data.

COHON: Any other questions or comments on this phase of the presentation?

(No response.)

COHON: Let's proceed to the next phase, then. Thank you.

MONTAZER: Thank you, Dr. Cohon.

We have talked about the alternative repository design and Nye County's interest is mainly the naturally ventilated repository for a variety of reasons that I'm going to be going through.

One of the things that I have come across when we're talking about the natural ventilated repository and how this really affects or helps the removal of the heat and moisture, a lot of people don't realize that there's really not that much heat generated by the canister, by the waste. Just in this room, we'd probably be generating about 3,000 watts of heat from just the lighting. And, each one of these canisters generate about 8,000 watts of heat.

If you go down to the ESF, if you have ever been down there, you see that every about 15 meters or so we have these 500 watt flood lamps. We experienced this accidentally when we had our long-term monitoring of the temperature, pressure, and humidity. One of these flood lamps was located about two or three feet from one of the probes and I didn't know that this was going on. When I got the data, I looked at them and it appeared that during the week when the ventilation was going on, things were relatively normal; the temperature, pressure, humidity, everything was normal. But, over the weekend when they shut down the ventilation, the temperature went way up in one of the probes. So, I sent the technicians out there to figure out what's going on. We realized that there was a flood lamp that was sitting about two or three feet away from this. The ventilation that used to go on in the ESF construction generated about one meter per second of air and that was enough to move the amount of heat to keep basically the heat away from the instruments. What I'm trying to get at is there's a tremendous amount of heat that can be removed by just moving the air through an open area.

First, I'd like to update you on more recent data collection activities. In the east-west drift, we're doing monitoring at different locations in the tunnel. This is a 17-1/2 foot diameter tunnel, and we have purposely put these in spacial position to see how the temperature, pressure, and the air velocity varies between these three locations. The main purpose of this separation is to come up with a way of calculating the heat and mass transfer in between these three ports and basically calibrating our model and coming up with a way of coming up with the parameters that we need to do long-term predictions.

This just shows the temperature over time in the east-west drift. I should have pointed out what it says is number one is closest to the wall of the tunnel, number two is NVP, number three is the one that was hanging below the ventilation duct. As you might expect, you see that near the rock is cooler because evaporative cooling keeps the temperature down. As you're going a little bit away from the rock, the temperature is, more or less, the same. You can see a similar pattern in the humidity. Humidity near the rock is--Port 1 is higher because the moisture is coming out of the rock and keeps the areas slightly more humid. And, as you go into the tunnel, that humidity is basically, more or less, the same. The air velocity varies in the east-west tunnel between one and one and a half meters. If you have these fluctuations, you can expect, but the general average is 1.25 meters per second. That's with the ventilation.

One of the interesting things that we have observed is we've been trying to get into the first couple of moisture probes that have used TDRs to see if we can detect the moisture changes in the rock. It takes about a week or two when the tunnel boring machine advances and cuts through a portion of the rock. It takes us about a couple of weeks to get to that point to drill a hole and put our instruments and set up for the pressure, temperature, and humidity and the rock moisture monitoring. We have not been successful to catch the rock that is wet enough for us to monitor. That is in two weeks and these probes average the moisture for about two feet length of the borehole. We especially are saying that in two weeks the rock dries out all the way to about two feet away. We've not been able to get fluid enough to follow the moistures. As you see, we put in the probes wet. The boreholes are silica flour which is wet and it dries up pretty quickly, relatively quickly, and comes up to where it basically is residual moisture content.

We've done a similar thing in the ESF just for comparison. I'm not going to go into details. Going directly to the naturally ventilated repository, why do we think that naturally ventilated repository or forced ventilated repository if that turned out turns out to be the case? The only difference really is that a naturally ventilated repository is more economical to operate and you can run it for a much longer period of time.

The heat in the canisters are a resource and we believe that they should be used advantageously. For the past 10 or 15 years, the heat generated by the canisters has really been an adverse or a disadvantage with this type of waste. I believe that we can take advantage of that heat and create a condition that is safer for the repository. The cooling basically comes in from the flow of the air. Aside from that, the evaporation from the rock, the air is falling and there is tremendous amount of evaporation. We have measured anywhere from 10 to 15,000 gallons a day from a small portion to like about 1,000 meters of length of the tunnel. So, there's a tremendous amount of moisture that is removed initially from the rock. That causes a great amount of cooling, just evaporative cooling, in the rock. So, it lowers the rock temperature and also assists cooling of the canisters.

The heat of the canisters help move the air if we create a situation that we have an inlet and outlet with a significant amount of elevation difference. That's why you would need shaft to create the elevation difference from the inlet which, I'm assuming, that it would be the ESF entrance and some shafts on the west side of the mountain that would allow for the air to move out. Even without the heat of the repository, we'll have the natural ventilation occurring. The only difference is that without the heat, the direction of the flow is not guaranteed, but using the heat and taking advantage of it, we can guarantee that the direction is always upward.

This moving of the air creates a dryer repository and I'll show you some simulations. We have done some simplified simulations. We're doing more sophisticated simulations using the UZ model--I'll get into that--to create a dry repository. And, that can be maintained for--I mean, the drying effect can be continued for at least 1,000 years, if not longer.

The economic advantages of it is that it reduces the aqueous requirement tremendously. And, what I have calculated, if the model and everything is correct, I think we can reduce it by--basically, all we need is core because, number one, it is an advantage to focus the heat into a smaller area that will create a larger ventilation force. Basically, it means that we need less construction, less area to worry about, and we can pick the best part of the mountain to put this stuff in. It gives us a lot more choice as to where to put the canisters.

As far as performance assessment, I think this is extremely important. It reduces uncertainty and I'll go through it in a little bit. The concerns are long-term stability of the repository. Human intrusion has been mentioned several times and atmospheric emission of the gases and particulates is also a concern. I'll touch upon these things in a little bit.

Before I go to that, I'll show you what we're doing with the model. We have obtained the input from the UZ site model from Lawrence Berkeley Lab and this is actually--there are several versions of it. This is a dual porosity model with the matrix and fracture discretized. Just for location purposes, this is UZ-14 and ONC-1 and this is ST-7. Right now, we are just simulating the ESF with a shaft down in here. I'm not showing the shaft. We're bit simulating this east-west drift. The reason for this thing, I'll talk about it a little bit later. It's something that I have in mind to propose. Hopefully, DOE can accommodate that sometime in the future in their plan to test.

One of the surprising things that I got was that the results of the--the results that I got from the site model are almost identical with the results that I got from just doing a simple cylindrical simulation. In this case, we even have a 4mm/yr infiltration which was originally the model that the LBL sent us. It had a 4mm/yr infiltration in it. I've taken that out and it doesn't make any difference in the result of--it's not even noticeable. So, at least, at 4mm/yr, we see no significant difference as far as this saturation profile.

