UNITED STATES

NUCLEAR WASTE TECHNICAL REVIEW BOARD

WINTER BOARD MEETING

January 27, 1999

Alexis Park Hotel
375 East Harmon
Las Vegas, Nevada 89109

VIABILITY ASSESSMENT OF A REPOSITORY AT YUCCA MOUNTAIN

NWTRB BOARD MEMBERS PRESENT

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Dr. Paul P. Craig
Dr. Priscilla P. Nelson
Dr. Richard R. Parizek
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

8:00 a.m.

COHON: My name is Jerry Cohon. I'm the Chairman of the Nuclear Waste Technical Review Board, and it's my pleasure to welcome you to this second day of the Board's winter meeting. We did the introductions of Board members and staff, as well as our three visitors from the Swedish nuclear waste program. We're pleased to welcome them back today as well.

Today we will devote the entire session to presentations on and discussion of the DOE's Viability Assessment for a Repository at Yucca Mountain.

In the 1997 Appropriations Act Congress directed DOE to prepare a viability assessment consisting of four parts: A preliminary design for the repository; a total system performance assessment, or TSPA, describing the probable behavior of a repository in the Yucca Mountain geologic setting; third part was a plan and a cost estimate for the work required to submit a license application to the NRC; and finally an estimate of the total cost of constructing and operating the proposed repository.

The DOE has been hard at work these last two years, to say the least, and the issued the viability assessment in December, last month. As the viability assessment states, its purpose is to--and this is a quote--"provide Congress, the President and the public with information on the progress of the Yucca Mountain Site Characterization Project.

The assessment also identifies the critical issues that need to be addressed before a decision can be made by the Secretary of Energy on whether to recommend the Yucca Mountain site for a repository."

The Board strongly supports the DOE in its position that the viability assessment is not tantamount to a site suitability evaluation. It was not intended to be so, and should not be construed as an evaluation of suitability. The VA is, however, the most significant landmark thus far in the characterization and assessment of the Yucca Mountain site.

I must say I'm very pleased that we have such a good turnout for this meeting because this meeting and this day in particular promises to be an excellent opportunity to get a complete picture of the state of DOE's understanding of, and plans for Yucca Mountain.

We will start momentarily with a presentation by Lake Barrett, acting director of the DOE's Office of Civilian Radioactive Waste Management. We're very pleased that Mr. Barrett could take time from his busy schedule to initiate this session and to give the Board his views of the viability assessment and any other aspect of the program as he feels necessary. The Board as always is very appreciative of

Lake's ongoing willingness to address the Board at its meetings and to furnish us with this valuable insights.

Following Lake's comments we will have a series of presentations structured around the Volumes or sections of the viability assessment itself. So as to get as much as possible out of this meeting and out of these presentations that are about to come, we have asked the DOE speaker to address the following questions.

Every speaker after Mr. Barrett is to address these questions: What is the purpose of the section being presented? How would you summarize what the section says? How robust are the conclusions and what are the uncertainties? And what is the proper use of this material, and what uses should be avoided?

We also asked some additional questions geared to particular Volumes. I will show you these questions as I complete my Overview of the rest of the meeting.

Steve Brocoum and Jerry King--not Rick Craun, it changed from the schedule--will follow Lake Barrett with an introduction to the viability assessment in a presentation of the all-important Overview Volume. This Volume is so important because in reality it's probably the only part of the viability assessment that most people will read.

We would like to know how this Overview should be regarded and how it is linked in its concluding observations to the other Volumes. Are there conclusions drawn that do not appear elsewhere in the viability assessment? Steve Brocoum will also tell us how the DOE intends to get from the assessment to a possible site recommendation.

They will be followed by Tim Sullivan, who will be presenting Volume 1, Introduction and Site Characteristics. The site characteristics section is a basic description of Yucca Mountain and represents the DOE's accumulated knowledge of the proposed site. We have specifically asked the DOE to address the completeness of the site description and how and when any gaps will be filled.

The last presentation by DOE in the morning will be by Dan Kane, who will discuss Volume 2, Preliminary Design Concept for the Repository and Waste Package. In asking for this preliminary design concept, also called the Reference Design, Congress undoubtedly wanted to see a real plan for a repository, not just an undifferentiated conceptual idea.

We have asked the DOE several specific questions: How was the reference design arrived at? How, if at all, was the design constrained by 10 CFR Part 960 or other criteria and standards? Is all of the reference design based on demonstrated technology? What role does the reference design play, given the ongoing work on alternative designs?

After this presentation, and before lunch, we have scheduled the first of today's two public comment periods.

As I explained yesterday, individuals who would like to speak should sign the Public Comment Register with Linda Hiatt in the corner here near the door. We may have to limit the amount of time each commenter is allowed, and I'm sure you all understand that. You've been very respectful of that in the past, and we appreciate that.

Those of you who prefer not to speak or who have more extensive comments, can submit your questions or comments in writing. And let me reiterate from yesterday, written questions can--we will attempt to ask those during the course of the meeting itself and not wait until the public comment period. So writing your questions gives you another way to participate in the meeting.

After lunch, Abe Van Luik will address Volume 3, Total System Performance Assessment, or TSPA-VA as it's called. The TSPA-VA is the heart of the DOE's technical assessment of the proposed repository at Yucca Mountain. It is a predictive computational model, or in reality a set of models, that describes repository performance in the future.

The Board has heard preliminary versions of the TSPA-VA at our public meetings in April and June of last year. We have asked the DOE several specific questions relating to TSPA-VA: What assumptions and models does the DOE consider conservative? What assumptions and models does the DOE consider nonconservative? What are the bases for the assumptions, for example, with respect to cladding credit and saturated zone flow? What does the TSPA-VA tell us about the existence and effectiveness of multiple barriers at the proposed repository? What does the DOE consider valid uses and potential misuses of the TSPA-VA?

This is a tall order, a lot of questions, and a set of rather delicate issues. But we know that Abe is up to the challenge and will address them with his usual candor and eloquence. That was a plug, Abe. I was told to say that.

Carol Hanlon will then discuss Volume 4, License Application Plan and Costs. In many ways this is the most important part of the viability assessment, at least for the future, that is where the program goes from here. This Volume lays out a rationale and plan for how the project will proceed from the viability assessment to a site suitability evaluation, a potential site recommendation, and a potential license application.

We have asked some specific questions for this Volume's presentation as well. Will the DOE have a plan for allocating performance, that is how various parts of the repository system contribute to a meeting of the dose standards? How have priorities changed from previous project plans? How are these priorities affecting funding levels? Among many specific issues, the Board also would like to hear about the status and plans for long term corrosion studies and natural analog studies.

The last specific presentation on the VA will be by Rob Sweeney on Volume 5, Cost to Construct and Operate the Repository. This Volume responds to the last of the four components of VA mandated by Congress.

Russ Dyer, Director of the Yucca Mountain Site Characterization Project, if he's still successfully fighting the flu by that time, will then summarize for the DOE, covering a number of topics, including the viability assessment, some recent Board recommendations, and proceeding to a possible site recommendation.

The Board is aware that there is considerable interest in hearing the Board's views on the viability assessment. We will be commenting formally and in writing at a later date. Indeed the presentations and discussions that are about to take place will provide important input to the Board's evaluation and deliberations about the document.

Although it would be premature to comment in any specific way, the Board does have an overall and preliminary impression of the VA which I will share with you at this time. The completion and issuance of the viability assessment represent a major accomplishment by the DOE and its contractors. The Board is pleased to congratulate them on this achievement.

The Board found the reports to be well written and attractively presented. This is not a trivial matter, especially in trying to communicate such a large amount of technical information about such a complex project. The Board believes that the VA is an important milestone for the Yucca Mountain Project. Most significantly the Board observes the the VA proved to be the hoped-for mechanism for achieving better integration of the program's many parallel efforts in science and in the design aspects of the project.

As I noted earlier, the identification of the work yet to be done for a determination of suitability is perhaps the most important part of the VA. The remaining work includes site research and design. Here the Board is pleased to note that the VA's priorities for the remaining work agree in most respects with the priorities identified and discussed in the Board's report issued in November 1998.

Finally, I wish to reiterate what the VA is not. The viability assessment is not a suitability evaluation. The Board believes that the DOE has work hard to keep a clear distinction between viability and suitability. We support DOE's position and commend them for their efforts in this regard.

As I said earlier, the Board will issue a report with more detailed comments on the viability assessment. Until then we will offer no more public comment on the VA.

Now finally, just to go over ground rules for the rest of today, please let me remind speakers that half of their allotted time should be devoted--should be reserved for questions from the Board and others. As we did yesterday, after each presentation we will ask Board members for their questions and comments. If time allows, I will then ask our guests from Sweden if they have anything to add.

This will be followed by questions from the staff, if any, and written questions from the public, if any have been submitted. Let me remind you, members of the public, you will have two chances to speak later today in our open sessions at 11:30 and approximately 5:00 at the conclusion of the meeting.

With that, it's time to get started; and again, it's my pleasure to welcome Lake Barrett. Lake?

BARRETT: Thank you, Chairman Cohon. Members of the Board, it's a pleasure to be here this morning to share with you my thoughts on the program. As the Chairman has mentioned, we've made substantial progress since I last addressed this Board last June.

Most importantly, as you know, the viability assessment was submitted to the Congress and the President by the Secretary in December. We will be presenting the details as Dr. Cohon just described throughout the day.

We do believe this is a significant milestone, and we are pleased to be able to tell you about the progress that we've done. I'd also like to express my gratitude to the Board, which their comments throughout the process over the last several years has been helpful to us in making the viability assessment the success that we believe it is.

The viability assessment intention was to provide all the parties with a better understand of the work that has been done and the remaining technical work necessary to evaluate the site, to support a decision by the Secretary whether Yucca Mountain will be suitable to recommend as the nation's repository. That schedule, if the budgets support that, will be in 2001.

Completion of the viability assessment effectively marks the midpoint of our five-year plan to finish the site characterization under the revised program approach. This focused approach, along with the ongoing management improvements, have trimmed approximately $2 billion from the estimates that we had before that time.

One thing I also would like to mention, besides the science and technology that we've put into the viability assessment, we also took considerable efforts to be sure that it was available to everybody to be able to understand what it is.

We spent a lot of energy and time to put all the scientific reports on the Internet, also to put the viability assessment on the day of release on the Internet; and we've had tremendous interest in that. We've had over 10,000 hits a month on our web sites for that information.

So we did spend considerable effort and cost to get that in basically the formats to make it as accessible as we possibly can, because it is a complex compilation of a lot of information. I was trying to touch on various aspects of the program besides the VA, because that you will hear more about later.

In fiscal year '99 Congress appropriated $358 million for the program. That was less than the President's request of $380 million for '99. Within this amount Congress appropriated $5.5 million for the local counties and $250,000 for oversight by the State of Nevada.

Congress also directed the program to further reduce its management and administrative support service contractors by an additional 10 percent. Congress also further directed that $4 million was to be used for the study of accelerated transmutation of high level waste.

Specifically we are developing, with international collaboration, a road map to identify the benefits and issues regarding the treatment of civilian spent nuclear fuel with accelerator transmutation technology. Issues that we are addressing are the technical feasibility of that concept, time schedules, the capital and operating costs, and the institutional challenges involved in such an endeavor.

Although the FY'97-FY'98 budget reductions have made things difficult for us, we do believe that the fiscal 1999 funding will be adequate to continue implementing the revised program approach, as we refined it in the viability assessment.

We plan to maintain our schedules to issue a draft environmental impact statement this summer, and completing the necessary site activities to support a decision for a site recommendation to determine if the site is suitable for recommendation in 2001. These budget constraints unfortunately have caused us to defer work in the transportation areas beyond that transportation work that is in the DEIS.

Now turning on to some Washingtonian unpleasantness, litigation. As you are aware the Department is in litigation with over a hundred various different agencies and corporations in dozens of cases in Washington and also in Minnesota.

In 1996 the U.S. Court of Appeals for the D.C. Circuit held that the Department has an obligation to start disposing of nuclear spent fuel by no later than January 31, 1998. In 1997 the same court held that the Department could not excuse its delay as unavoidable under the contract.

The court also held that contracts between the Department and utilities provide a potentially adequate remedy for the Department's delay and therefore refused to order the Department to remove the spent fuel from reactor sites.

This ruling was appealed by both utilities and state agencies, and the federal government, to the Supreme Court. The utilities and state agencies asserted the court should order the Department to begin removing spent fuel from utility sites, and sought Supreme Court review of the ruling.

The federal government also requested Supreme Court review of the portion of the ruling which prohibited the Department from making a determination that the delay in removing fuel was unavoidable. On November 30, 1998 the Supreme Court declined to accept either request for review, and the appeals court ruling stands.

The Department will comply with the lower court's ruling and process any claims presented to it under the standard disposal contract. To date 10 utilities have filed claims for monetary damages in the Court of Federal Claims in Washington. The Department of Justice estimates these claims could total as much as $8.5 billion.

On September 16, 1998 oral arguments were held in the lead cases in this series. As of last week no schedules have been established for hearing the cases. The results of the litigation could severely impact the funding and possibly the continuation of this program.

In November the Board--you have issued your report to Congress and the Secretary providing your views regarding the objectives and priorities for the site characterization program. This report discussed the key remaining scientific and technical uncertainties related to the performance of a repository at Yucca Mountain.

We appreciate the Board's recognition of the considerable progress that we have made characterizing the Yucca Mountain site, and developing a comprehensive repository safety strategy. We also appreciate the Board's views on specific technical and scientific activities undertaken by the program and its suggestions to improve those.

We are in the process of preparing a detailed response to your report. In advance of that, however, I would like to briefly discuss our plans and how we are going to address the suggestions in your report. Both your report and our revised program approach explicitly recognize the site characterization cannot resolve all uncertainties and provide absolute proof of any repository performance.

We agree that an acceptable level of uncertainty for decision making is ultimately a policy question. Our experience has shown that significance of uncertainties, as they relate to our understanding of natural and engineered processes, cannot be determined in the abstract. These uncertainties can only be meaningfully evaluated within the context provided by a specific geologic setting, a coherent repository design, and a comprehensive assessment of its performance through TSPA. Only then can we ascertain what an acceptable degree of uncertainty may be.

For the viability assessment we assembled information collected in more than 15 years of characterization at the Yucca Mountain site, and our efforts to put that into a workable repository concept and a reasonable assessment of its cost as well. This process illuminated several issues with uncertainties and impacts to repository performance. The plans we developed to address and potentially reduce these uncertainties and provide the underlying logic for decision process were very important.

We look forward to receiving the Board's views today and in your future reports regarding the work plans that we have laid out in the viability assessment.

The work plan we have established for completing the characterization retains the basic tenets of our revised program approach by seeking convergence of the technical work and completion of key milestones. We have set forth an integrated approach that will produce comprehensive technical documentation to support a potential site recommendation.

This body of information will enable policy makers to evaluate both the suitability of the site and the significance of residual uncertainties to the national decision on whether to proceed with designating the site and then proceeding through a licensing case if that is warranted.

The Board's report highlights the need to continue focused studies on both the natural and engineered barriers to develop a defense in depth repository design, and to increase the confidence in predictions of future repository performance. Our efforts to streamline the site characterization program centered on the importance of the information as it relates to the performance of the repository. The logical evolution of this approach is to identify the methods to reduce uncertainty in repository performance and to also develop defense in depth.

In addition to providing estimates of potential does in the future from a repository, the total system performance assessments that we have prepared over the past several years have also helped identify those areas where uncertainty significantly affects repository performance. This information in turn supports the prioritization of future activities.

As we proceed I expect that decisions on these issues, and ultimately those in repository licensing, will center more on the underlying confidence in our analyses than on the absolute values that the analyses produce.

The Board's report also highlights the need to investigate alternative waste package and repository designs, including those that may provide benefits to repository performance and to also reduce uncertainty.

I agree that the repository design should not be prematurely fixed, and potential design enhancements should not be foreclosed. Our design approach balances the need to maintain a cohere working concept with the recognition that such a design concept will invariably change over time.

In response to suggestions by the Board our contractor team has undertaking an evaluation of design alternatives. On Monday a panel of the Board received a detailed briefing on that status. I hope those discussions were helpful so you could see the progress that we're making in this area.

I believe it is essential that we complete a fair, unbiased evaluation of alternatives with insights gained from the site characterization before we proceed with the evolved reference design for the site suitability activities and the license application thereafter. The reference design is envisioned to continue to evolve through the site recommendation process, the licensing process and actually into construction and operation.

I am closely following the evaluation of these design alternatives, and pleased with the questions and the dialogue that is taking place in this process. It is very healthy in our internal family, and also dialogue I understand occurred between the Board and our team on Monday.

I am also pleased that the process has enabled us to look individually and collectively at the previously identified design features with a new perspective. I urge the Board and other interested parties to follow this important activity. I believe it is important for the program and interested parties to develop a common understanding of the repository reference design for Yucca Mountain.

General agreement on the concept will ensure we have considered the facts objectively and reached a sound position for this point in the program's evolution. The public interest deserves constructive input from all the knowledgeable participants in the evolution of this design process.

On several occasions over the past three years I have discussed with you the status and our plans in the program. In those discussions I emphasized our focus on completing the viability assessment. Assembling this information into a coherent workable repository concept was a significant challenge and accomplishment for the program team.

I also noted that our plan called for substantial effort in the viability assessment to complete the characterization, continue our design evolution activities, and to complete site activities necessary to determine suitability. We are now well into this post-viability assessment work.

One of the challenges that we have in this area is to complete our implementation of the nuclear quality assurance requirements of the Nuclear Regulatory Commission. World class science and state of the art science is necessary but insufficient in Nuclear Regulatory Commission licensing proceedings. This is a meshing of cultures that we need to do.

We faced this four years ago in the tunnel construction where basically tunnel construction folks really weren't in tune with Nuclear Regulatory Commission requirements for quality assurance.

We successfully passed that and we now have a challenge in front of us with our scientific community, most in the natural sciences area, that Nuclear Regulatory Commission requirements for documentation, traceability, process control for evolution of codes and models is also a requirement that we must work into the system. So this is going to be a major area that we are factoring into the program, that must be done for a successful license application.

This year we plan to publish the draft environmental impact statement for Yucca Mountain this summer. In general the environmental impact statement will describe the environmental impact statements of the Yucca Mountain repository under a range of implementing alternatives.

Following the public hearing process and consideration of comments as required by the National Environmental Policy Act, we are scheduled to publish a final environmental impact statement in the year 2000, provided we have the necessary fiscal 2000 financial support from Congress.

Should the technical information assembled by the program indicate that geologic disposal at Yucca Mountain is an environmentally sound approach for the management of radioactive waste, we will complete the evaluation of the site and prepare the technical documentation necessary to support a secretarial decision and a recommendation to the President in 2001 concerning the suitability of the site.

Should the site be designed under law, we would then proceed to submit a license application to the Nuclear Regulatory Commission in early 2002.

The viability assessment clarified the remaining work required and illuminated those technical issues that should be further addressed prior to determining suitability of the site. We are addressing those issues in an aggressive manner and we have commenced work on assembling the information required to support national decisions for geologic disposal at Yucca Mountain.

I would be pleased to try to answer any questions that you may have at this time.

COHON: Thank you very much, Lake. That was a nice presentation; very informative. Bullen, Board.

BULLEN: Bullen, Board.

Lake, on Monday and Tuesday of this week we learned about enhanced design alternatives and we learned about the alternative design that may be carried forward. And in light of the budget constraints that you see, is there a possibility that more than one design may be carried forward? Or are you going to have a tight enough budget that you'll only be able to pick one and not be able to carry forward a couple of designs that would be appropriate for further consideration?

BARRETT: Excellent question; difficult balancing that we're trying to do here as we try to balance all the drivers in the program. The principles we have in the design is we need a reference design and going to have a reference design. We also do not want to prematurely foreclose other considerations.

Keeping in our approach as we shifted to the monitored geologic repository concept is maintain flexibility, maintain reversibility throughout the process. So we are balancing now how much we can afford to carry in design flexibilities as we go forward. We are striving to do as much as we reasonably can. I doubt we can carry multiple design concepts done equally all the way through the process.

So we're balancing tremendous needs throughout the program to address natural science issues, to address issues that are of importance to many of the important parties, and still do all the necessary things; and also to improve our processes and implementation on the quality assurance areas as well.

So it's a challenge. I think the views of this Board are helpful to us as we go through this process. Our independent repository consulting board gives us input, so we are--you know, it is helpful as we go forward. And I really don't know yet what we're going to be able to do. I think how the 2000 budget goes will also be important as we look on maintaining the schedules if we can.

COHON: I have a--Cohon, Board--I have a couple of questions, one related to Dan Bullen's question. First though, on the budget, do you have a number yet from OMB for FY2000?

BARRETT: Yes, I do, but in accordance with that 1948 Harry Truman memo, on Monday the President will roll out the budget and it's the President's budget and he will roll it out. And we will follow it up Monday afternoon.

So I'm not going to get out in front of the President and Secretary. But I will forecast that we will be consistent with the numbers in the viability assessment in the President's request for the year 2000.

COHON: Thank you. The question that's in the same spirit as Dan's but in a somewhat different direction, one of the aspects of the program at this stage which really can't be avoided is the need to do research that necessarily extends considerably beyond both suitability decision as currently scheduled and even a license application, and perhaps quite a bit beyond that. I know you've given thought to this and the program continues to work on it.

I'd be interested in your current thinking about how some of this might be handled; that is, if you've thought about a waste emplacement schedule that might be able to take advantage of research that's ongoing as we discover ever more about the mountain.

BARRETT: As we prepare our work plans, once we get a budget from Congress, we spend an awful lot of management energy trying to have a balanced program that addresses all the desires and needs but doesn't necessarily fulfill them completely, but does them all necessarily, for example, engineering, natural sciences.

And those all have a timing complement to them, short term, long term, and you need to deal with the short term, fire drills and crises that we may have; but you also better be investing in the long term because that's the crisis of tomorrow.

An example would be we spent a lot of time on long term materials corrosion tests that we started at Livermore. It is a multimillion dollar operation. We have--I think you may have been briefed on that--over 14,000 coupons that are in place in these very carefully done, under full nuclear quality assurance requirements and documentation, that are going to go for many, many decades into the future. We have invested in that. It's a long term investment, we think it was the right investment, and also dealing with the short term items.

We also need to balance issues that I think you probably discussed on Monday about to what degree do we do the design alternatives and do we want to go forward, and what we're going to go forward, how many can we carry forward, and try to have a balance of all of these; and have the proper balance between the natural and the engineered, and also the Nye County drilling and balance all of these things.

And we are still straining under the success of nominal $30 million cuts that we received in '97 and '98. We committed virtually all our reserves at the time to do the cross drift on an accelerated schedule. And there is not much margin for us to do it. I mean Russ and I commit our reserves much too early in the year for comfort, that we not end up in an antideficient situation, and you're never quite sure at the end of the year what's going to happen between the Congress and the President budgets.

So we're trying to balance these things, and we try to get what we consider the right balance between the long term and also the short term as we go through this all the time. So we're trying to get the balance. An example would be in the quality assurance area.

We spent--I wished we'd maybe spent more historically on the nuclear culture in the scientific community on implementing the quality assurance requirements down on the deck plates or in the laboratory, I guess I should say in this case. But we also needed to get the viability assessment out and have that integrated and have appropriate substantiated cost estimates and others.

So it's a constant struggle for us for this balance as we go forward, and it's very difficult; and it ends up that if all the various segments are equally dissatisfied, I feel we're probably about close; because I've used the analogy, it's like a chain with a lot of links in it, and we hold up a very heavy load, and you don't want to have one link very big and the other link smaller because the weakest link is the one that snaps.

So we constantly are evaluating that each link is at the right strength relative to the whole program, working within the constraints that are severe constraints that we get from the budgetary situation.

COHON: Other questions from members of the Board? Debra Knopman?

KNOPMAN: Knopman, Board. Lake, I'd be interested in hearing your views about lessons learned from a management perspective on how to integrate large amounts of scientific information with the engineering design, and then the mechanics of assembling VA as you did; if this may turn out to be a dry run of a license application.

And I'm wondering what things came up in the course of this process that you'd do differently, or that you found more difficult than you anticipated, or easier? Just what did you learn from having to go through this management exercise?

BARRETT: There was nothing easier. I expected it to be hell, and it was. But it's like steel. I mean you beat it up and it gets stronger as it goes, as you forge it. I think some key things are everybody needed to have their eye on the goal for the program for the nation. There would be a fair objective evaluation to this; we weren't rushing to anything;

there were no--it was appropriately balanced as what we were trying to do.

Everyone--and I think did--on a team respected other people's views on this thing, and we forced the practicing of covey skills, listen, add light not heat--those kinds of--it was a team type of thing sort of like the halftime coach giving a speech in a football game kind of thing. Don't get--stay in the middle and listen and act right for the nation on what you're trying to do, and let the chips fall where they may from a science and engineering point of view.

Communications was another critical thing, that the left hand had to constantly know what the right hand was thinking as you went forward. Traceability and don't overreach. We constantly were tempted in the technical areas in science, well if I could only put in this next iteration of the model or this next piece of science, it'll make a difference. And this is constantly dynamically changing all the time.

And you don't want to use the word--I hate the word "we've got to freeze that" months before. But you had to basically kind of blow the whistle and say "That's--for now we'll do that later."

It's very hard to take basically thoroughbreds on the team who want to go that extra little bit, but that extra little bit can be out of synch with one of your colleagues. And that is very detrimental to the process, because the worst thing people would say, "If on page 325 of Volume 2 disagrees with page 400 in Volume 1, that will be pointed out." And you will be penny wise and dollar foolish.

So coordination--we had weekly meetings, we put management schemes in place, we had--Steve Brocoum ran a group, I ran a group, the contractors had groups that went through these many times. We had to be able to withstand the changes in emphasis as we received feedback and in put from parties beyond the program.

The Board clearly, the Secretary instituted reviews of his own, other parties--the Nuclear Regulatory Commission and the issues that were important to those groups were naturally important to us, and as those would change a little bit, or change in intensity with the function of time, we had to respond; but we had to make sure the team stayed relatively--no big swings--but change when you need to change but bend when you need to bend; but keep your principles and keep the basic tenets there.

So it was a constant thing that we had to all be darn near hundred percent focused on to steer it, manage it to withstand the forces that forced us sometimes to the left, sometimes to the right, sometimes faster, sometimes slower, to keep it on a steady keel with your guiding star being that we are public servants, we are trying to do an accurate fair portrayal of the situation for the policy makers and decision makers--not a decision in itself to not.

So that was some of the lessons that I personally got from it, and I was just so pleased that the team, the contractor and DOE team withstood the pressures and withstood some very difficult internal meetings and came through with a product that we're all proud of.

And we do appreciate the recognition that the Board has given us in the meeting that you had with the Secretary and Chairman on behalf of the Board, and the Board comments that have been made.

COHON: Dan Bullen.

BULLEN: Bullen, Board. Lake, you mentioned potential litigation or the litigation that is underway, and it may threaten the actual existence of the program.

I was just wondering if you had done sort of the scenario analysis of the "what-ifs"; that what if the litigation goes one way or the other. How will or how do you foresee--and I know I'm asking you to look in a crystal ball--how do you foresee the program continuing, or do you actually see its complete demise?

BARRETT: All those things are possible. We just don't know what is all going to happen. These are very complicated things. We're going places where Supreme Court rulings will tell us and votes in Congress and the President will tell us, and we don't know. The whole range of things are there from continuing as sort of normal to substantial huge changes; and they're all there, and I don't know what is going to happen.

We on the team are going to continue doing the scientific technical work to evaluate the situation at Yucca Mountain--is it suitable to be recommended or not--and try to withstand that. I try to isolate the Yucca Mountain folks from this stuff back east. But it does take up more of my personal time in sworn declarations under penalty of perjury before courts than I'd rather have to do.

COHON: Priscilla Nelson.

NELSON: Nelson, Board. I want to tell you that the Board meeting on Monday was very interesting, and our participation as observers at the tremendously intensive workshops that were held earlier this month was wonderful to be able to hear the discussion--lots of good ideas coming out. And we realize that many of these ideas, alternative concepts have received attention before now on the project. And some are being treated newly or again in a different light now. It's very exciting.

I believe it's fair to state that the people who attended, the Board members who attended the meeting however were extremely concerned about the possibility of not having enough time, or having schedule really limited the good work that would be possible as an outcome of this exercise.

So the question I have for you is how--is there flexibility in the schedule where additional time can be made for seeing this process through as fully as it might go and become fully developed as alternative concepts?

BARRETT: Yes. Now this gets into a question from the chairman, and also on lessons learned from the viability assessment. If you're going to manage a complex program like this, some of the Management 101 principles kind of go down into this.

First of all you need to have a reference schedule that you are working toward, and you start backing out from major things like site suitability evaluation, and you start backing up what you need to do where; and we have 4000 node schedule that we manage this to.

And you start backing up and you start finding the design is that we would really like to have the conceptual design locked down and very clear, and only that one item in May of '99--let me take an example. So you start this back say a year ago when we started this, and we said "Go forth and try to do this and do an appropriate evaluation of this that's fair, unbiased and complete enough for where we are in this program."