Here, I apologize for this. We're going from .2 to .8; .2, .3, every .1, and you can see this is the ESF tunnel. The initial saturation that I assigned was 80 percent to all the Topopah Spring and this is basically at the repository level. You see that the saturation drops down in the vicinity of the ESF down to about .3 from .8 which is the ambient condition. That's after 1,000 years. The extent of it is somewhere about 30 meters or so away from there.

So, at least, the model shows--and there's a lot of other things. By the way, in this instance, I have placed the canisters, the heat sources, in the ESF which is not necessarily a design option. I was just doing the experiment. Our next step is we're trying to set up a small area of the repository in this with shafts on the west side of the mountain and see if we can calculate the conditions over in that area.

I've already touched upon the advantages of reducing acreage. The uncertainty, I think, as we've talked about it a lot and we've heard about it a lot in today's presentations, the problem that I see is that we have--there's a lot of great ideas and technology that we're trying to get to and use and experiment. The problem I'm seeing is we really don't have a lot of experience and background and historical information and data on developing a good confidence whether these things are going to really perform for 1,000 years or 10,000 years. The effect of heat and humidity on the rock at high temperatures, we really, aside from a few analogs which are really--we don't know very much about their true nature--we cannot really put a lot of confidence in how these things are performing. All we have--we don't have a data to calibrate these models, as far as the effect of heat on the rock and the corrosion processes are concerned.

By using ventilation, we'll bring everything back to the ambient, normal conditions where we have a lot of data on. All we have to do is go back to the historical, the Egyptians and the Romans and the Greek and the Persians and look at how their swords, etcetera, have lasted. You don't find very many swords intact in Rome because of the wetter climate. But, in Egypt, there are plenty of intact artifacts and weapons you can find in their museums.

One of the things that I have a problem with is the concrete liners that are going to add a great deal of uncertainty as far as geochemistry is concerned. How is this going to react with the rock over a long period of time? How is it going to affect the transport processes? In the naturally ventilated repository, the concrete liners are actually not required. It is better not to have them because we want to have an open interaction between the tunnel and the rock. The rock is fractured and open and we've got to take advantage of it. The reason I'm seeing this both in the data and in the model, the extent of the drying and the heat removal is because of the fractured nature of the rock. If I just use a matrix flow, this is not going to happen. The matrix is too tight to allow either heat or moisture to come into the tunnel. It's through the fracture interaction and network that we can remove a lot of the moisture. Therefore, it's advantageous to leave as much of the repository surface as open to interact with the tunnel or inside the area of the tunnel.

As far as the concerns are concerned, long-term stability is a problem because the repository has to be open. There are a lot of ways to engineer around this. My thinking is that we haven't had time to really think about it. If we put the engineers at work, they'll come up with good solutions. And, I'm just pointing out some of the observations that there are on man-made and natural openings that have stayed at least for 2,000 or 3,000 years. We know they have been stable and open. We have to figure out why they've been open. What are the special features of those things? In cases like in the shaft and we really don't trust the shaft to stay open, we want to do a backfill with rubble or a certain kind of reinforcement that allows air to go through it that maintains stability.

This last part is really meaning that we really have to plan on monitoring this. Now, I know right now the idea is to monitor the repository for at least 300 years which basically within that period of time, I think, we're going to learn whatever there is to learn about the performance of this repository. So, basically, this is saying that we need to monitor this remotely.

Human intrusion, I don't see it as a severe problem. If there's an intelligent human, there's no way you can keep him out of there. He knows how to deal with it. If it's not an intelligent human, there are really simple ways to keep him out of there.

As far as the atmospheric emissions is concerned, from what I hear, is that the inventory is not really sufficient to worry about especially once this stuff gets into the atmosphere. There's so much dilution that doses have just got to be a way below the--as far as particularly the emissions are concerned, there are many, very simple, passive ways to take care of it. The simplest one is by creating velocity-reducers. Just increase the diameter of the shaft and the velocity reduces to the point that the particulates would deposit. You just have to know what size particulates you have and what velocity was the maximum velocity. It's very easy to calculate the diameter you need to have these particulates deposited so they don't go past. We use this all the time in drilling for dust control.

There's been a concern in the water flooding into the shaft. I think Solitario Canyon is a very good place to have these shafts surfacing horizontally. We don't have to surface them up in the surface. All we have to do is maybe 100 feet below the ridge, just turn them horizontally. Then, we don't have to worry about flooding the shaft.

I think these kind of things are just the things that come to my mind and I'm sure if we turn these things into the engineers, they'd come up with all kinds of brilliant ideas and solutions for these kind of problems.

What I wanted to propose, if this becomes--if it fits into the program, the east-west drift or northeast-southwest drift, whatever we're calling it, it's a good opportunity to experiment. We don't need to have a really long shaft. We can put a short shaft and surface it in the Solitario Canyon and put a heater down in here and an instrument and see how this thing performs. I think this may be a relatively inexpensive tagalong on the east-west drift. But, you can think about experimenting.

That's all I have. Open for questions.

COHON: Thank you very much. Questions or comments?

BULLEN: Parviz, could you take a look at your temperature distribution for the 4mm/year? I was a little bit intrigued there by the fact that .3 meter radius is the peak and the others all fall below 20 degrees Celsius over that time period. Is that due to the fact that you get more mass transfer with a larger diameter?

MONTAZER: Let me find it. All right.

BULLEN: I guess, could you just explain the trending there for me?

MONTAZER: We're talking about the--okay, which one? This is the heater. This is the source.

BULLEN: Oh, that's the source, okay.
MONTAZER: Right, that's the source. That's where the canister is.
BULLEN: And so, you're coming out in the radius and you're doing the temperature distributions as they go?
MONTAZER: Right. This is at the wall.
BULLEN: Okay. So, your delta T across the canister to the wall is on the order of 25 degrees C?
MONTAZER: Right.
BULLEN: And, it converges down to--
MONTAZER: Right. In this particular instance, we start at 19--at this level, the temperature is 19 degrees C. And, the reason, it's following--the temperature of the rock falling below and in this case--this is kind of strange, but I have not seen it in the tunnel, but we've seen it in the desert. It's mainly evaporative cooling that does this.
BULLEN: Okay. I guess, the other question is what's the velocity of the flows; just a meter/sec?
MONTAZER: Yeah, in this case, we are flowing at one meter a second.
BULLEN: Okay, thank you.
MONTAZER: Sure.
NELSON: Two comments. First, my experience with rates of dry-out with air moving past a rock surface, particular smooth TBM excavation, is that a two foot depth dry-out in

two weeks is pretty fast. I'm wondering about the use of TDR as moisture probes. So, that's one observation because I'm not for sure how sensitive they are in terms of picking up that kind of moisture condition. But, I'm also aware that DOE has installed what they call heat dissipation probes. Quite a number of them are planned for the ECRB an are also used in some of the test drifts that have already been done. Have you used that data, for example, in your model to verify?