Now once you start that, as you witness some of that, this program has a lot of creative minds to it and all kinds of neat things come out of that. Now if you let that go unrestrained it will go on forever and ever and ever and never come to closure.

Now you can't say you have one week to go do this and it's over and I want the final report. So you start off and give what is a reasonable time that you think you have, and we had a goal and a milestone of May.

Now they are working, as you saw, very vigorously under those constraints. Now we're going to see--we constantly watch this, and we've done this--we will extend that if it needs to be extended, but only in the balance of looking at every link in the chain and everything else where we are. So--and we're going to see where that is.

If it's necessary to do, we'll do that, and we have work-arounds and adjustments and how many we carry and this all fits together in the entire program and how we balance this. An example is that would be more work, more money, more time.

I don't know if we're going to talk about it today, but I mean I'm still struggling on trying to put in some of the alcoves and do some of the science in the cross drift that you and I would like to do, that I've had to defer; and some of that is deferred out into 2001 that I really wish it wasn't, so we're trying to bring some of that in, trying to support the Nye County drilling and all those other things.

So we've got to balance this thing, and we're not going to prematurely close this and we're not going to let it run on unnecessarily long and start to affect other parts. This is like porridge temperature--not too hot, not too cold; just right.

We're going to look a little closer to May and see where we are. Russ and I and Steve are watching it closely, and we will extend it if it needs to be extended, it should be extended, and we won't if it shouldn't. And I don't know what that's going to be.

We're going to see what kind of progress they make, but we do hold--we don't tell people now, "Oh, yes, you're going to get an extension" because I just know automatically what happens, from Management 101. The work will immediately expand to fill whatever time Russ and I set.

NELSON: I was wondering, we've had so many analogies over the past couple days, and porridge is a new one.

BARRETT: One of my favorites.

NELSON: Do you have--is there a project analogist who--

BARRETT: That's about Goldilocks and Three Bears.

COHON: We have a question from Dr. Forsling from the Swedish National Council for Nuclear Waste Management.

FORSLING: I'm also very impressed by this document, viability assessment document, and also yesterday and today we listened a lot about different activities going on in this area. Actually I'm interested--I think all this activity must be part of a big master plan, original master plan, and I'm interested in who has made this master plan from the beginning? And in what way has it been worked out?

BARRETT: We'd all like to know that. It's kind of like theological activity, to say it was all made above and it was all preordained. But I don't think it was.

Basically the Congress in '82 set out after much thought and debate over the '70's and early '80s on a path forward policies basically formed by intergenerational ethics, the generation that made this stuff should not pass it on with an unknown consequence to the future. We should start to work on that. And then it was adjusted by the environment around us. And so there's been changes, and in a democracy it comes through basically statute changes, and also environment.

I'll tell you something that I think is in play today, and we'll be changing things and you will see it ripple down here, is good things happened in the world in the late '80s and '90s, and that was the end of the Cold War. And the global situation on global nuclear materials management including domestic in this country about what we're doing, and what's going on in nonproliferation.

The Secretary announced that we're having a conference this fall here in Las Vegas on global nuclear materials management and repository technologies, which are quite intertwined. What goes on in the United States, what goes on in the North Korea negotiations, in the former Soviet Union, you know, Russian submarine fuel, and litigation and all sorts of issues.

As we, the world--and the world gets smaller every year--wrestle with responsible management of materials that we've already made and continue to make, and how this all fits in, in global risk, in this smaller information age world where there, as the Secretary said on national television here not too long ago--I mean there are risks involved that are real and they're now. And this plays a role in that as we in the United States who basically in World War II started this, is to that we continue to responsibly manage this.

So these forces work, and what they do is they ripple on down into budget decisions which are very important here as to we do more of this, more of that, and how much of this, to what completeness, because everything in a scientific endeavor like this is never done completely to everybody's satisfaction. And you have to have a balance.

So the basic policies are there in the law, and then we get buffeted by these hurricane force winds, it seems, that flow from different angles, and we try to keep a common course, doing basically the right environmental things, look back to our mission plan for responsible management of this material for the future, and balance the crises of the day, but not lose sight of what it's about; that we are an environmental program trying to implement our responsibilities for responsible management of what this society has made in the global scheme of things.

So then we try to articulate it as clearly as we can, realizing that we have an audience that reads the VA from basic people at home watching television to eminent scientists that get down into detail. So it's a fine balance that we try to do as the forces work upon us.

COHON: Going to conclude this with two questions submitted from the audience. We're a little bit over time, and these are brief and to the point, and I think you can deal with them quickly. They're also relevant.

One is from Sally Devlin, who made the point yesterday, Lake, when you weren't here, that she and others, especially in the communities near Yucca Mountain don't have access to the Web yet. So that communication for them is more difficult.

So the question--two questions really--is what can DOE do to make communication better for people who do not have access to the Web, and maybe find it difficult also to get the Federal Register; and in particular, what can be done to make this ongoing LADS alternative design process more accessible to the public?

BARRETT: Okay, we still have the good old fashioned 800 phone number that--some places don't have phones--most have telephones. Call that number and we'll send any of the information that's on the Web to you. Sally can have a copy of the viability assessment if she would like to carry it home. So we still have that.

You can write. We respond a lot of times in writing, sending things to anybody--anything that's on the Web we'll give you hard copies. So that's what we can do, and we have the reading room in Pahrump.

Now I realize Pahrump is not Amargosa Valley, and Beatty--and we have a reading room--I believe we still do. And we have an office in Beatty, and we're going to having some update meetings up that way coming up in the next couple of months throughout the state.

So I mean there are other good things, so those methods still exist for those that don't have access to the Web.

COHON: Last question, also from the audience though I don't know who submitted it. How many of the advanced designs that are now being considered will be addressed and included in the EIS?

BARRETT: Basically the EIS will--there's an infinite number of permutations and combinations of various design features. The EIS under the NEPA rules basically will bound these.

I believe what we have in the EIS are basically three that will adequately bound the range of--because I think the design alternatives are 26 various, and then there are--we call that from a broader set.

So the EIS will basically have three that will basically bound the considerations that we have in the design work, and the design engineers and the EIS team are closely coupled. The EIS team is using the best available information to bound it.

COHON: Thank you very much, Lake; and thank you again for taking your time to be with us.

BARRETT: Okay, thank you.

COHON: Our next presentation and the first one on the VA specifically will be by Steve Brocoum and Jerry King. Steve, as you know, is from DOE; Jerry King is assistant vice president, SAIC, and they are viability assessment management for the Yucca Mountain project.

Steve Brocoum.

BROCOUM: Assume this is on?

COHON: It is.

BROCOUM: My role here today is to introduce the viability assessment and begin the transition of the viability assessments to the continuation of the program, culminating if we get that far at site recommendation and a license application.

Russ Dyer at the end of the day will also build on what I started, how we're moving on beyond the viability assessment.

Okay, so I'm talking about the viability assessment and the transition to site recommendation, title of my talk; so I will talk about the viability assessment and its contents in Overview fashion, about the availability of viability assessment.

I will then give an introduction to the planning we're doing for site recommendation. I will talk about the content of the site recommendation, the major products for fiscal year '99, and I will close with overall program schedule.

The Congress directed the Department of Energy in the Energy Appropriations Act of '97 to prepare a report in '98 to assess the feasibility of developing a repository at Yucca Mountain. The viability assessment provides that information on the progress of site characterization through I would say fiscal year '97, and identifies the key issues that must be addressed before we can proceed with the site recommendation.

The viability assessment is composed of an Overview and five Volumes. In the back of the room we have the

Overview for those that have not picked it up yet. The Overview contains a CD ROM which contains the whole viability assessment, so in a sense if you get the Overview you have the whole viability assessment. The Overview was written for the general reader, and Jerry King will go through the Overview in the next presentation.

Volume 1 is an introduction and a summary description of the Yucca Mountain site, and Ken Sullivan will go through that. Volume 2 is a description of our preliminary repository and waste package design concept, the viability assessment design concept, that will perform in concert with the natural system to protect public health and safety. Dan Kane will talk about that Volume.

Volume 3 is a total system performance assessment of this design, and of the national system was we understand it today. And Abe Van Luik will talk about that. Volume 4 is the plan for completing the necessary work to evaluate the suitability of a site and to prepare a defensible license application if the site recommendation proceeds. Carol Hanlon will talk about that.

Finally, Volume 5 is is an estimate of the costs to construct and operate the repository in accordance with the design concept we have in the viability assessment. And Rob Sweeney from the M&O will talk about that.

We have all but 300 references and supporting documents today available on the Internet.

We've shown this diagram before. We call it the bookcase. The top layer of the bookcase is the viability assessment itself. It is supported by technical documents such as the site description and process model reports. There's various design analyses, the technical basis report--that big 3000-page document that supported the VA, the repository safety strategy, and other technical records.

Total system life cycle costs, fee adequacy report --all these documents in green are now on the Internet. Copies may be obtained by either going to that Internet URL address shown here, or by calling the Yucca Mountain office at 1-800-225-6972.

The VA was transmitted to Congress on December 18, 1998 and was made available to the public in paper form, on CD ROM and on the Internet all at the same time. Supporting documentation was also put on the Internet. Hypertext links from the VA to the actual references are in the process of being prepared and they will available by the end of January. Checking with Claudia here to get an affirmation of that. That's just a few days away.

One can go to our home page. That's the Yucca Mountain home page, click on What's New Here and get into the document assessment.

Just again to show you the public interest, I have some updates to this. These are the hits we got on the document assessment over--through January 5, overall, and then by Volume in Overview.

And I've got a couple of updates here. Since between the 5th and the 26th we've had 1,948 more hits overall, we've had 216 additional hits on Volume 1, 239 additional hits on Volume 2, 299 hits on Volume 3, 114 hits on Volume 4, 147 hits on Volume 5; and another 437 on the Overview--those in addition to what this histogram shows.

So that was on the Internet. This viewgraph is the 800 number. You can see overall about 400 or 500. Since the 5th--since the 1st because there's a blank here--we've had about 162 additional requests for the Overview and 172 additional requests for Volumes 1 through 5. Gives you an idea of the type of interest there is in the viability assessment.

The viability assessment is out in the sense it's history. It's a point in time. So the rest of my talk is basically now, how do we now transition from having done a viability assessment to move on.

Site recommendation--we're preparing a work plan for acquiring the necessary information to evaluate the suitability of a site and to prepare, as I said earlier, defensible LA, assuming we get to a site recommendation.

We have a comprehensive--someone asked before about how all this was planned. Well we do have a comprehensive multi-year plan that is consistent with Volume 4, and that's the plan we update every year as we go into each new year to do our work.

We are currently conducting detailed planning on the site recommendation and company reports, and we are prepared an outline of the site recommendation, which I believe is coming out in March of '99. So from that outline could tell exactly what our site recommendation will look like.

This is just a kind of a summary chart of a flow of work in the project. We have site characterization and site testing work, we have design work, we have TSPA work; and the all feed the EIS and site recommendation, and things like site testing, fluids or drift-scale heater test, unsaturated zone flow and transport tests, saturated zone, rock mechanics, cross drift tests.

Design, of course, the LADS effort, study EBS material, developing the design for the SR and so on. The site information feeds the design, both of them feed update in the process models, updated process models feed the TSPA.

We have to address peer review in oversight comments we get. We have to incorporated updated models and do analyses, create updated versions of the TSPA, the EIS, which is coming out at 8/00--that's the final one--and the site recommendation in 7/01.

I'm going to try--I don't usually do it--a two projector thing for a few minutes here. I'm going to leave that on as we talk. This triangle kind of shows you the whole site recommendation documentation structure that we envision today. This is the site characterization program; these are the more detailed documents.

There will be four Volumes which I'll go through in my viewgraphs. There will be an Overview, a recommendation from the Secretary to the President, probably from the President to Congress.

Now, next viewgraph on the machine there, we will have four Volumes. The first Volume will be a summary of the technical information required by the Act itself. The Act requires a description of the proposed repository design. These are the sections of the Act: description of the proposed waste form and the packaging, and the data obtained in site characterization related to safety of the site.

Volume 2 will contain our compliance analysis with respect to our siting guidelines, based on our TSPA for site recommendation. That represents our lower case suit suitability analysis.

Volume 3 will contain other information required by Section 113 of the Nuclear Waste Policy Act. Those are the views and comments of the governor and legislature of any state or affected Indian tribe, together with the Secretary's response; any other information the Secretary might consider appropriate; and any impact report submitted under Section 116 by the State of Nevada.

Volume 4--fourth Volume site recommendation will contain the NRC's preliminary comments on the sufficiency of site characterization. The NRC is required to provide those comments. The final EIS will accompany the site recommendation.

Volumes 1 and 2--go back a slide--Volumes 1 and 2 will be issued in our current planning in draft form in the fall of 2000 as we go into our hearing process. So that will consider the information we prepare required by the Act and the information we prepare relating to how we meet our guidelines.

Next viewgraph. Volumes 3 and 4, we don't have that information at that time, so that comes in later.

Next viewgraph. This is just an overall milestone chart for the project, and we mention the integration, we were able to achieve with the site recommendation. I just want to remind the audience that integration requires constant vigilance.

Last night I was reviewing my talk at 10:00 last night and I noticed that this chart, the dates on this chart were not consistent with the dates on the next chart. I picked up the phone at 10:00 to call our technical support contractor, and they sent people into the office to update this chart overnight and get it on that projector.

Unfortunately they were not able to update the CD ROM that we prepared for the Board that has all the presentations, so this chart has somewhat different dates in the CD ROM. It's the same chart. I just wanted to give you an example of integration. It's always a challenge.

If we go down the chart we're going to publish the draft notice of availability, DEIS in July of '99. In blue are the design things. We're going to have the SR design and any options or multiple designs in May of '99. We talked a lot about that yesterday.

Feeds from design to TSPA go in about 6/00 and the--I don't want to call it the final design--but the SR design is in a sense locked in in 8/00. Remember we're going into hearings at the end of the year.

In July of this year we'll have the methodology and assumptions for the TSPA SR. We'll have various info feeds in October of this year. We'll have the first rev of the TSPA-SR in September of '00 and we'll revise it one time before the site recommendation goes out.

We can't go to site recommendation without our guidelines. On our current baseline we have completing our guidelines in June of this year. If you have any questions on that I'm going to defer those to Lake.

In our current planning we would go into the consideration hearings around November of '00. At that point we will have released Volumes 1 and 2 in draft form. So that's what this next bullet is here. We will complete those consideration hearings in December and January, complete our comment period in January; we will notify--the Act requires--the state of our intent to proceed in April '01.

We hope to receive our sufficiency comments from the NRC in May of '01; we will complete any revisions to the SR based on all these inputs and hearings and public comments, submit the SR to the President in July of '01. That is the overall current planning, actual baseline schedule for the project.