MONTAZER: Not in the most recent one. I've talked to Allan Flint and use his data from the ESF. He had some moisture measurement, and there, I can't remember the exact timing, but he confirmed that, at least, in 10 or 15 centimeters. It didn't take very long for it to dry out.

NELSON: Well, I mean, it would be interesting to have these measurements because I think sometimes those measurements in the ESF are made a little bit belatedly and these are being put in fairly quickly. At 30 meters a day average advance, that might be several days behind which is fairly fast. Is that data generally available for you?

MONTAZER: You mean, the USGS data? It takes a while before we get the data. Usually, we don't get it done before six months--you know, six months or a year. It takes us that long to get--this is just the process of QA, etcetera.

STELLAVATO: We get data--we have to request it and it has to be turned into the technical database as per their milestone requirements before we can really get any of the data. We can look at data and sort of just tease us with it, but we can't get it until it goes into the database and then we can get any data we need. But, we got that lag and we'd like to get it sooner, like monthly would be great.

SAGÜÉS: Have you worked out some of the biological implications of the concept like, for example, plant life or animal life getting into the drifts over a--of time and, you know, blocking--

MONTAZER: No, no, that's an interesting consideration that we've got to get a biologist or botanist to look into. No, I haven't thought about that.

SAGÜÉS: Thank you.

CRAIG: Since this comes from Nye County, I guess it has some kind of quasi-official status. I'd like to ask Wendy where this concept fits within the environmental impact options part of the DOE?

DIXON: I'm sorry, could you clarify what you mean by this concept?

CRAIG: Well, we've just heard about a concept which is very different from any of the ones that DOE is looking at. It's at the very minimum interesting. And so, my question to you is what kind of thought is being given to including the concept as an alternative in the environmental impact process?

DIXON: Okay. I'm going to roll back to the overall umbrella of the presentation that I gave earlier, but with respect to the analyses of design features that Lee Morton was talking about which I think is what you're referring to, not as it relates necessarily to implementing an alternative. In our analyses of design features that we mentioned, one of the design features was type of ventilation and what would be the environmental impacts be as it related to ventilation. So, what was presented really is already incorporated as part of our design features analysis for the EIS.

BARRETT: Could I clarify? You know, Wendy's ventilation alternatives do not--none of those have the repository open for the post-closure period. For the monitoring period for up to several hundred years, I think do. This does not. You don't have it open indefinitely like this proposal.

DIXON: No, it's not open indefinitely from this proposal.

BARRETT: So, the answer is--when Wendy drew those little diagrams up there, if this works out--we won't prejudge it. If this ever becomes the reference design at some point, then we would have to go back and basically address in NEPA space what we would do with the EIS. It may be an EIS supplement or whatever it is if this were to happen. Okay? But, right now, this is not bounded by the draft EIS, this concept. But, that doesn't preclude it from ever happening.

DIXON: We have that issue with respect to taking credit for institutional controls beyond 100 years, too, which is--

BARRETT: This is for thousands of years this would be open--

DIXON: Which is why ours don't go beyond that.

BARRETT: Yeah, and this doesn't cover--know it's not bounded by Wendy's.

COHON: Any other questions or comments?

(No response.)

COHON: Thank you both very much.

Before we start the public comment period or perhaps as the first question in the public comment period, a Board member actually would like to ask a question of Lake Barrett. Lake, are you ready?

PARIZEK: This morning, you mentioned about to close or not to close the repository and sharing that decision perhaps at a Nevada State level through the University system. It would appear like we were all brain dead when you said that because that's a new suggestion and nothing was ever said about that. But, could you elaborate what the thought process is there?

BARRETT: Okay.

PARIZEK: Again, whether those would include to withdrawal and retrieve wastes or not or just strictly to close or not close?

BARRETT: No, this is just an expansion of what we discussed in a previous Board meeting of the operating concept that we will have in the viability assessment of basically a monitored geologic repository. Now, just to review what that concept was, we are designing the repository to be in a monitored condition meaning the waste is in place, the drifts are there, the ventilation is operating at some ventilating mode--it may very low or it may be high--and then we're going to do as part of the studies in ventilation that we talked about a little bit today, and the decision will be made as to when to seal the repository. Slang, to seal the repository, close the repository. That could be as early as a few years after the last package is emplaced, and it could be from an engineering design point as 100 years. But, we believe that the reference design drifts would be stable with maintenance, you know, out to, say, 300 years. After 300 years, you'd have to have a major refurbishment if one wished to keep it opened after that point. At that time, I think future society will decide if the repository should be sealed or continue to be in a monitored condition. I did not address retrieve. That option to retrieve is there. If you decide to retrieve and you have not closed the repository, it's easier to retrieve than having to dig the seals out the plugs out and retrieve. But, I've never talked about retrieve.

Now, we never talked before about who decides to seal, when to seal the repository. I would propose that that be kept to the nearest local scientifically competent organization to do that. And, it would be my opinion--I won't say it's official. In my personal opinion, that that ought to be something like, say, a University system of the host community that you're in. Now, it did not have anything to do with retrievability. To retrieve would require substantial resources. If the decision is to retrieve the material, okay, that's an iffy, that would have to be done on a national basis because I don't expect any State, local sort of--to have the resources to "retrieve the material". That would have to be done basically by an equivalent of a Federal body to retrieve the material. The resources, that's a substantial amount of resources. We certainly wouldn't want to emplace the waste or even start a repository unless we had some reasonable expectation that this was going to work. But, I wouldn't put the burden to retrieve the material upon any, let me say, State system to do that.

PARIZEK: But, just if they would recommend, they--and they want you out of town, so they say retrieve, you're saying it's one to seal or not seal and they might have opinions about--

BARRETT: That's correct. To seal or not to seal, that decision basically is delegated from the Federal, let's say, the national body to the State body and they can do that as they deem it appropriate to seal or not to seal. If the decision was to retrieve or not to retrieve, I would say that the local body would recommend to the national body, look, the thing isn't working right; you know, I believe you should retrieve this stuff, and then I think the national body would have to make that decision.

COHON: We'll turn now to the rest of the public comment period. Let me announce at the end of that period, we will have a presentation of the public TSPA slide presentation which we did not have time for earlier today.