Next viewgraph. This is somewhat a more detailed chart. This chart and the previous one did not agree on dates, and that's why I had to last night make that phone call and make people go to work overnight.

The top line, for those that are interested in the actual steps in the process, are all the steps in the SR process. The different colors are just whether it's a project level, a program level--project level in green, a program level in red, or Secretarial level in yellow.

The bottom line of the key are technical milestones. The middle line has to do with EIS. This is consistent, but has a few more--little more detail. Next viewgraph.

Our major products this year: we issued the VA in December of this year. That's one of the major products. We will complete an annotated outline for the site recommendation in March of '99.

We will complete our design alternatives activity and select the SR design concept and any options in May of '99, hoping to complete the rule making in June of '99, publish a notice of availability for draft environmental impact schedule in July; and thinking also ahead to the LA, we will have a working draft LA in August of '99. That's really a detailed skeleton of the LA, not a complete LA.

Next viewgraph. So in summary, already my thinking, since I'm responsible for most the things I showed you in previous pages, I'm beyond VA right now. I'm thinking ahead as the products are coming out ahead.

So we're shifting from focusing on the VA to focusing on the EIS--obviously a big issue this year with the July date just around the corner--and the SR; and we are finalizing a plan that will I hope provide sufficient information for defensible evaluation of the suitability in 2001, and if suitable, recommend to the President that DOE proceed with submitting a license application to the NRC for construction of a geologic repository.

Any questions at this point?

COHON: Hang on one second. Should we entertain questions now?

BROCOUM: Yeah, now what we do is we go into each Volume.

COHON: Priscilla Nelson.

NELSON: Nelson, Board. On slide 12, is there a chance that you might pull that up? You have a one-way arrow going from site testing down to continued design, and this may be a minor point, but it's sort of important to me.

BROCOUM: I know it is.

NELSON: I can see a real opportunity for some of the design alternatives to actually perhaps give some feedback into the site testing program, and wonder if there might be consideration to making that arrow two-headed?

BROCOUM: My mind recalls, and I think you've asked me that once before.

NELSON: Maybe.

BROCOUM: You're correct. There has to also be feedback from design to site testing, because as the design alternatives are evaluated and we start to focus on design concept, we get a set of requirements, if you like, on the--one case, on different barriers, including natural ones, that will have to conform.

So you're correct, there should be--I will make a note to correct that in future charts, that there is a feedback from design to site program.

NELSON: Right, that came up in some of the figures of the panel meeting on Monday as well, that sense of the feedback.

COHON: Dan Bullen.

BULLEN: Bullen, Board. Actually along this same diagram, if you compare the feeds that you have from continued design and continued testing and conducting a laboratory and data gathering efforts, but then you go look at your timeline that basically says--and I'm quoting the date here--10/29/99 you have the complete information feeds from science and design to TSPA.

So basically that's the end point? Instead of having information feeds are you going to have to--

BROCOUM: That's not an end point, but PA--the PA people are at the very top of the pyramid, and certainly in doing PA that became very apparent. The PA people depend on engineering, they depend on science to do their PAs. They have to get some input to be able to proceed, and they have to get input.

Now information continues to come in. If it's consistent with the previous information I think we're okay; but if there's something new you've got to go back and have a feedback loop to do that. And we're very well aware of that.

In fact that happened often in the VA.

BULLEN: Okay, I wanted to reiterate that Lake mentioned that you have to kind of hold back the palominos here, and another analogy I know--I'm sorry about that--but it indicates here, I want to make sure that you have continued input all the way up until sort of the bloody end there, that if you get new data it's incorporated into your models and that you can--

BROCOUM: Yes.

BULLEN: --provide more justification for the technical bases for a decision at 7/01, which is your site recommendation.

BROCOUM: Just as an example, our actual final draft of the VA was complete on August 28, and we were incorporating new information right through I would say early August. In the Overview itself we were incorporating it--which is a more general thing--information right almost to the time of publication. So we were able to do that in this case, so I see no reason we won't be able to do that in the future here.

COHON: Debra Knopman.

KNOPMAN: Knopman, Board. I'm wondering in the spirit of integration if you were able to line up your planned major milestones schedule with what John Greeves showed us yesterday about the NRC schedule; and wondering if the NRC dates jive with what you've got. It seems like it's a little bit out of synch or phase, just from a quick glance.

BROCOUM: They should jive. Is John here--the NRC here? They should jive. I mean their work--

GREEVES: The SR date is the one I focused on, the license application date is the one I focused on; and in our arena, having a standard in place so that they have a target to design to, to do a performance assessment to, those are the key dates, and I think they do jive. I just got this chart. I will look at it and the next time I'm back they will--if they are not consistent I'll explain to Steve why they should be.

KNOPMAN: Okay, it seems a few things off by a few months, and things are tight enough that you might want to talk about that.

COHON: Richard Parizek.

PARIZEK: Parizek, Board. I'm looking at that same plan, major milestones, and I see all of the boxes that have been drawn in there. To what extent do the worker bees have to kind of provide information to meet those deadlines, have input into this?

I mean if you'd ask me "well I want to have that yellow star by that date," and then I'm out in the field trying to collect data, there's "no way I can deliver this stuff," so you really put a lot of pressure on the people. The VA must have been very demanding on science and engineering staff who would have otherwise been out learning more about the Mountain. You had to gather them all in and say "help us with this task."

So these checks really dry the system, and in an actual program we put that red star on the bottom, floating. They let that thing float. Maybe you want to remind us, can that red star float or is that fixed--and who fixed it--because this compresses the whole process; and then we worry about adequacy of the data and can you get it all in the time available, and how much staff time is committed to each of these boxes and stars.

BROCOUM: Let me talk from the VA and I'll move to this. In the VA there was a lot of pressure; in other words a lot of pressure from Lake to Russ and from Russ to me, and from me to the people that did the work. But we had what we called the VAIG, VA integration, which consisted of representatives from all parties--M&O, various parts of M&O, and DOE, and technical support contractor.

So we met once or twice a week, and we addressed these kinds of things in real time. If somebody said "I need another week" to do something and they convinced us, we gave them another week; and we took it elsewhere.

In the license application design effort we're doing the same thing. We have formed an LADSIG, which has met twice so far and is going to go as we do the LA. My guess is we will set up some kind of an organizational structure similar as we go on the SR.

In the planning we bring all the parties together, we debate these, we argue these things. It's done in an overall spirit of cooperation. It's never, I would say, done in the sense "You've got to be here July 1st," boom, end of argument, okay? It's always in the spirit of cooperation, and I say in most cases the parties on both sides agree.

There are some times they don't and we elevate it in management. It's like any--what happens in probably any organization. As much as we can we try to get buy-in from the people that are feeding the information, so they can get it done. But yes, there is a lot of pressure. It's not--

PARIZEK: But the VA star deadline is set. That star down there, deadline is set--

BROCOUM: Yes.

PARIZEK: --environmental impact statement--

BROCOUM: But--

PARIZEK: --some of these are pretty much--

BROCOUM: --as we're going through this--say I come in with "It's impossible to meet," or "we can't do it," my first thing is to go Russ, and say "Russ, we can't meet it." He's going to of course want to know why. I just can't say "we can't meet it," and he's going to just change it.

We'll have a big debate and we'll go to Lake.

That's how it works in the real world. But we will try to figure out a way to meet that anyway, before we ask for relief. That's in a sense our last option, not our first one.

COHON: Colin--on, I'm sorry, Lake.

BARRETT: Barrett, DOE. 3/02 date, the way those--we did those dates, and the process we used sort of as follows. We ended up--we started off back in '94. That used to be 9/01 I believe it was in '94 in the very first program plans.

The way we did that is we got basically Steve and basically the high command in the room--the science people there, the engineering people there, senior ones--went through and said "What looks like a reasonable plan achievable, given budget scenarios." We came up with the best, and then we said go back to the troops and do the planning exercises with those as targets to see how this works.

Some of those dates in the very first phase were sustained by the workers. Some were not, and we changed them. And this is a dynamic schedule.

The 4000 node things, it's dynamic--they change depending on what happens. Sometimes the work scope grows. Seldom does it shrink. Sometimes the money changes, sometimes the staff availability changes. We had budget cuts and layoffs and all kinds of things; we've had storms we've had to withstand. And on good reason we'd change them; and we do change them.

And I've gone back--some of these are secretarial control, some are my control. I say now "why can we not meet that," and he will have an answer--"Here's the situation." And we will change these dates if they need to be changed, but we will not change them, not for good reason kind of thing.

So it's a process: starts at the top, goes to the bottom, bottom comes back up, and the work plans are signed off by the engineers, the principal investigators each year, what the deliverables are, the contractor awards. They're all held accountable for these dates in a controlled dynamic manner. And that's how the process really works.

We have reserves and I'll ask Russ, "Why have you--if before you changed that have you examined everything, have you balanced it," just like I will--if I go to the Secretary and say "Sir, I recommend we change a date out there," he's going to say "Why?" And I'd better have a story and explain to him why.

I've never had a case before when we change that date, when we had a budget we changed the license application date. I wrote a thing up and explained to him why, because of the budget cuts of '96, and we changed it. And that was--but not without a basis in control.

COHON: In calling on Paul Craig, let me just say that we're going to limit questioning at this stage to five more minutes so we can move on with Dr. King's presentation.

CRAIG: Paul Craig, Board. Yeah, this is more in the way of an observation. We have a Swedish delegation here, and a couple of days ago we had a briefing from them as to how they're proceeding. Their program appears to be primarily science driven and public acceptance driven, whereas you've just described a schedule driven program--very, very different approaches to the same problem that perhaps represents different national styles.

And I'm just hoping that at some point you'll react to what you've just heard and give us some of your insights about this whole difference, perhaps not now, but at sometime.

COHON: Actually the U.S. program, if I'm following the metaphors, is a bunch of worker bees acting like palominos, creating--making porridge to try to meet a red star floating in the sky. It's a great image. I'm sure we'll be hearing from our colleagues in Sweden about this.

I have a couple of questions, one dealing with this diagram. Clearly there is a key decision point where the Secretary decides or not to recommend a site to the President. But not explicit in this--and I would like to know whether there is also a decision point before that where the OCRWM director decides or not to recommend the site to the Secretary; and if so, where is that?

BARRETT: Page 17. Put page 17 on the screen. It's there, follow that, right before the recommendation.

BROCOUM: On July 11 of '01 OCRWM completes the review and concurrence. In other words OCRWM, that's the director, concurs on that site recommendation.

COHON: Oh, okay, concurs. All right, I've got it.

BARRETT: And forward to the Secretary, just like in the viability assessment--Barrett, DOE--we recommended that the Secretary issue the viability assessment in their review.

COHON: I infer from this, and check me if I'm correct or not, that this is a decision point in the sense that the director, having looked at everything that's been collected, may say "You know, this doesn't look suitable to me, and my recommendation to you, Secretary, is not to recommend this to the President."

BARRETT: That could happen any day if we believe--

COHON: Okay, but the concurrent step applies--there's a formal point in this process where the director must say "Yes, I concur, this should go ahead," or not.

BROCOUM: Director, yeah--I don't have delegated that authority to make the decision. I'm delegated the responsibility to make a recommendation and a proposal to my superior, Secretary, to take an action on that thing.

And comment on Dr. Craig's comment, I would say this is a science driven program to a schedule. It's not scheduled for science second.

COHON: The other question I have is a big one, and one we'll be talking about I'm sure for months or years--and have already. But your very explicit presentation here really brings to the fore the question of uncertainty, which we just can ignore any longer, and we have to start getting explicit and quantitative about.

Your page 14 refers to a compliance analysis, compliance analysis with the DOE siting guidelines. What do the proposed guidelines say about uncertainty, how it will be quantified, and what role it will play in a decision? That is what does compliance mean in this case with regard to uncertainty?

BROCOUM: I just looked at Abe, who's sitting way back in the corner there, and he went like that.

COHON: But he didn't leave the room.

BROCOUM: He didn't leave the room. And as we speak, the lawyers are working on 960, which will be called I think 963 in the new version. Whatever the regulation says, our general policy has been to present all the information. In other words that debate that you had with Tim McCartin yesterday, you know, we would envision not only presenting the mean or the median with the 95th and 5th--and any other information we had. So our vision has always been to present all the information.

For example, if it's a 10,000 year, we will still present information beyond 10,000. So we have all that information will be available; will be in our technical basis document, whatever we happen to call it; and it is available in the current one. So we will put all the information out there and we will discuss it with all the parties that are interested.

So our policy is to be open and have all the information available; it will be on the Internet, it will be on--you know, available by all means that we can. So that's the best I can do in answer to your question now, because I don't know exactly what 963--

COHON: It's a good--

BROCOUM: --say--yeah.

COHON: --but one that I said that I'm sure we'll continue to discuss. I'm afraid we'll have to move on, but I'm sure you won't go away, Steve. I expect there will be more questions.

We turn now to a presentation by Dr. King as part of this still first presentation on the VA. And Dr. King, if you can, do you think you can limit your presentation to about 20 minutes? Okay, hang on, I don't think the mike's--oh, that's because you're not miked. Is 20 minutes enough?

KING: Yes, I will do my best to make it fit into 20 minutes.

COHON: Thank you.

KING: I will make it fit into 20 minutes. Well Steve has already relegated the viability assessment to the dustbin of history, but I'm going to talk about it anyway. I'm subbing for Rick Craun, obviously, who still has a very bad cold. I need to skip to 3 and then come back to 2 please.

As Steve mentioned, the viability assessment overall is primarily intended to be a progress report to Congress and the President, and to the public. So one of our key audiences, on the Overview in particular, is focused on Congress and the public, congressional members and staff, people generally interested in radioactive waste issues; and secondarily the broader policy community, and of course we knew the document would be of great interest to the Board, the NRC and the ACNW.

But because the Overview is specifically targeted toward congressional members and staff and the general public, it was written to be accessible to a non-expert, non-technical but educated audience. Now we can skip back to the first one please.

So therefore we thought that the Overview needed to provide information beyond what was in the technical Volumes 1 to 5 on the background of the program; specifically what is the nature of the problem we're dealing with, general introduction to the project that would not appear in the technical volumes.

We tried very hard to keep the language non-technical, to provide a glossary of the technical terms that we couldn't avoid using, and it was obviously a vehicle to present programmatic conclusions because we realize, as Dr. Cohon pointed out, that for many people the Overview would be the only document that would be read.

And I will use this opportunity to answer one of the Board's questions. Simply put, there are no conclusions in the Overview that are not also in Volumes 1 to 5. Now having said that, a little more on process as appropriate.