Five people have asked to speak which is nice to hear. That's gratifying that there's that much interest. In light of the number, I propose that each person limit their remarks to 10 minutes and I will keep track.

Judy Treichel? Please, identify yourself again and whatever affiliation you carry, give, if you want one.

TREICHEL: Judy Treichel, Nevada Nuclear Waste Task Force.

I won't need 10 minutes. I wanted to make some comments about some of the things that Lake had said earlier and about just some of the presentations that we had heard. There was a lot of talk today about uncertainty and how many things are uncertain and how uncertain they are and a lot of those are just guesses. There is one thing that is absolutely certain and that is that this repository, as the conceptual design or as it's shown on the viewgraphs, will leak. It will deliver doses. That's a given. There's some uncertainty about when it does that and to what extent it does it, but one of the things that Lake said was that he did not want to provide an unreasonable insult to future generations. On some of those viewgraphs, we saw doses in the range of 300 millirems to 3,000 millrems possible and there are other people who say that they could even be higher than that. In my estimation, that's an incredible insult, much beyond unreasonable.

I'm also distressed with the interactions between DOE and the EPA. I was gratified to hear the conversation that went on about how do people talk to the Department of Energy and the sort of disconnect with all of the talking that the Department of Energy does the other way and, in fact, gets trained to do it. Don't take the time to get the training, Lake. You can just talk to us. It will work just fine. But, there is no way to do that.

I can write letters to President Clinton. I can probably write letters to world leaders. I can write letters until I'm blue in the face. What I will tell you, in my opinion, the way the public talks to DOE is right here. This is the best venue that we have to do that when DOE is here. It's going on the record and the Board hears it and it becomes real. This is probably the only place that that happens.

I started to say I'm concerned about DOE talking to EPA about standard. Yes, this is site specific standard. I disagree with that. I think there has to be a standard for radiation exposures that's allowable or not allowable and it doesn't matter where it is. A rem is a rem, a rad is a rad, a dose is a dose, and it's wrong to have it site specific. It's also wrong to be telling EPA what you think technologically can be done. That doesn't matter. If you don't think that you can meet a standard, then that's too bad. You can't build the facility.

That goes for a whole lot of other things that we hear on and on about, well, winning the game. I don't like an analogy where a repository going in or the license to construct is a win in the game. It's not a win in the game if this thing cannot isolate waste. We know that it can't isolate waste. It can possibly dilute it. The last thing we heard in a very recent meeting was that it would delay the dispersal. Well, that's a hell of a long way from what we all started hearing in the very beginning about waste isolation. And, I know that you alluded to that, Lake, in your presentation where you said that absolute assurance of complete containment is unreasonable. Well, that isn't what we were told. We were originally told that's what we would get. You go on to say that if the repository becomes so saddled with expectations that it may lead to the rejection of an otherwise suitable site. Well, a site isn't otherwise suitable. It's either suitable or it's not and I think there's a lot of evidence that probably this one is not.

And then, finally, I think this whole conversation that we've just had about Nevadans deciding when to close the thing is ridiculous. Who pays, by the way, when Nevada decides to close? Is that something that they--you said it was too expensive for us to retrieve. Is it sort of affordable for us to close it?

BARRETT: May I respond or what?

COHON: By all means, please?

BARRETT: What the plan would be is monies will be set aside paid by the waste generators is the concept to close it and to monitor it. And, what you do is for every year you're monitoring, you'd take the interest on investments and that would pay for the monitoring costs. When it came time to--if the entity wished to close it, they could take that money and those investments and use that money to close and then it would be closed and the money would be gone. But, that money would be provided to the entity for the monitoring period and it should be sufficient to close it or to monitor it as the future generations decide to do it. That's the concept. It would be provided by the Waste Fund, by the waste generators.

TREICHEL: Will Nevadans also be monitoring or this would be the Federal doing that?

BARRETT: Well, I would say the monitoring should be done by, to me, the credible scientific body that's closest to it. So, I would say--would be basically the Nevada or, you know, something like that. Now, this is decades in the future and, you know, it's not now. I think it should be nearest to where it is as opposed to being Federal. So, I would propose it would be the state--if the state would wish to do it. Now, if the local body wished not to do it, then the Federal Government would continue to do it. But, I think that choice should be--

TREICHEL: Well, if you want to test how well that works and remove some of this uncertainty that we hear so much about, maybe you should go to those entities and ask them about opening the facility and see how well that works. I have as much confidence that you would rely on Nevadans for a decision like this as I do the reverse. You're not going to come to us and ask us whether or not you should open it because you know what the answer would be. I also don't think that there's any possibility that Nevadans would do that and I would hate to see Nevadans get saddled with the monitoring job, and obviously, my worst fear would be when the dose receptor from Amargosa Valley comes running up and says, hey, it's not working, as you mentioned. I mean, this is really bizarre. If there's even a possibility of that, this thing has got to be a no-go. We don't have to do this. There's no absolutely no reason and specifically when you say this repository solves an environmental problem and goes about the business of increasing the safety of the population from a lot of what we see when you're looking long-term, a long ways out, it's doing exactly the opposite and we can't let that happen and we probably won't.

Thank you.

COHON: Thank you, Ms. Treichel.

Ivan Stewart?

STEWART: Thank you. My name is Ivan Stewart. I'm employed by a company known as NAC International in Atlanta, Georgia. My reason for interest here is my company does some things that makes us continue to follow the activities here. We provide NRC licensed containers for spent fuel for both storage and for transportation. We also run for the Department of Energy a program that monitors where all the fuel is at the present moment and in the future. That is, is it in the reactor, is it in the fuel pool, or is it already in dry storage? Finally, my company is the project manager for a private interim storage site in Wyoming and we hope to be storing 40,000 tons of the 70,000 tons that this facility will be designed for someday.

After I wrote my remarks, as I usually do, I asked myself what are you really trying to say, Ivan, so everybody will understand it? And, I concluded I'm appealing to the subject of finances and conservation of resources. Here is my observation. It seems to me that the products that my company makes and the competitors of my company will probably be the packages that contain the fuel when it arrives at Yucca Mountain. It seems to me, as you said this morning, Lake, that you don't have all the money to do all the things you would like to do and you also pointed out that the utilities are suing the Department for some $3 billion again. It seems to me that if they are successful, there will be even less money around to do what you want to do. So, I would say that it seems to me that the container suppliers like my company who work under the same NRC that you will be dealing with looking into things like criticality and heat transfer and materials properties, although for a shorter period of time than you're considering, could have lots of input to your waste package design.