Volumes 1 through 5 were complete when the Overview was going through DOE headquarters review, and it was in the headquarters review that the final language about DOE considers that the site remains promising, work should proceed to support a site recommendation decision, that's where those final words were distilled in that back and forth with DOE headquarters in the final review of the Overview.

Then after those words were agreed upon, they were then put into Volume 1 to 5 to be consistent. So it was not a linear process of developing 1 to 5 and drawing all the conclusions there, and then writing them into the Overview. It was more of a iterative process.

For readability, and again recognizing that many people who have a limited interest or limited need to know wouldn't even read the entire Overview, would look at the results in brief and skip to the end. We summarized the overall results at both the beginning and the end of the document.

As I said, the text is written for a non-technical audience. We tried to maintain parallelism with Volumes 1 to 5 so we address the site information, PA, the design PA, the license application plan and the cost in the same order as in Volumes 1 to 5.

We tried really hard to make the Overview a readable document, so it's designed to be read in chunks. Specifically, if you open it up any two opposing pages are designed so that you can read those two opposing pages in one sitting between metro stops on a subway, if you will, get something out of it, understand it, be able to go back to it at a later time.

That approach to designing the document necessarily introduced some redundancy in the document which you will see if you just sit down and read it all the way through from start to finish. We thought redundancy in this case was okay. And of course we attempted to make it a coherent story if you do read it from front to back.

As I mentioned, we do provide background information in the Overview that is not in the technical Volume itself, some overview on the nature of the nuclear waste problem itself, the nature and types of waste that are destined for geologic disposal, where they are currently located, a brief history of the nation's history of dealing with nuclear waste disposal starting with the National Academy's 1957 report summarizing the major legislation which provides the framework that we work in, the NWPA, and leading up to the Energy Policy Act of 1992, and the National Academy recommendations and the pending regulations from the EPA.

We also provide a short answer of why Yucca Mountain--because that's obviously a question that many members of the public ask--this section on why Yucca Mountain parallels the site characteristics in Volume 1, and we talk about the basic attributes of Yucca Mountain that made it initially attractive to scientists in the late '70s, and that make it still attractive--namely it's remoteness, geologic stability, semi-arid climate, and an unusually deep unsaturated zone that enables a design in which the repository would be located well below the surface yet well above the water table.

We have a section on reference design which parallels Volume 2 of the Overview--of the major document, a brief discussion of the design process itself in which we point out the iterative nature of design, doing site investigations, developing preliminary design, running performance assessments, analyzing how how that works, feeding that back into the site program by identifying information needs, updating the design and continuing that iterative process. We've done that about three major iterations now and we're now beginning the fourth and final iteration.

It describes at a very high level what the current reference design, VA design is, describes what the surface facilities would look like, what their functions would be, waste handling, ventilation, support for excavation of the repository, describes the engineered barrier system, the VA reference design of having the in-drift emplacement of the large waste packages, dual layers.

It introduces the design options that are associated with the VA reference design, namely drip shields, ceramic coatings and backfill; points out the important fact that NRC regulations require retrievability of waste up to 50 years after waste emplacement operations have begun; and states that it's DOE's policy--was DOE's objective in designing the repository that it could support closure as early as 10 years after waste emplacement operations end--that would have to be with NRC approval--or for hundreds of years if society deemed it advisable to keep the repository open for hundreds of years. That certainly would require maintenance, but that is one of the objectives of the current reference design.

Important section on performance assessment which parallels Volume 3, a very high level description of how one goes about constructing a performance assessment model, collecting the data on the site processes that are important, constructing process models and then abstracting those process models into a total system performance assessment; introduces attributes of safe disposal.

In Volumes 1 to 5 these are called the four key attributes of the repository safety strategy. We didn't want to get into that terminology in the Overview in that level of detail, so we call it the attributes of safe disposal here, which are limited water contact, waste packages, long waste package lifetime, low rate of release of radionuclides from breached waste packages, and reduction in the concentration of radionuclides as they are transported from the waste packages.

We have one page in the Overview devoted to each one of those four key attributes, summarizing in layman's terms where we are now, what we think we know about each of these key attributes, what the uncertainties are about them, and what we're planning on doing about those uncertainties in future work.

We also present the mean peak annual doses that correspond to the TSPA base case, and we present some of the fifth percentile and other percentiles to help characterize what the uncertainty about those does is. And there's also a text box on that page to provide some context for the non-expert reader about what a millirem is or what does a 100 millirem mean. The text box describes what average background radiation is in the United States, just so there's some means of comparison.

Other safety issues--this is where we talk about potentially disrupting events, volcanism, earthquakes, human intrusion and nuclear criticality, and devote a paragraph to each one of those describing what our current assessment is of each of those.

And then it sums up with a What We Are Learning page, and this is where we make the point that the most important single factor affecting performance is the amount of water that directly contacts the waste. And therefore multiple barriers are important.

We make the point that Yucca Mountain serves well to limit the amount of water that could contact waste, but there is enough water to cause dripping after some time and the amount of that water is uncertain; therefore we need to have a system of multiple barriers, including engineered barriers.

We also state in there that--or make the point that only 0.2 percent of the inventory by--as measured by curies, is mobile and capable of moving at Yucca Mountain; nevertheless that small fraction is hazardous enough that it needs to be mitigated.

License application, this corresponds to Volume 4 of the VA. This section goes into some detail about what the licensing process is, what the process is envisioned in the Nuclear Waste Policy Act for recommending the site, what the State of Nevada's role is in that, what Congress's role is in that; and provides dates--as Steve just talked about--provides the dates of the major milestones to put all of this in context.

Operational safety outlines DOE's overall approach to ensuring operational safety in the repository design, and emphasizes the basic point that DOE is using all of the information it can or all of the industry experience that it can use that's relevant to design an operation of nuclear facilities, using the existing NRC reg guides to the extent that they're applicable, existing industry standards, and try to minimize the amount of novelty involved in the actual preclosure operational phase of repository operations; and also makes the point that DOE has a specific program to identify design basis events like earthquakes, external events like earthquakes, internal events like cask drops in a design program to assure that those design basis events will be accommodated.

Then it goes into long term safety, and here is a little bit of a departure between the Overview and Volume 4, in that in the technical Volumes 1 to 5 and in Volume 4 we talk about 19 principal factors of expected post-closure performance and summarize what we know about each of those, how important they are and what our plans are for gaining more information about that.

We decided that 19 factors of principal post-closure performance was a level of detail that was inappropriate for an Overview, so we rolled that up into three key objectives. It's no different; it's just described at a higher level, namely increasing understanding of key natural processes, specifically the movement of water in the unsaturated zone, the effects of heat on water and water movement in the saturated zone; evaluating ways to improve the design, including increasing design margin and defensive depth, evaluating design options and design alternatives which you've heard about earlier this week; and increasing confidence in the reliability of the performance assessment models.

Next. The section on estimated cost corresponds with Volume 5 of the VA. Quite simply we present the high level cost, estimated cost of licensing, building, operating, monitoring and closing the repository; and the key assumptions that those cost estimates are based on, including a license application in 2002, construction authorization in 2005, emplacement beginning in 2010 and extending through 2033; a capacity of 70,000 metric tons of heavy metal; and closure in the year 2116--in other words a 100 year operation period.

We also note that DOE is considering approaches that will enable the Department to reduce or levelize the annual funding requirements to knock down some of those funding peaks, probably at the expense of stretching out the program.

We also present total system life cycle costs in this document, and the only reason we do that is because we did not want to mislead the readers into thinking that the $18.6 billion repository cost would be the total bill for the national program to dispose of spent nuclear fuel, high level waste.

So we present the entire programmatic cost profile in this document, and it concludes with a description of a nuclear waste fund and a statement that the Department has determined that the current fees are adequate in a nuclear waste fund considering projected income and cost, assuming those funds are available to build a repository.

And then finally the concluding observations in the Overview, as I've already stated, based on the viability assessment DOE believes that Yucca Mountain remains a promising site for a geologic repository, and that work should proceed to the site recommendation decision.

We also conclude on this page that although 15 years of research is validated, many--not all, but many of the expectations of the scientists who first suggested deep unsaturated zone as a favorable location for disposing of high level waste, that performance of a repository over such long time periods cannot be proven; that there are irreducible uncertainties involved in the forecast of repository performance over such long time periods and these uncertainties can never be completely eliminated; but that the NRC's overall standard for licensing is reasonable assurance that public health and safety can be protected, and the Department believes that the work that is planned, if conducted, should lead to being able to demonstrate reasonable assurance in a licensing process.

And I think I was less than 20 minutes.

COHON: Thank you, Dr. King. Questions for Dr. King or Dr. Brocoum from the Board? Dan Bullen.

BULLEN: I was waiting for my colleague Paul Craig to ask this question, but I'll ask it in his stead if you don't mind.

NELSON: Excuse me, Bullen, Board.

BULLEN: Oh, Bullen, Board. I'm really sorry, Dr.

Nelson. I thought Dr. Cohon introduced me.

I have to admit to being one of the five percent of educational people that have surfed the Web and looked at the VA online. I also looked at the other associated documents that are there, like a fact sheet and a press release.

And I guess I'd like you to comment sort of on your last conclusion and observation, there's probably a caveat missing when there was the no show stoppers statement that was made by the Secretary in the announcement of the VA, in that that's based on the fact that you don't have a regulation. And so if you have a 10,000-year regulation there's no show stoppers, but if you go beyond 10,000 years, what's the VA's conclusion?

Tough question for you or for Dr. Brocoum there.

BROCOUM: The debate--we had a long debate on that statement that Jerry showed at the end, concluding statement, which is in the VA Overview. And the debate varied because there was a range of opinion as to what we should say; and the range of opinion went from a statement put in the positive to one in the sense in the negative. There was no show stoppers.

And so I truly say there was a range of opinion. This is how it was decided to go when we went to press on the VA and the Secretary decided to make the statement he made when he went public. We've seen the whole range within the

Department. But keep in mind that we're going through the license application design workshop and we are hoping to have a more robust, if you like, repository and waste package and overall system.

So based on what we know we see no reason not to continue. The bottom line is the program should continue because there is no reason we should stop; that if we can prove our design we should have a satisfactory site for a repository.

BULLEN: Bullen, Board. I agree with that. I was just wondering if there shouldn't have been a caveat in there that says "based on what we know about the regulations to date," or something like that; because it's always couched in that.

And if you look in your regulations section of the Overview you say--you tell us the history, but--and obviously you don't predict the future, but you do set things like your 25 millirem dose or the NRC's 25 millirem dose.

BROCOUM: Sure, and we realize the NRC at least has gone public with their--not their proposed draft but their pre-proposed draft, so we know what that regulation at least is saying, and they gave that presentation last night. We are working on 960, we had a proposed draft on the street about a year ago--EPA, we're still waiting on to see where they--how they come out. They're all--right--that all contingent on the regulatory structure finally getting in place.

BULLEN: Thank you.

COHON: Richard Parizek.

PARIZEK: Parizek, Board. I'm looking at the total cost of the project, and then we read the period 1983 to 1998, $5.9 billion spent. And this always creates a lot of anxiety around the nation as to where did all that money go. And in here you do point out that a lot of that money went into the exploratory tunnel and also in looking at nine sites all over the nation before you got to Yucca Mountain.

What percentage of that total dollar amount was really Yucca Mountain dollars? It's obviously one of the nine, but it would help to maybe put in perspective that not all of this money was spent at Yucca Mountain.

KING: I don't have that number. Is Rob Sweeney here?

BROCOUM: Believe the Yucca Mountain number is in the range of $2 billion plus.

KING: Somewhere around there.

BROCOUM: But I don't want to be--I know this is being on the record, so I want to try to qualify because I don't have the exact number.

PARIZEK: Is that in the main document? I didn't happen to dig it out to see, because I think the public in general needs to know the focused effort on Yucca Mountain has produced a lot for a limited number of dollars, relatively speaking, to this total for that 10-year period. I think it's helpful to understand that.

KING: You'd probably have to go to the total system life cycle cost estimate document itself to get that exact split, which is also available. It's not in the VA itself, that particular split.

COHON: Leon Reiter has a question.

REITER: I have two questions. I guess the first is Steve and/or Lake, about 960 or 963, as you say it's probably really important to get this criteria standard in there so people can know what they're working towards. John Greeves was indicating that they were trying to work to give you a standard also. I know you said you're going to try and get it out or decide by June.

Can you give us some insight as to some of the considerations that you're working with back and forth on the old version or the new version?

BARRETT: Barrett, DOE. Is this thing alive? On 963 will be the new number for the siting guidelines. That is because we're going to follow the EPA and the NRC, which we must do.

Now regarding the proposal from December of '96--if I've my year right, long time ago--we received public comment, we're going through those public comments and digesting that at this time and waiting to see what happens with the EPA and the NRC, what that will be.

So we will follow what they do in our siting guidelines. We would--ideally one would like to have had that years ago all set up, but it's not. But we are basically developing sort of the best available technology in both the natural sciences and also the engineering sciences to have basically a good repository as we can to perform over the long haul, and that's what we're doing.

So with the schedule, I doubt very much that milestone of June of '99 of Steve's will be met--quite sure it will not be met, I would say. Now what it will be, I don't know yet. We must have that in place before a suitability decision because that's what it's compared against.

COHON: I'm sorry to interrupt, but Lake is on a particular point about which there is a question from the audience. And you more or less answered this, Lake, but I just want to pursue it a little bit further.

Judy Treichel asks basically what happened to 10 CFR 960 and how do you get from that to 963? You talked about 963, but the first half of that is, is 960 gone forever? Isn't it still the applicable siting guideline?

BARRETT: It is the siting guideline. It remains the siting guideline unless it is changed. We have not decided--we proposed to change it, we got a lot of comments, some of those comments ranging from supporting the change to vehemently opposing the change. We are digesting those and deciding what we're going to do.

If the NRC has changed the number to 63, if we're going to change we'll change our number to 63. So it will be the DOE siting rule and it may be 960 and it may be 963 if we change.

BROCOUM: I believe that 10 CFR 63, the NRC regulation, will be site-specific. I also believe that we're going to keep 960--the lawyers aren't here, they're off working on the regulation--and if we were to start over to compare sites we would use 960. I think 63 is for the situation wherein we have a single site and need to evaluate it.

BARRETT: But again, this is--there is no agency decision regarding changing 960 or not. Right now the planning basis is that will be changed to be consistent with the EPA and the NRC, but that is under review; we've made no decision on it; that's a planning date there that I'm quite sure we're not going to meet even if we did change it.

COHON: Go ahead.

REITER: Yeah, just aside from which particular performance assessment standard you use, 960 has some additional requirements that the revision doesn't have, for instance ground water travel time, and also things like reasonable--I mean there's who bunch of things that are not related to the standard.