During the break this afternoon, one of the Board staff members approached me and said, Ivan, it's been a long time since you've been to one of our Board meetings. What brought you to this one? And, I said, well, I read the announcement and it said that DOE was invited to present the waste package design and I'm very interested in that. So, I came to listen. He said, well, then you're probably very disappointed, Ivan, because we didn't discuss it today. I said, yes, you're right. I was hoping to hear all of the detailed design and maybe that will happen at another time.

But, at any rate, my point is that the utilities are spending a lot of money to buy my containers and other people's containers, as you well know, Lake, and that's part of the reason that they're filing a lawsuit. But, there is something going on in my part of the world that I don't think is quite consistent with your part of the world. That is to say in my part of the world, the compelling factors are maximum MTU per container because that's what results in the lowest cost to the utility. And, also, they want an NRC approved container because they don't want any risk. So, it seems to me that suppliers could perhaps do you a lot of good if they were considered to be the prepackers of your system because our containers will be what arrives at your site.

Here's some specifics of what I would like to offer as an observation. Number one, I don't think we're being consulted today as a group. We used to be when you were doing MPC, but that seems to have stopped. Container suppliers like my company are getting NRC licenses and are struggling with many of the issues that you are facing. But, they're also struggling with what's the future product that they should offer. For example, I heard today for the first time that you would like to see or possibly would like to see C-22 as a desired material in your waste package. Well, I'm not sure that we can accommodate that in our packages of the future, but at least if we know that's what you want, we could try. If you wanted to really help us in that regard, the single most important thing I can think of is if you would make sure that it's an ASME approved material. Maybe, it is. But, if there's one thing NRC likes, it's ASME approved materials. So, if you could arrange for that, that could be very helpful in our decision as to whether or not to put it into a future product.

More importantly, I found out that oftentimes it's more important what's not permitted in a design than what is permitted. I'm hearing things, rumors I'm afraid, about things that are not permitted in your waste package. I would dearly like to know what those are. So, again, I think if we were consulted, we could be quite helpful on that regard.

After having written these remarks and then hearing Mr. Morton's paper, I wasn't so sure that my remarks made any difference anymore because I noticed on Page 2 under design features and characteristics that he says he's going to include blending of wastes which, to me, means you're going to take our packages and open them and blend the waste, in which case what's in the package perhaps doesn't matter. But, that's just another reason why I think we should get together. I noticed some other items on the list also about shielding, fuel consolidation, and filler materials which we have several opinions on and would be glad to contribute. I personally think I'm the oldest living supporter of fuel consolidation. So, I would have a lot to say on that matter.

But, anyway, my main point is I think we could be quite helpful.

Thank you.

COHON: Thank you.

Sally Devlin?

DEVLIN: I want to thank you again for coming to Nevada and I hope you had as good a time as you always have. I do want you to know Jim and I are going to find out about these contaminated--or these canisters that we were talking about with the Navy.

But, I'm really here to quote and it's my day to pick on Lake Barrett, but I can't help it. And, that is his attitude--and this is from the January 20 meeting in Amargosa--was that those who really clearly opposed geological disposal and I expect that the viability assessment will be used by them to stop the program and so on and so forth, and he says, but both of these arguments seek to reconsider the international consensus on geologic disposal in my opinion are a step backward in the face of accumulating inventories of spent fuel, accelerated cleanup of nuclear weapons complexes, and support for our international nonproliferation national defense objections. The debate regarding viability assessment and the continued pursuit of geologic disposal at Yucca Mountain is likely to be contentious and polarized. Then, we want, we share, we appreciate, we will, we are also, and so on.

Now, I've worked with a million groups except on being a stakeholder and I'm kind of isolated in Pahrump. But we, as I said, is a royal plural. And, I really feel that it's inappropriate. I am sure that Mr. Barrett is a group of people. I've never seen anything from the Board that said we, the Board. It's always the Board or the group or this one or that one. What he ends with today is our plan calls for substantial effort after the VA, as though it's already passed and I don't appreciate that, at all, because it isn't. It may not be a viable assessment to complete the site characterization, to continue our design activities, and so on. And then, you go on to the dates and what have you.

In my very humble or not so humble opinion, I feel that what you are doing is appealing to ignorance. For those of you who remember your philosophy and your critical thinking, what this means is because you say it that it is so because nobody has proved that it isn't. This is a very dangerous thing that you're doing and I feel it should be looked into because this is not a done deal. As Judy said, there's so much to look at. And, I go back so many years and I remember Wendy saying I'm going to save the desert tortoise with my life. Remember that? And, John Cantlon--yes, you do--and then he said did you see the hydrologists and the thermologist and you said no. Well, that was the last the desert tortoise were ever mentioned. So, things do change and we do grow up and we do have different concepts. My point of view is, living within the shadow of Yucca Mountain, that I am petrified that this appealing to ignorance is prevalent and has got to stop in my opinion.

And, I again thank you for coming. There's only one other thing and that is, of course, I wrote the Congressional Report and I called Washington and I talked to Sheldon and I said, Sheldon, you left out three little words. And, he said we knew you were going to call and, of course, my three little words were that Yucca Mountain will be open and you forgot for a hundred years. When I started, it was 50 years. And, it was 100 years. Sheldon said you're talking about 300 years. I think that should be brought up and I didn't know whether the Board was talking about it or who was talking about it. But, my question is are we going to have Ride a Pale Horse or are we going to have 10 million people or 10 billion or 12 billion or whatever it is and how is all this going to fit in? And, who is going to be there to monitor it in 300 years? Most societies have died within 200 years and we've always had our share. So, it's something not only what languages are you going to say keep off the grass, but who is going to be around to monitor it?

Questions always. I hope you can answer some. Thank you.

COHON: Thank you, Ms. Devlin. I'm sure those questions were intended for Mr. Barrett.

BARRETT: First of all, Sally, you mentioned about the "we". I will try not to use it again. When I use it, I am merely as the head of the family, as I would say, of the DOE staff and the contractor support. I do use the term "we" because I like to say we are a team doing the nation's work here. So, that's why I use the word "we". It certainly is not the "royal we". It is not the deity and I doing this, at all, as you can obviously see. But, I will take that into consideration and be careful of its use. Thank you very much.

COHON: Lake, would you say something about the last issue Ms. Devlin raised with regard to how long the repository might stay open before closure?

BARRETT: Okay. What we are trying to do is to dispel the notion that many have of technological arrogance that, you know, technicians today are saying that we're going to put this down a hole and we're going to seal it up and we know exactly what's going to happen in the year 2060. None of us will probably be alive in the year 2060. The future generations are going to decide do they wish to seal it or not. And, clearly, we expect to be around--this society, we expect to still be here in 2060 when we put the last can in. Then, if we think that then that society, if they wish to seal it and basically have the ultimate in passive engineering where basically you can seal it and you can walk away and future generations do not need to meddle with it because the environmental situation will be adequate in our opinion and certainly will be society's opinion if we go forward and do this, it won't depend upon future generations. So, it doesn't matter, you know, what society is here, if it's an advanced society or a non-advanced society at that point. But, it doesn't say it has to be left open. And, clearly, you would want to seal it before--if you believed society was going downhill, you'd want to seal it before it did that and that's what the plan would be.

COHON: Thank you.

DEVLIN: Again, you didn't say--

COHON: Ms. Devlin, Ms. Devlin--

DEVLIN: (Inaudible).

BARRETT: Thank you very much. I'll be careful with my language.

COHON: Tom McGowan?

MCGOWAN: I, for one, have no questions for Dr. Lake Barrett. That's a pretty name, but I really have nothing to inquire about. --and I'm very impressed, particularly with the latest--this morning which sounds like a very prudent and advisable opening a crack of the back door. I'll explain this later. It's not important right now. But, there is that perception if you don't mind my saying so and I think it's ingenious.

I would say this to you, however, in a spirit of levity being a Navy man. There is a message for Dr. Van Luik from close family members who have said if you're not in bed by 10:00, get home right away. That's quite all right.

Mr. Chairman, how much time are we allotted?

COHON: 10 minutes.

MCGOWAN: 10 minutes?

COHON: Yeah, because more people signed up.

MCGOWAN: Surprise, surprise, I have no intention of going that long. I don't think I would persist that long.

COHON: Okay.

MCGOWAN: I have diuretics and things to take. In conclusion, I would be remiss if I would have failed to commend the Board for their outforming perstandance--I've just come from the lounge--in taking the discharge of their mission and mandated responsibilities and in deserved recognition of the superb achievement on the part of all participants with the sole exception of you know who. And, that sets minds in motion right away.

--means imperfect, my understanding. Perhaps one day when they approach a closer understanding of what has been the missing link in these interminable proceedings and review or surmise the attribute and amenity obtained to a higher idealized standard of human spiritual quality effectiveness in terms of morality, reason, integrity, responsibility, and above all, conscience, you may have achieved the realization that the fundamental crux issue problem is not and never was nuclear energy and nuclear waste, or inscrutable mountains, or an elusive repository characterization, but rather a near perverse potential of limited--human nature itself which even in the best case scenario is vastly more so insurmountable than the complexities of hydrology, geochemistry, microbiology, and thermal loading combined, much less as exacerbated by the inseparable wisdom of the Congress of the United States and their bucks. Which is perhaps why I harbor no illusions, but naturally rely more so on creative intuition rather than on technical bases and why I risk--by questioning basic assumptions.

For example, what is geologic permanent--

repository about the subject facility? Anybody know? Why would they transverse east-west exploratory tunnel and enhance characterization with a repository block more so than a diagonal alternative except the goal is to insure the characterization is not as suitable or unsuitable of a single sub one mile repository drift? Which I think is brilliant in terms of cost-effectiveness. When did the term "viability" mean anything other than the insured capability to exist and sustain independent of any external impetus or impact, whatsoever? And, in what--void was any such viability assured in repository be suspended in continuum and by whom if not the--why would seismic energy be of less impact or consequences upon an array of underground cylindrical apertures and more so impacted upon a hypothetical surface at the same repository horizon, but devoid of geologic overburden? --albeit the one in open horizontal plain surface and the other a closed cylindrical--geologic domain which seem to be greater impact of consequence when you stop to think about it, by why quibble?

Perhaps, the greatest significance with anyone will ultimately say I'm responsible and the conceivability that the Board exhibits the historical impression of integrity and the courage of their convictions. I don't mean the Board integrity; I mean, historically unprecedented human integrity. There's been a dearth of that lately, notwithstanding persuasive compound of political, economic, scientific expediency, not to mention Lake Barrett, that looms in crazily imminent even as we speak. I love you, Mr. Barrett. I really mean that. Okay? Notwithstanding, forget all this. It's not import--I'll talk to you later, okay?

And, who would recommend the sole, rational, responsible, unconscionable alternative? Who? Anybody ready for that? But, in closing, Sally, keep quiet. In closing, perhaps the most excruciating unresolved puzzle is this. When once securely externalized, DOE--Dr. Abe Van Luik purged as he observed the infinite singularity or ring or sphincter from which this whole thing was just--extruded and apparently still obtains in terms of sustainable dynamics except perhaps Yucca Mountain, Nevada and perhaps also in West Africa. Imagine, the two are almost coincident; isn't that right? And, precisely what, if anything, did an organism spontaneously evolve if not from nothing in particular?

Alternately, as advances get in scientific investigation, it continues to probe ever deeper in to the elusive ultra-microcosm of quantum mechanics. Is it conceivable that the scientific community has discovered nothing and that if anything, at all, that nothing persists as--and scientific wisdom and serves--in scientific reluctance to admit the confounding discovery that that nothing is not else but the Supreme Being, the creator of all things including each and every one of us, for better or for worse.

Finally, please, join me in a brief recitation of a time honored hymn emblazoned in the hearts and minds of--and others who matriculated at the hallowed halls of Ivy to wit: We are poor little lambs who have lost our way, baa-baa-baa--and I won't even go as far as the part that says, ladies and gentlemen, songsters--because it's inevitable somebody is going to say--with the DOE, but that's not my point, at all. I want to compliment Mr. Steve Brocoum, Dr. Lake Barrett. Oh, excuse me, Abe, I forgot, Dr. Abe Van Luik, Dr. Cohon, Mr. Barrett---with his hands in his pockets, he's very industrious--this gentleman, whoever it is, who has got a southbound view of the northbound hymn, who is that?

COHON: That's Dr. Runnells.

MCGOWAN: Is he anybody? Sagüés, where are you? I can't even pronounce your name. There's a lady here, what's her name? There's two of them actually. That's Wendy, right? Hi, Wendy. I never forget a dress. You were here before. And, this lady, what is it, Priscilla? See how quick I am; look at that. Yeah, everybody else, all of you, God bless you, my son, wherever you are. He's reading the paper, racing form.

I want to say in conclusion, Dr. Cohon, I cannot remember when I've taken this much time to do anything except in the--you had nothing to do with that. I want to thank who else is here from the bottom of my heart. Remember one thing in the words of the gentleman who nobody recalls ever having voted for, there may be a viable alternative called retreat with honor. You might begin thinking about that because it may be cheaper in the long run and move this to some more advanced civilization to cope with. Incidentally, long before the mountain gets to Mohammed, you can bet Mohammed will get to the mountain and decide to dig probably within the first 200 years. --there's nobody on this planet that has come up with a guarantee of a sustainable formal government for a very long--and particularly none with our institutional controls. If you've been out here in the traffic, at all, you've got some idea what I'm talking about.