It seems to me that people who are working on preparing compliance should know whether they have to meet these standards or not, particular ground water travel time we know has always caused a lot of problems for lots of people.

BROCOUM: Leon, we are assuming right now that we have 960 in our planning.

BARRETT: And the saturated--as the VA says, and as the Board has recommended, we have work to do in the unsaturated zone and the saturated zone; that's why the Nye County drilling, et cetera. So we are working very much in those scientific endeavors.

If those scientific endeavors are against the existing 960 or if it's against a new one, whatever that may or may not be, the same basic science program serves all.

REITER: I have a question for Jerry King, if I can?

COHON: Sure, go ahead, Leon.

REITER: Jerry, the statement that you made about living up to the expectations of 15 years ago, I wonder if you could be a little more explicit and say what expectations you think have been met with respect to the site and what expectations you think have not been met or have not yet been demonstrated?

KING: I say a basic expectation that the amount of water is limited, quite limited at Yucca Mountain and other semi-arid areas of the desert southwest; that the unsaturated zone, a thick unsaturated zone provides a unique opportunity to site a repository at a location where it is not going to be immersed in water, where waste packages are not going to be immersed in water.

They may be dripped on--probably will after a time. They're not going to be completely submerged, which is the case for any site that would be in a saturated zone. It is geologically stable with respect to the time periods that we're concerned about. We're not stable compared to the Canadian Shield, but that stable with respect to the time periods that we're concerned about.

I think an expectation that was not met, and this is actually explicitly pointed out in the Overview, is that infiltration rates are higher than we initially expected. Percolation flux is higher than we initially expected. That's what comes to mind immediately.

COHON: One of our standard questions that I articulated at the outset was what uses of this volume should be avoided? Are there any?

KING: I would say just the point that you already made, that that is not a suitability evaluation. And we know there are some people who are tempted to treat it as such, and it simply isn't. It's a progress report and it means what it says.

We think the site's promising but there are significant uncertainties that remain to be resolved and need to be resolved before a suitability determination can be made.

I think that's the biggest caveat.

COHON: Thank you. Seeing no other questions--oh, Richard Parizek.

PARIZEK: Parizek, Board. About expectations, in terms of stability of a site, as you spoke, the news media and TV brings up the earthquake and this proves that the whole place is unstable and so on arguments, there's some question about clarity. Under what situation would earthquakes be damning to the site?

Obviously the one that occurred was not felt by people who were underground at the time we there on Monday, and so you could have earthquakes and it wouldn't necessarily threaten the site; but what kind of earthquake could you have and when should it threaten the site or design or engineering, safety concerns.

Can you kind of speak to that, because that's definitely a big issue in the news right now--

KING: Sure, be happy to--

PARIZEK: --itself would be a basis to throw the whole place away.

KING: I think what we would really consider to be unacceptable, and I would expect the NRC would consider to be unacceptable would be locating facilities where they have a significant probability of being subjected to actual fault displacement. There would just be no excuse for that. I mean we know you can find sites where you couldn't have to put up with that type of hazard.

We believe that the site has been investigated and mapped in enough detail. We dug a trench all the way across Midway Valley where the surface facilities would be located. There's no detectable surface offset at that location.

We believe we know where the active faults or potentially active faults are. The repository has been designed to stand off from them, and earthquake shaking, which we obviously can experience and will experience, is we believe a design issue rather than a suitability issue.

And we believe that we know enough about the earthquake hazard--or assume will know enough about the earthquake hazard to be able to formulate a design basis that will stand up to regulatory scrutiny; and that the engineering expertise and knowledge is sufficient to design any critical components of the repository to withstand earthquake shaking.

PARIZEK: Parizek, Board again. So shaking by itself obviously can be tolerated providing you can include that in design. On Monday I didn't think I heard too much specific discussion about the magnitude of shaking that needs to be designed for, and then exactly how that design would be accomplished. And that may have been discussed during the two-week workshop.

I guess more clarity needs to be given to us because I guess if you heat up the rock and then you have shaking, is that different than if you didn't heat up the rock, and on and on--all of those kind of open ended discussions come into play on earthquake stability. Surely the motion itself isn't necessarily a problem.

You could design for the motion is what you're saying, and there's no active faults you say--and there are faults, but they haven't been shown to be active in some long timeframe.

KING: Well there are--be a little more clear. We have the Bow Ridge Fault for example, which bisects the repository block. There is no evidence of quaternary movement on that fault, but there's also a lack of alluvial cover that would enable you to make that determination with high confidence, because we know the bounding faults, Paintbrush Canyon, Solitario Canyon, Windy Wash, are active faults, we assume that Bow Ridge could move. Therefore we stay away from Bow Ridge in the waste emplacement area.

COHON: Alberto Sagüés.

SULLIVAN: I'd like to add something to that please, Tim

Sullivan?

COHON: Just one minute. Could you identify yourself again?

SULLIVAN: Tim Sullivan, DOE. Just for the record, hate to correct my colleague, Jerry. There is evidence of quaternary movement on several of the block bounding faults in the vicinity of Yucca Mountain, including the Bow Ridge Fault. I'll discuss that briefly in my upcoming presentation.

COHON: Okay. Thank you. Alberto Sagüés.

SAGÜÉS: Very good. I got impression during the panel meeting Monday that the reference design as described in the VA Overview and the other documents, maybe does not provide defense in depth, the definitions that will be understood in here, or would you say that it does provide defense in depth?

KING: That question per se is not addressed in the viability assessment, but I do believe that is the way we are headed. Dennis Richardson's presentation which showed one rem, 1000 millirem doses in the case of neutralizing the waste package, I think most people would agree that's unacceptable. And that probably the reference design that's in the VA, unless it were augmented with one or more of the design options, probably would not provide adequate defense in depth.

I don't think we would--knowing what we know now--

would put forth the VA reference design without design options as a design that we would like to license.

SAGÜÉS: Thank you.

COHON: Donald Runnells.

RUNNELLS: Runnells, Board. Something you said a moment ago caught my ear when you were talking about the earthquake hazard. You said that we know enough or will know enough very soon to design a repository to take account of the earthquake hazard.

You also said it would be inexcusable to put the waste packages near a fault that might move. Those are very positive kinds of things. They go directly to the design and to, if you like, optimizing the design to avoid the earthquake hazard and the faulting hazard.

Let me ask you what you think about the seepage hazard, the seepage of water into the repository? I know we don't know enough at this point in time to sort of design around that. In other words we don't know enough about the flow paths to make sure we don't put a waste package under a flow path. Is that right, we do not know--

KING: I agree that knowing the details of the mountain to the extent that you could predict where particular drips are going to occur is probably unattainable.

RUNNELLS: Okay, that's the rest of my question. Do you think it's attainable to know enough about moisture seepage to be able to incorporate that into the repository design?

KING: First let me caveat my answer by saying I'm not a hydrologist. I'm a seismologist which is why I was answering some of the earthquake questions in detail. But my understanding is no, that you would have to--you simply cannot predict a flow path of water. There's too many fractures, they're too tortuous.

There's just no way that you could do that, and furthermore the drip patterns may move around. You may get mineral deposition that would plug up a certain path and the drips would move to some other point.

So I personally don't think that there's any way you're going to be able to deterministically predict where particular drips are going to occur.

RUNNELLS: This probably isn't the time to ask anybody from the USGS to comment on that, but I gained a more optimistic view from some of the USGS people when I visited the site about 10 days ago, in the sense that they're beginning to recognize what controls the flow paths of moisture. Maybe sometime during the course--

KING: I hope I stand to be corrected. They've got new information; you're obviously more up to speed on that than I am.

RUNNELLS: Well if--

KING: They'd have to convince--

RUNNELLS: --USGS people in the audience would like to grab me on a break, I'd be--

KING: Oh, here comes one.

COHON: Let Bob Craig from the GS--

CRAIG: Bob Craig, I'm the technical project officer for the GS, and to answer--the last thing I heard, "would like to grab"--not really, but I will. I think we're somewhere between.

I think there is high value in the information that we have learned and are learning, and assume we will continue to refine in the next couple of years, the processes--the alcove one stuff, the amount of water that's coming into the system or putting in artificially, where it's coming out.

This certainly can help refine, define and refine the design to be able to predict as you look--as you map a section of tunnel or a drift, an emplacement drift, and say "that fracture up there in the crown is going to drip, and the next one down isn't."

We don't have enough money in this program to ever refine it and understand to get to there, but I think we can provide value in terms of the processes in defining likely places and more concentration of the water versus others. To that extent I think we can impact it.

RUNNELLS: And your last sentence answered my next question, namely zones of moisture seepage may be identifiable and perhaps you can design the repository in such a way you take advantage of that. That is the most likely zones of seepage, the greatest water flux will be recognized and incorporated into the repository design, or could be.

CRAIG: I believe we can provide some value to that design process.

RUNNELLS: Okay, thank you.

COHON: That's a nice upbeat note on which to conclude. Our thanks to our presenters this morning. We will take a break now for 15 minutes. We will reconvene at 10:30.

(Whereupon a brief recess was taken.)

COHON: We will not continue the presentations on the viability assessment. Having heard the presentation on the Overview volume, we now turn to Volume 1, Introduction and Site Characteristics. Tim Sullivan from DOE will present.

SULLIVAN: Good morning. I'm going to give you a summary of what's in Volume 1 of the VA, and I'm going to focus particularly on section or chapter 2 on site characteristics.

The first part of Volume 1 is the introduction, and it provides information on waste forms, the history of the program, the regulatory framework with which the program operates, the organizational structure that DOE uses or did use to manage the program at the time the VA was issued, and a description of the key components of the program introducing the repository safety strategy.

The repository safety strategy is introduced in Volume 1 because it provides an organizing theme that is used in the subsequent Volumes of the viability assessment, particularly in the LA plan where the repository safety strategy is described in more detail, and finally in a separate repository safety strategy description document that provides additional detail.

I'm going to move quickly now to section 2--chapter 2, excuse me. Chapter 2 provides an overview and description of the characteristics of the natural setting at Yucca Mountain. Now the appropriations act itself and DOE's program plan in describing the viability assessment did not explicitly call for a description of the natural setting of Yucca Mountain.

We felt however that it would be useful and helpful to include an additional volume in the viability assessment to provide background for the design chapter, the design Volume 2, and for the performance assessment that's described in Volume 3.

Chapter 2 consists of seven sections, as you see here: geology, climate, unsaturated zone, saturated zone, radionuclide transport, and the effects of repository construction and operation, and disruptive events and processes: earthquakes, volcanos and human intrusion. This organization is parallel to that which is found in the site description, which is our comprehensive treatment of our current understand of the Yucca Mountain site.

In Volume 1, in each of the seven sections we provide a comprehensive but not a detailed description of our current understanding of the features and processes that could affect the site's ability to isolate waste. It's technically accurate and defensible, but it's written at a level that we hope will be understandable to the non-technical reader, to members of the general public.

In addition to description of our current understanding we include a brief statement of the issues and concerns identified by the NRC and a brief summary of the current status of site investigations and planned work. Of course Volume 4 contains a thorough treatment of DOE's planned work between now and the license application.

Now I'm going to step through each of the seven sections here and provide you some highlights of the information that's contained there. First in the geology section, the stratigraphic and structural features of the site are well known and are incorporated in the integrated site model that forms a consistent framework for the process models that describe the natural processes, and as well provides a consistent basis for repository design.

The model is built from surface mapping at several scales, from underground mapping of the tunnels and the drifts, and from bore holes that have been drilled since the late 1970s at Yucca Mountain.

The description of fractures with respect to rock characteristics and geologic structures is generally understood. For example the density, connectivity and conductivity of fractures is greatest in the non-lithophysal welded tuffs and least in the non-welded tuffs, with the welded lithophysal tuffs attenuating the fractures and having properties intermediate.

In terms of geologic structures the influence associated with faults in the underground is one to seven meters; that is the influence on the fracture sets by the fault zones exposed in the ESF, and not the cross-drift now, is one to seven meters.

Finally, the potential repository host horizon which will support construction of stable openings is of sufficient lateral extent, and located sufficiently above and below the surface, to support repository construction at Yucca Mountain. It's located in the middle and lower Topopah Springs welded units.

The locations of block bounding faults are well defined. They are restricted to areas outside the potential repository block. I should say more exactly that the repository block is located in the areas in which the block bounding faults do not exist.

Alternate tectonic models are compatible with available data and are considered in assessing geologic hazards, particular seismic hazards. Such tectonic models assess the subsurface geometry of faults at Yucca Mountain which are not amenable to direct evaluation.

The principal tectonic models considered a planar fault model, allistric fault model in which the fault's shallow at depths--shallow in dip at depths of two to six kilometers, and a buried strike slip fault model.

Also in this chapter, long term erosion rates a Yucca Mountain are low, approximately a tenth to a centimeter per thousand years. This is based on several lines of evidence, including cosmogenic exposure ages of bedrock on hill slopes at Yucca Mountain, and rates of downcutting of alluvium both in Forty Mile Wash and in Midway Valley to the east of the repository.

The climate--the Yucca Mountain vicinity is currently semi-arid with annual precipitation averaging about 170 millimeters per year. This information comes from weather stations that have been established at Yucca Mountain.

Evidence of past climates in the Yucca Mountain vicinity indicate that the area was often wetter and cooler than today. Such evidence includes paleodischarge sites at which springs flowed in the past, and they represent higher elevations of the water table.

Vegetation found in pack rat middens such as junipers, pines and firs; these pack rat middens span a period of 10 to as much as 50,000 years ago. The creosote bush which dominates the landscape today did not appear until about 4,000 years ago.

Over the last 500,000 years conditions have been glacial over about 80 percent of the time, and interglacial similar to today for only 20 percent of the time.   Future climates a Yucca Mountain will likely be similar to those in the past, wetter and cooler. Future annual precipitation may be double or triple that observed today.

UZ hydrology--Yucca Mountain exhibits a thick unsaturated zone; provides a key barrier to limit water available to contact the waste. Available data support an infiltration model indicating that infiltration varies spatially across Yucca Mountain and ranges from zero to 40 millimeters per year, with an average value of about seven millimeters per year, as described in the VA.

This infiltration model, together with climate estimates, indicates infiltration will increase by a factor of seven to 20 under conditions of greater precipitation expected in the future.

Multiple approaches to determining percolation flux at the repository horizon yield values ranging from .1 to 18 millimeters per year. Six different lines of evidence are described, including temperature and heat flow, matrix saturation, carbon 14 equilibrium, perched water volumes and residence times, and two approaches to chloride mass balance.

This percolation flux occurs through a combination of fracture and matrix flow. Some fraction of the flux moves downward relatively quickly; much of it, however, travels more slowly.