Thank you very, very much and I'll leave at this point while I'm still able.

COHON: Thank you, Mr. McGowan.

Bill Vasconi?

VASCONI: Sure, this old country boy follow Tom McGowan.

COHON: Sorry, someone had to do it.

VASCONI: Yeah, God gave us two ears and one mouth. So, I guess he fully intended us to listen twice as hard as we talk. I've certainly enjoyed today and the presentations. I surely enjoyed the fact that the site of this county, Nye County, had a presentation here. I, for one, would have liked to have seen our state with a presentation here. I'm a Nevadan. I've been here not all my life because I ain't done living yet, but I've been here some 34 years. I originally come out of Pennsylvania.

So, I think I have a little bit of entitlement to talk on the microphone and I wanted you to know that there's a lot of Nevadans, regardless of what the State of Nevada says, that do believe that centralized storage is an answer. They're not fighting you all the way as our state delegation, our governor, etcetera, would have you believe. Now, yeah, a guy getting up on the mike talking like this will get a little name calling once in a while, but I don't mind it. I get along pretty good with DOE. I get along pretty good with NTS Development Corporation. I'm a board of director on it. I've been a past member of the community advisory board. I represent as a spokesperson some of our organized unions. Not all folks are opposed to Yucca Mountain.

Now, I do hear the terminology time and time again, 10,000 years, etcetera. One more time, this old country boy will give our educational system a little better credit than that. I think they might find some of the things we're doing now ludicrous and it may not take the 55 years since we've been messing with nuclear. In 200 or 300 years, they might have it figured out. I like that terminology "retrievable".

And, yes, once upon a time, we did talk about going in there and gunniting (sic) it, concreting it, and putting the rock on top of it, telling what was buried underneath, and walking away and leaving it. It's more acceptable if it's monitored for temperatures, moisture, radiation, ventilated, and the possibility of being retrievable for a couple hundred years, 300 years, that's very acceptable to the people of Nevada.

The other thing is, speaking of Nevada, you know, 35 years in this state, 34-1/2, right now you're sitting in a county that's the size of Rhode Island and Connecticut and part of Delaware, Clark County. Here in Clark County, we've got 1.2 million people. Fifty percent of those people have been here less than 10 years, less than 10 years. Now, you ask them what's important to them and it's traffic, crime, schools, water, tv, the weather at the lake, and about #14, you say what do you think of Yucca Mountain and they say Yucca Mountain? Not all folks know where Yucca Mountain is at and you tell them it's 100 miles outside of town and they're going to have nuclear waste there. Yeah, you get a lot of this--hysteria that's been brought on, but that's because perhaps DOE and the State still aren't talking. There's no meaningful dialogue there.

After all, tomorrow, the State, Bob Loux, who Judy works for--she's paid to get up and say what she does; I don't get a damn dime for what I say. She's paid to get up and ostracize and criticize the committees, etcetera. But, bottom line is they're asking the State of Nevada for monies tomorrow because the monies were cut off through the Federal Government for their oversight. The county is--counties are about money. I didn't hear any of them jumping up and saying let's give it to the state. They're doing a pretty good job. I'm glad you folks are still sticking with those affected counties.

One or two more comments and I'll get down off here. I did want you to realize the fact that Nevada is a good, big, old state. We've got all the material out here, as you look around and see all these new buildings. Nevada don't make steel, but it's produced in a country that has nuclear power. They all drive automobiles. Some of them are foreign made. They're all made in a state that has nuclear power. Even if it comes from overseas, it has nuclear power. I don't care if it's draperies or cement or two-inch rebar, those folks probably manufactured that with some sort of nuclear power. California and Arizona has got nuclear power. We're all on that electrical grid, but Nevada says we don't have anything nuclear. Hell, how many of our sons and daughters have served in the military on atomic submarines or carriers?

Nevada says leave it where it's at. Leave it where it's at. --aquifers, populated areas, throw it off board ship. You're doing a good job. I want to see this project continue. One thing you can do for Nevadans and you've heard me say this before if you've been around me, Clark County should be taken out of any equation you get up against because we have enough crazies here. Somebody is going to lay down on the railroad tracks or lay down on that highway and let you run right over them. Clark County should be taken out of the equation; not so much Clark County, greater Las Vegas area.

Now, there's an answer to a lot of this; railroads. You know--out of Caliente, you've still got to go 361 miles to Yucca Mountain--do you know what our state says? If it snows, they won't even move the snow for you. There's another alternative and the State might go along with it. Between--a little place called Borarie, it's pretty dang flat for a good many miles. You've got to go through the little Cortez stretch there and then you go down to Smokey Valley. You hit Tonopah and head south back toward Las Vegas.

Now, we've got a railroad system that's a geographical center of the State of Nevada. There's no railroads there. Once the waste is hauled, this opens up the State of Nevada for economic issues and development so that we can maximize the potentials and the credits that can be realized by our southern Nevada area due to the scientific and expertise developments of the Nevada Test Site over the last four and a half decades. A railroad system. When you get into a conversation about routing, etcetera, have DOE give you a presentation on railroad systems. I don't believe it's cost prohibitive. I think it could be a done deal. I think there's money out there from DOD, the Air Force, etcetera, that will make it work.

With that in mind, I'll just close by saying thanks for giving me an opportunity to speak and, keep in mind, you've got Nevadans out here that are wishing the best for all of us.

Thank you.

COHON: Thank you, Mr. Vasconi.

TREICHEL: Can I make just a comment?

COHON: Certainly, Ms. Treichel?

TREICHEL: I do not want the record to reflect that I work for the State of Nevada. I have not done that for years. I'm the executive director of the Nevada Nuclear Waste Task Force and our sole income is through 501(c)(3) tax deductible donations from individuals; no foundations, no state, no government money. Bill knows that and I sent him a registered letter to tell him not to keep saying that and he refused to accept it. So, I just want the record straight.

Thank you.

COHON: Thank you.

May I ask for you to come up and start queuing up the presentation while I make closing remarks?

Were there any other members of the public who wished to make a comment? Yes, sir, please identify yourself?

BECHTEL: Sorry, I got here late. I didn't have a chance to sign up. My name is Dennis Bechtel. I'm the manager for the Clark County Department of Comprehensive Planning, Nuclear Waste Division. We are monitoring, of course, Yucca Mountain issues.