In the PA treatment in Volume 3, six spatial areas of the repository were assigned differing values of percolation flux based on this UZ model. They varied between 3.7 and 11 millimeters per year. Detailed mapping of fracture fillings in the underground have provided some insight into the fraction of flux that moves through fractures.

For example, nine percent of the fractures in the ESF contain calcite fillings. This suggests that there is a limited number of interconnected continuous pathways at Yucca Mountain.

The Ghost Dance Fault contains no more abundant calcites than the surrounding rock, suggesting that it has not been a major pathway for water movement, although there is so me bomb pulse chlorine 36 associated with the Ghost

Dance Fault, which suggests there may be some past patterns.

Current data support a model of unsaturated zone flow that yields a percolation flux that varies between one and 20 millimeters per year. Perched water is probably common throughout the site near the base of the Topopah Springs or in the Calico Hills, and may indicate some lateral diversion of flow, down dip to the east or southeast from Yucca Mountain. Adjusted carbon 14 ages of the perched water range from 2,000 to 6,000 years, indicating a post-glacial origin for the water.

The tertiary volcanic section at Yucca Mountain has a composite thickness of approximately 6,000 feet. 4,000 feet of that section lies below the water table, and for the purposes of saturated zone hydrologic modeling has been divided into four hydrogeologic units: two aquifers and two confining units. The aquifers generally consist of welded tuffs or lavas that are fractured. The confining units contain moderately welded or unwelded units that have been altered.

Regionally, the underlying carbonate aquifer and the valley fill aquifer beneath the Amargosa Desert are also important. Hydraulic tests in the volcanic rock suggest fractures are more important than rock type in determining conductivity. For example, multi-weld tests at the C-wells yield transmissivities that are 100 times single well tests, suggesting that as larger rock volumes are accessed more fractures are identified. More fractures contribute to flow.

The regional saturated zone model is limited by sparse data, but it indicates that water from Yucca Mountain flows to the southeast toward Forty Mile Wash and then south-southwest toward Amargosa Valley.

Mineralogic and paleodischarge studies indicate past water levels at Yucca Mountain have been no more than 60 to 130 meters higher than present, meaning they have never been closer than 100 meters to the repository level.

This is based on evidence from the elevation of the vitric to zeolite transition in bore holes at about 100 meters, and from reconstructions of water table elevations based on paleodischarge sites at Lathrop Wells, again indicating water level changes of about 100 meters.

Radionuclide Transport--the range of solubility for key radionuclides has been determined for expected conditions int eh repository. In table 22 in Volume 2 you will see a range of solubilities for americium, plutonium and neptunium. The solubilities vary with environmental conditions over several orders of magnitude.

Absorption coefficients have been determined for key radionuclides, and three principal mineral groups may function as barriers to radionuclide transport. Zeolites are the most continuous and well defined, clinoptilolite and morganite; clays and smectites are not as abundant, but are widespread, and exhibit a strong affinity for plutonium. Magnesium oxide is less abundant, but it is common in fractures, and some recent evidence suggests strong neptunium interactions that may contribute significantly as a barrier at Yucca Mountain.

A 3-D mineralogical model based on site data indicates that zeolitic altered zones are present between the proposed repository and the water table that defines the thickness and areal extent of those units, and it's incorporated in the integrated site model. Work continues to determine the effects of colloids on transport.

Ongoing work is focused on better understanding that concentrations of colloids that are or may be available at the repository and below; better understanding the reversibility of colloid absorption, and analyzing examples of colloid transport from the NTS for their application to Yucca Mountain.

Potential effects of repository construction and operation--thermal effects on rock properties have been characterized for Yucca Mountain tuffs through lab testing. Thermal effects on the hydrologic system at Yucca Mountain may include dry-out zones caused by the boiling of water. This is a transient effect that lasts hundreds to thousands of years.

The maximum vertical extent is about 100 meters, or approximately to the top of the Topopah, with the result that relative humidities are lower than ambient conditions. Condensation zones--these are zones where the saturations exceed ambient conditions.

And alteration of fracture properties affecting flow--stress redistribution from the heating and expansion of the rock mass are expected to affect fracture properties. Thermal effects on the geochemical system may include redistribution of silica in the unsaturated zone, principally by dissolving quartz or chalcedony in the fractures, resulting in opening and closing and redistribution of the fracture fillings.

Changes in the sorptive properties of the zeolites, their ability to absorb decreases with temperature, leading to the design requirement to limit temperature at the top of the--at the base of the Topopah to less than 90 degrees C. And alteration of water chemistry, as the water evaporates as a result of its heating, solutions will become more concentrated and calcite will precipitate.

COHON: If we could move quickly through the rest--

SULLIVAN: Okay--

COHON: --questions. Thank you.

SULLIVAN: Okay, I just have two more. The final section of chapter 2 assesses potentially disruptive events.

We completed a probabilistic analysis of volcanic hazards involving an expert panel from within and outside the project, and the results of that analysis indicate that the annual probability of a volcanic event disrupting the repository is one and a half times 10 to the minus 8. The hazard investigations at Yucca Mountain are now closed, as we believe further information is not likely to reduce uncertainties in that estimate.

A probabilistic analysis of seismic hazards integrates ground accelerations of .17 and .53 G respectively, have an annual probability of being exceeded of 10 to the minus 3 and 10 to the minus 4, for a reference rock outcrop.

I want to be careful to point out here that these results at a reference rock outcrop do not--are not the seismic design basis for the surface facilities. Our investigations of ground motion side effects at the surface facilities continue, and need to be completed before we finalize the seismic design basis--which will be higher than those values.

For the first time that I'm aware of, we've completed a probabilistic fault displacement hazard for a civil engineering facility. The results of that assessment indicate that fault displacement hazards are low except along the primary block bounding faults.

Away from those faults within the repository block, within Midway Valley, displacements with a 10 to the minus 5 or one in a 100,000 annual probability of being exceeded are tenth of a centimeter or a millimeter or less. This includes areas of the Ghost Dance Fault, the Sun Dance Fault. These should not be a concern then for waste emplacement or for seismic design. For the block bounding faults potential displacements at an annual probability of 10 to the minus 5 are 7 centimeters and 32 centimeters.

An economically viable natural resource potention at Yucca Mountain is low. The evaluation included metallic resources such as gold and uranium, industrial minerals such as building stone, clay, fluorite and oil and gas resources.

So in summary, section 1 of Volume 1 provides background information, and section 2 is a summary of our current knowledge of the geologic--of the natural setting at Yucca Mountain, but it is not a detailed technical discussion and it should not be regarded as such. That discussion is found in the Yucca Mountain site description which is currently available on the Internet and will be available in hard copy soon.

I have included at the back of your package a series of five figures out of chapter 2 which I don't intend to discuss today, but they're available for your information. Thank you.

COHON: Thank you. Questions from the Board? Debra Knopman.

KNOPMAN: Knopman, Board. Tim, can you--let me do this question in phases. Is there any other place in the United States or in the world that you're familiar with that has similar hydrogeologic properties that has been characterized in the way that Yucca Mountain has? Is there any comparable study of this step in any other place on the Earth that you're aware of?

I'm trying to develop--trying to establish the notion of baseline of what's adequate information and how one proceeds to make what you have better.

SULLIVAN: I don't know that I can answer that question.

KNOPMAN: Okay, well let me--

SULLIVAN: I can get you answer if you'd like, or we could table it for--

KNOPMAN: I think it would be good to have that in the record just in terms of some standard here. But how do you--how should one read this Volume in terms of understanding the completeness of the characterization?

What yardstick do you use or do you suggest for determining how much is enough in terms of understanding the site, and to the extent you see gaps how do you anticipate they're going to be filled?

SULLIVAN: You will not find that in Volume 1. It's intended to capture our current understanding.

In Volume 4, as you will hear later today, we have evaluated our current understanding of the natural and engineered systems at Yucca Mountain, we've identified where we think we need to be at the time of the license application, and we've used those assessments conditioned by our understanding of the importance of each of these factors to performance assessment in prioritizing the work and identifying the key data caps.

COHON: Could I just give one specific instance that to some extent takes issue with what you just said? Maybe it doesn't; you maybe perhaps can explain this away. I may have this wrong, but on your slide 6, your first bullet was "The stratigraphic and structural features of the site are well known and are incorporated in the..." et cetera, et cetera, et cetera.

And if I followed it appropriately yesterday, I thought I heard in a report on current work in the cross drift that we discovered structural features that we weren't aware of, that we could not--did not know of from our exploration from the surface.

So how do I reconcile, if I have that observation correct by the way with regard to the cross drift, how do I reconcile that with your statement?

SULLIVAN: Yes, there are several minor faults, if that's what you're referring to, exposed in the cross drift that are not mappable at the surface. And we understand and would expect that there will be features beyond the resolution of the mapping and the drilling data that will be present in other drifts that are constructed at Yucca Mountain.

However my view would be these features are not significant to the geologic setting or probably to the hydrologic setting.

COHON: So this goes to the point, how much is enough? We recognize you could study this site forever--

SULLIVAN: Right.

COHON: --and still discover more probably with more study. So--but I accept your comment also, but this Volume is not the place to address that.

SULLIVAN: As you will hear, performance assessment is the tool that we use to identify--is the tool we will use to identify the impact of additional work on reducing uncertainty. And that forms the basis for our prioritization of the work to be done.

COHON: Debra, did you finish?

KNOPMAN: Yeah.

COHON: Richard Parizek.

PARIZEK: Parizek, Board. A different tack on this would be the infiltration and percolation flux issue, and some more recent discussions by survey, USGS members about the magnitude of the numbers that are being used in VA versus some other opinions.

Elaborate a little bit on that, as to how that maybe important in the work that still remains to be done, characterizing infiltrations. That's a critical part of the whole dripping issue and the rate at which counter schist may come apart and cause problems for us.

SULLIVAN: Well I'm not aware of the comments the Survey made yesterday. I'll ask Bob to respond to that. What I've presented here comes from chapter 1 and indicates that the available lines of evidence support a wide range, as much as two orders of magnitude for percolation flux. And that is treated in the VA through some sensitivity studies, and in chapter 3.

We do believe that our knowledge--as you'll see in chapter 4--we do believe that we can continue to reduce that uncertainty through additional data collection, specifically seepage tests in niches and the drifts, and the cross drift. And so we have prioritized that work to attempt to reduce that uncertainty and provide greater confidence in our best estimate of the infiltration.

Bob, do you want to add anything to that? I wasn't here yesterday.

COHON: If you could identify yourself again for the record.

CRAIG: Bob Craig, USGS. I'm afraid I'm going to have to maybe get a quick recast of what you heard from other Survey people yesterday, because I did miss a good portion of the Board meeting yesterday. I was--John Greeves was sitting next to me--I was at Scientific Notebook training yesterday afternoon, the first part of the afternoon.

I wonder if I could get you to maybe kind of paraphrase?

PARIZEK: I think--Parizek, Board--Debra, you asked that question and I thought you got a response. Can you remember whether you were happy with the response?

KNOPMAN: No. Why don't you--

PARIZEK: Well, maybe just bring us up to date in terms of some of the thinking of some members of the Survey that I guess have a position, suggests the mountain could be dryer.

SULLIVAN: Can I ask for clarification?

COHON: Sure.

SULLIVAN: Did you hear information that suggested that the percolation flux was outside of the range that's presented in the VA, point 1 to 18?

PARIZEK: No, inside.

CRAIG: I'll admit I'm struggling a little bit with it. The only thing I can think of that would have a tag of USGS on it is something that was done outside of our branch, which was a review done on behalf of the director of the Survey for providing the director a recommendation should the director be queried about his position, what did he think about the viability assessment.

The review panel that looked at the viability assessment and provided that recommendation to the director did feel or does feel that the future climate input to TSPA is wetter than they might expect, and of course that then ripples down throughout the system if you were to go with what they believe.

And quite frankly, that's the only thing that pops to my mind that falls into this vein of perhaps dryer than we were looking at.

COHON: Richard, let me suggest that if we want to pursue this further we do it later. That will allow Mr. Craig to be informed of what happened yesterday rather than having to guess.

Paul Craig.

CRAIG: Paul Craig, Board. On the sequence that begins on page 6 that you have here and extends through page 10, there are some 14 different points made.

A rough review of those shows that 13 of those points relate to the geological characteristics, infiltration characteristics and the like, and one of them--the one at the bottom--is the only one that refers to assumptions about what you might actually put into the mountain.

And implied in that last one is an implication where you say "sufficient lateral extent," there is an implication of some kind of an assumption regarding the heat loading. Now as you recall, the heat loading is a matter of considerable interest to the Board, and my question to you is how low a heat loading could you go to such that that statement would remain correct?

SULLIVAN: 25 MTUs. Remember the natural setting discussion here was intended as background for the VA, which assumes a reference design that you'll hear described in a minute by Dan. That's a 70,000 metric ton repository high thermal load.

As described in the site characterization plan, there are expansion areas available in the same rock units to the west, to the east, and to the north. So considerable areal expansion can be accommodated at Yucca Mountain.

COHON: We're going to have to--

SULLIVAN: That is not discussed in the VA, however.

COHON: Sorry. We have two more questions and then move on. Priscilla Nelson.

NELSON: Tim, can--and I have not been exhaustively through this Volume yet, but in your reference you have reference to models and other sources of information that derive the conclusions.

Throughout there's been input from data and also input from expert elicitations. To what extent is that nature of that input clarified in terms of where these values are coming from that become part of what you present as license site characteristics?

SULLIVAN: Volume 1 presents the results of DOE and other investigations. The expert elicitations consider that information and other information that the experts considered appropriate to come up with specific key parameter values and uncertainty in those parameters. That was input to TSPA.

So that is discussed in chapter 3.

NELSON: So the information in this Volume is just the facts, and it's not including derivations from expert elicitations.

SULLIVAN: Correct. But it's intended to describe the information that the elicitation panels had in front of them as they continued their elicitations.

COHON: Debra Knopman.

SULLIVAN: That and its references. I mean as I said, this is not a comprehensive tool, not a detailed treatment.

KNOPMAN: Knopman, Board. Just a point of clarification about your statement of the relative fraction of flow going through fractures versus matrix, you talked about the nine percent of fractures that contain calcite. But what can you say about volumetric allocations of percolation flux through fractures versus matrix?

SULLIVAN: Well as I said, the secondary mineralization in the fractures gives us an indication that water has flowed through those fractures in the past. And a relatively small percentage of fractures that contain calcite suggests that the fracture system isn't interconnected.

That doesn't get at the amount of water that moves through fractures versus through the rock matrix. I mean our early conceptual models at Yucca Mountain had significant proportions of percolation flux flowing through the matrix as a result of suction from fractures.