I appreciate the questions about the communication between the public and the Department of Energy. I think those were very perceptive and important. Of course, we're not funded for a couple of years. We have been funded for FY-98. We're very appreciative of that. We intend as local governments to try to inform the public in our own way and elicit comments from the public, but there's actually another dimension to the interaction. Because we are affected governments and part of the law, it's uncertain in our mind just how our input gets into the Environmental Impact Statement process. I think we feel that it's more than just that we should be providing that during the draft comment period. We did provide extensive comments during scoping and with the fact that we have a defined role in law, I think it's important that we not--and because we are developing information as an affected unit of local government, it's important that we have an opportunity to understand how the information that we're developing gets into the EIS process and I think it's probably going to be more beneficial for Department of Energy and for the affected governments that have this prior to when the draft comes out.

So, I wanted to put that on the record. We've had some meetings with Department of Energy periodically and I'm hoping this can be worked out, but it's important that our input gets in because of the fact that--and, you know, in the interest of nuclear--the users of nuclear power are funding us for our opinion and that opinion, we feel, is important. We're on the bottom line when and if this project is developed. So, our input should be valuable, we would think, to the EIS process and prior to the release of the draft.

COHON: Indeed.

BECHTEL: So, thank you.

COHON: Thank you very much.

How long does the presentation take?

SPEAKER: It's very short like about less than two minutes.

COHON: Okay. Would you like to make some introductory remarks?

ANDREWS: Yes, I think I will.

COHON: Okay.

ANDREWS: One of the things about a TSPA, as we talked about this morning a little bit--although the two words never came up in this presentation, the Board has mentioned them several times. These two words are part of the NRC's issue resolution strategy for the evaluation of TSPAs and also our own peer review has mentioned these two words. And, those are traceability and transparency. The Board in one of its recommendations, I think, either in '96 or '97 mentioned a lot of different ways to potentially enhance traceability and transparency of what is ultimately a fairly complex system, an uncertain system, and how do you communicate that?

We in the VA are trying to make strides to improve traceability and transparency. One component of that is communication at all levels. So, we are starting down a road of trying to essentially layer the communication starting with the system and then walked back into various levels of detail where ultimately when it goes out on the web or in public discussions, the user of the information could go to whatever level of technical sophistication or technical detail he or she desired. We haven't gotten very far.

Holly is going to show you how far we are essentially by taking the part of the presentation I gave and start layering it, at least the parts that are done, back to some technical inputs. So, Holly, if you'll go ahead and start and walk through it. Holly Dockery from Sandia.

DOCKERY: As Bob said, we tried to layer this, but it's not very far along. We were responding to about 1600 mandatory comments on the VA. So, this took the extra three hours we had left. What we envisioned, as he said, is having something you can move around in very easily. You don't have to go back to Slide 43 by clicking backwards. You can move around much more quickly. It's done with a program called Director.

Do you want me just to go to seepage or--

ANDREWS: Yeah, that's probably the easiest one.

DOCKERY: Okay. What we can do is we can show the model components, the various components that Bob was talking about, and there will be some bullets come up. For Abe, when he's out giving this presentation to the public, hopefully, he will be able to go to whichever portion or piece he's most interested in talking about. For instance, we have climate put in with graphic representation of what the various climate states would look like and then talk about some of the details in terms of precipitation and the type of--that you would find in it.

I can go to the next step which talks about the model confidence foundation, the types of information that goes into that, and maybe discuss some of the inputs. The next box, I could either have gone back to the components or I will just go forward and show you some of the methods of infiltration and, hopefully, the animation will give a sense of what we think is happening and we won't have to just rely on the words; you'll have more visual.

I can go back to my components, and in this case, as Bob said, if we just talk about seepage, this is the one example where we went a little bit deeper. We show the water moving around the drift and the drips coming in and then some of the discussion that you would want to have about that particular item. Again, we have the model foundation, the inputs, and then the outputs. In this case, we talked about the repository--we showed the repository regions that are being modeled and so we're trying to get at the computer simulation and how we simulated seepage in the total system performance assessment. So, you can see the various areas where the waste package is and how you might have a variation in seepage in the drift and then again you would show--this is the computer grid and showed the percolation flux coming in. You have higher and lower permeability cells. The cells fill up. You get dripping and then there's a little bit more text in there that talks about how the dripping water occurs.

So, our next step from this might be to actually show some plot files and then go deeper and deeper into the data that supported this or the modeling results. In thermal hydrology, we have some computer simulation movies that we can plug in. So, this is what we're hoping to build on to help enhance the transparency of the TSPA models.

And, that's all we really wanted to show you.

COHON: That's a great start, very impressive, well done. It would be useful, I think, to use focus groups to see what kind of reaction you get to this to see if it's really working. You're to be congratulated for the work you're doing.

DOCKERY: I did want to mention that Abe and others are putting together some focus groups in concert with the public policy group at UNM and we're hoping to use them as a springboard to find out if this is a useful format for them.

COHON: I see. Well done.

PARIZEK: A suggestion if you had some real photographs of real places, as well, because this is all stylized, but very well done. But, some real scenes could be thrown in there to make it really real.

KNOPMAN: I'd like to volunteer at least part of the Board as a focus group. I'm serious. I think we would benefit greatly from it and we can also produce some quick feedback on what works for our purposes, too.

COHON: I think we can safely volunteer Paul Craig even though he's in the back of the room ignoring us.

Yes?

STEWART: Will that software be available that it could be used by someone else, for example, to give a public understanding speech like in Wyoming?

DOCKERY: Director is Adobe software. So, it's a commercial software that's available. It's like $700 or $800 for the software. It's a program. It's not like Power Point. You do have to do a fair amount of programming to make it work. That's why it has the flexibility that it does. But, yes, you can go buy it.

STEWART: Well, I guess, what I'm really asking is the work you've done, is it available?

DOCKERY: On this PowerBook? No, it really is a prototype that we've just started working on. So, we haven't gotten very far yet.

COHON: But, when it's done, it's going to be public domain.

DOCKERY: When it's done, it would be available for the public.

COHON: I would say you've struck a nerve. There's a lot of interest here and I'm glad we had a chance to see it.

Let me close this meeting by saying a very strong thanks to all of our speakers. I think it was an outstanding day. I want to congratulate and thank especially those who took on the coordination and planning for this meeting. From my perspective of having been on the Board now, I don't know, something like three years, maybe a little more, I've found this set of presentations the best coordinated, the best connected set of presentations I've seen. They were all very well thought out and very well prepared. They reflected a great deal of thought in trying to respond to what the Board had requested and we appreciate that greatly.

So, my thanks to DOE and its contractors and all who participated. My thanks also to our staff for their role in arranging this meeting, and everybody else who participated. How about that so I cover all bases?

Thank you very much. We stand adjourned.

(Whereupon, the meeting was concluded.)