Chlorine 36 and other evidence suggests that there are fast and continuing flow paths from the surface to the underground, that suggest that there are some volumes of water that move quickly through fractures and avoid imbibation into the matrix.

However the UZ flow models constrained by the six lines of evidence that I mentioned do put limits on percolation flux, and on the volumes that can flow in fractures. But I don't know what those limits are.

KNOPMAN: You don't know--perhaps someone could provide that information to us so we know exactly how the model is limiting.

SULLIVAN: I think Abe is going to address that in chapter 3, the proportion of matrix to fracture flow is an important sensitivity study in the TSPA/VA and he'll provide some information.

COHON: Thank you very much, Mr. Sullivan.

We turn now to Volume 2, Preliminary Design Concept for the Repository and Waste Package, with a presentation by Dan Kane. We would ask that you limit this to 15 minutes please, so we have time for questions.

KANE: Is this thing on? Yes. Apologize for that.

COHON: Probably needed the wakeup call.

KANE: Everyone's awake. Mr. Chairman and distinguished members of the Board, and ladies and gentlemen, it's a pleasure to be here with you this morning to share a few thoughts on what we were doing with Volume 2 of the VA design.

There's been a lot of discussion as to is this the design, is this a good design, is this a bad design. We'll I'm an old engineer. I've spent almost 30 years doing engineering, and to go back to some of the things we learned earlier when we were engineers, I'd like to ask you a simple question, all of you in here.

How many of you drive the best car? All right, we've got--and what kind of a car do you drive?

SPEAKER: A Volvo.

KANE: What kind--what kind of car do you drive, Tom?

TOM: BMW.

KANE: Well, then I think we've got a problem here, don't we, ladies and gentlemen, as to who has the best car.

The rest of you who do not drive the best car, are you somewhere significantly dissatisfied to terribly dissatisfied with the performance of your car? Would you raise your hand?

SPEAKER: At times.

SPEAKER: Currently.

KANE: All right, we have one brave soul. So what we have here then is a lot of people, none of whom except for two, drive the best car; they can't agree what's the best car; and the rest of us who admit we do not drive the best car are reasonably satisfied. I think you guys know where I'm going with this conversation.

One of the things we have to keep in mind is that we have to have a good design, we have to have a defensible design, we have to have a design that we as DOE are confident will work. We have to have a design that we have confidence in, that we can convince the NRC and they can come to the same conclusions that we have.

Right now we have something called a reference design. We present it in the VA. And no doubt everyone on this Board could look at that design and say "Ah, okay, but I could make it better if I tweaked it here. It's pretty good, but I can make it better if I tweaked it there."

And after everyone was through with their tweaking, if we don't integrate these things correctly, we have one of those types of cartoons you see in the engineering magazines about what the client really wanted, and here's this complex Trojan Horse that was actually built instead.

So these are just some caveats that I wanted to address up front, that is to reconfirm that we have a VA reference design. We're not saying that that is the design and we're finished, but by the same token we don't want you to think we came to that design simply because a stork dropped it off on our front porch. Thank you.

Could you go to about--let's do one more? Okay, I'm not going to go through all this where you can read it. It's in Volume--next Volume--thank you, John--it's in the next slide. It's in the VA in Volume 2 in quite a bit of detail.

Now one of the things I mention to you is that this design we currently have did not get dropped on our front porch by the stork. We have come a long way since we developed the site characterization plan design and the advanced conceptual design.

Millions of dollars have been spent in looking at materials, in looking at design features, and evaluating material--evaluation design features, conducting TSPA so that we could move from where we started when this project was given to DOE in 1982, so that we could move out and make progress--keeping in mind coming to a focal point at some point in time.

One of the things that we've done that's significantly different from our earlier designs is we're now using mechanical excavation. We had earlier planned to use drill and blast. Courtesy of the Board at that time you and your predecessors suggested that we go to mechanical means, and indeed we did. We feel that's made some significant improvements.

In 1992 the Department came up with a multi-purpose canister concept which took us by necessity to a large thick wall, heavy waste package. Prior to that time we were looking at a thin wall, about 5/8 of an inch, much smaller waste package that would be put in vertically into bore holes. So that's been another aspect of the change, going to a larger waste package.

I hate to get to this one with Dr. Bullen in the audience, but nevertheless I shall persevere. Earlier designs were spent fuel rod consolidation. We're no longer looking at that as part of the reference design, but we are evaluating it as part of our alternatives.

We felt at that time that the experience the industry had with regard to rod consolidation was a little--well, I'll be honest--it was significantly less than what we thought it was going to be.

We did some rod consolidation in about four plants under 5059, which is the NRC regulation, and we were expecting great things and the great things didn't materialize, and that's why we went to increased density of spent fuels storage racks and the pools, as well as subsequent to that--when that ran out--to onsite dry storage.

As I mentioned earlier, we now have a very robust waste package design, thick walled, dual material for defense. With regard to the design and layout of the repository, the repository host horizon area, the earlier design had a ramp that had a six to eight percent grade. We couldn't use ordinary industry type of railroad equipment.

We have subsequently changed that and we now have in our emplacement drifts something on the order of about a two percent grade, and we can use standard railroad technology, standard railroad equipment. We think that's been a significant improvement. And we've extended the retrieval period and the service life.

These are things I'm sure you're familiar with, the size and the buildings that we're going to use. We'll say a little more on that later.

This is a figure from Volume 2. It shows the radiologically controlled area here in pink. It shows the carrier preparation building as well as the waste treatment building, which are both prominent buildings in our mission.

The carrier preparation building of course is a non-containment building. The reason it's non-containment is the head of the incoming transport cask is never taken off. What we do in the carrier preparation building is we remove the personnel barriers which are on there to prevent somebody putting his or her hand on the cask and receiving a nasty burn, and we also remove the impact limiters. We conduct HP work in that area too. Then when the cask has been made ready, then we send it off to the waste handling building.

Now the waste handling building is a containment building because in that building we will be taking off the head of the transport cask that's coming to the site. We will also be handling fuel. This is going to be done in shielded areas, whether it be the pool or whether it be the dry transfer cells. It will be done remotely when the head is off.

And we have a segment HVAC, radiation control and monitoring, for the various areas, with the affluent monitoring, the ability to run through HEPA filters to filter out any particulates that may get involved.

This is a plan view of the waste handling building. We have three lines for individual spent fuel assembly, handling; we have three pools, then after the cask is unloaded at the pool the fuel is transferred to baskets, the baskets are sitting on an incline plane much like you're familiar with BWR--for those of you that are--up to a dry transfer cell, assembly cell, where the assemblies are picked up individually one by one and transferred into the waste package.

Then the waste package would be moved to another area where the first head would be inserted, the first head would be welded and tested, then the second head would be welded and tested; and then it's ready for movement underground.

We also have two dry transfer cells for canisters. We'll be getting some--we anticipate getting some large canisters with commercial fuel, and we also anticipate getting some Navy canisters and also some high level--solidified high level waste, which will be smaller canisters, all suitable for direct insertion into a waste package.

The repository host horizon is about 1,000 feet below the surface and about 1,000 feet about the water table. The footprint at this time, based on the 85 MTU per acre is about 741 acres.

You can see we have the diameter of the drifts, 18 foot in diameter. We have on the order of 100 drifts, we have contingency area there if we need to expand or if we run into an area where we don't believe that it would be appropriate to insert packages. So we're not forced with regard to space.

We have a bifurcated ventilation system--that is the emplacement area ventilation--and the construction are separated. You have the higher pressure on the construction site so that any bypass leakage--for you old reactor guys like me--would be from the uncontaminated to the potentially contaminated, where you have HEPA filters that in the event that there is a release--which is very unlikely--the HEPA filters would filter out the particulates.

This is just a cross section section of the mountain to give you an idea of the different stratigraphy.

Now the present design that is discussed in the VA, the reference design, doesn't use ventilation in the post-closure period. We have a ground control system in there for the emplacement drifts--I'm talking strictly emplacement here now--that would consist of either precast concrete or steel sets with steel lagging.

But this has not been cast in stone. We're still evaluating that. The reason we would be using the steel lagging in some areas rather than precast concrete is so we can do geologic mapping in those areas.

We have an underground transport system that picks the waste package up and moves it down a relatively slight incline, takes it around to the emplacement drifts. All this is done remotely because we have an unshielded waste package.

We place the waste package off the floor because if and when there's seepage and water might begin to accumulate, and we have the drift slope like this so that the emplacement drift will drain toward the mains, but you still want to keep the waste package up off the floor. It is a good idea.

The waste package--it's purpose is to provide waste isolation during the post-closure period and to control the amount of water that contacts the fuel that would be inside. We are trying to ensure a long waste package lifetime. We have looked a various metals. This has been a long process.

As I said, the earlier designs had a very thin wall, 5/8 inch single material. Now we're looking at a much more robust waste package. It's made of two materials. Now we haven't made a final decision yet on which materials we're going to go with, but the reference case discusses where we have 516 carbon steel, about four inches on the outside, and then about 8/10 of an inch of allow 22 on the inside. The structural strength in the early years being provided by those four inches of 516 steel.

The waste package has an upper limit on it thermally of 18 kW, which is considerably higher than what we had in the older design. This is a picture of the waste package which is in your presentation as well as in Volume 2 of the VA. You see that there are two materials, two lids. These are the materials I just mentioned.

We are conducting studies to test waste forms, waste package package materials because we want to confirm how we believe these are going to act long term. Those of you that were in the nuclear industry might remember when we got into EQ and we had to environmentally qualify equipment.

We sent that to Wylie Labs and they were able to, through accelerated testing means, tell us how these pieces of equipment and controls would work in an extended environment where you had what I always assumed was roughly 40 years, then you had your loci. And we came up with the doses like 2 times 10 to the eighth rad, so for the seismic requirements and so forth and so on. So that's analogously speaking what we're doing here.

In our reference VA design we discussed in chapter 8 some alternatives, but we discussed in section 5.3--chapter 5 being the waste package--5.3 some options we were looking at, mainly the use of backfill and it would really be the use of backfill with a ceramic coating or backfill with a drip shield.

One other thing, I was asked by somebody to specifically address designing for earthquakes. I heard someone mention earlier this morning outside that you couldn't design a nuclear power plant in this area because it can have earthquakes. There is not a single area in the United States where a nuclear plant exists where--that is earthquake free.

The key is you design the facility, whatever it may be, whether it's Prudential Tower in California--which they built--or whether it's a nuclear plant. You can design that, as the chairman said, to accommodate that shaking and still not represent a threat to the health and safety of the public.

But one has to anticipate that there will be earthquakes as well as other natural phenomena. That's what we did in the nuclear industry. We designed the facilities to be able to accommodate that.

In fact I don't know if any of you have ever lived in the midwest, but if you ever have and you worked at a nuclear plant, when tornado season hits and they start talking about a tornado, the place we all headed was the reactor, the containment building, the fuel building, because we knew that was the one thing that wasn't going to get blown down.

That's it. Any questions?

COHON: Thank you very much. Questions for Mr. King?

Jeff Wong.

WONG: This is Jeff Wong of the Board. I don't have a question. I have actually a comment.

KANE: Yes, sir.

WONG: I think that your opening statement is an interesting attempt to put practical thinking in terms of perspective on the issue of design, but individually we choose cars that work for us. They're not necessarily the best.

So in the case of the repository, that's the single model for all of us, and so I think that there--you could see why there are multiple demands from various stakeholders. So there's a demand for the best design--

KANE: Yes.

WONG: --to meet most of the expectations that are reasonable. So I understand your initial perspective, but I sort of differ with it.

KANE: Let me ask you this question, I think we can get the best design. Do you think we can ever know that we have the best design? Heisenberg's Uncertainty.

Will we know it when we're there, or will one of these Board members say "Well I think you're close, Dr. Wong. If you just do this you'll be there." And then Dr. Bullen says "Well now wait a minute, that's fine, but I think we need to do this too." So will we ever be able to tell when we have the best design?

WONG: Well really the NRC will know when you have the best design.

KANE: I submit to you on that point.

COHON: I'm going to use Chairman's prerogative here to jump in and disagree somewhat with Dr. Wong and support your program, but be somewhat different yet again.

To take your comments at the beginning and put in another context, another way to say what you did was that the problem of designing a repository is one with multiple conflicting criteria.

In such a case the idea of a optimal solution is no long supportable because what's good in terms of one criteria may not be good in terms of another. It is exactly why one person might buy BMW, another buy a Volvo, and both feel that they've got the best. For them it is the best.

Supporting Dr. Wong's point though, there is only one repository. You're acting on behalf of everybody in this country, here and for many, many, many generations to come. It's incumbent on you therefore, you--the DOE program--to be very clear about the criteria that you use, and in light of the fact that these criteria conflict with each other, the weights that you use as a way to resolve those conflicts.

So I'm agreeing with you, but then you are obligated to be as clear and open as you possibly can so that anybody who cares knows how it is you arrived at the design that you propose.

Dan Bullen can't wait to disagree with me. Go ahead.

BULLEN: Bullen, Board, and I won't disagree with you, Jerry. But along the lines of the handout that you made this morning one of the questions is what is the role of this design given ongoing work on alternative designs. And I guess I would like to submit another analogy along the car line here, is this design the Yugo or are we on our way to the Cadillac, and where do you see it falling in there?

And I also want to point out that both the Yugo and the Cadillac when they're brand new are licensable; but I would expect the the longevity thereof would be significantly different. And since we're looking at longevity in this case, how do you see this design evolving?

And I have another specific issue with respect to would this be the design you would pick for a cooler repository? We heard that there could be a 25 MTU per acre repository, which I submit won't necessarily be cooler. It could still be a hot package. But if we had options for a cooler repository, would this be the design or would you do something else?

KANE: To answer the first part of your question first. The design that we came up with in the reference design is one that is promising to us. It tells us, to our way of thinking--and there will be people who will disagree--that it looks like we're on the right path. It looks like we're making progress. It looks like this might be doable.

Now where we want--it's not so much where we are now, it's where we want to end up. Obviously we would all like to end up in a Rolls Royce, to use your analogy. The question is would we ever know it when we got to the Rolls?

That's what my point is, is if we get set so that it has to be the best and it takes the longest time and the most resources to get there, with Heisenberg's Uncertainty principle analogous in speaking, will you know you're there? And I maintain that you won't.

We're engineers. We have to have a good design. We have to be able to sleep at night. We have to protect people, the public health and safety of people, protect the environment. And we have to do the best job we can do.

But if we think we will have the best design as measured by when everybody agrees that it's the best design, I'll tell you now we'll never get there. That's the philosophy.

BULLEN: And the second part of the question about where we go from here?

KANE: Second part of the question is we are conducting studies now, Dr. Bullen, to--as you heard a presentation on this--to see what types of changes we want to make, what kinds of enhancements and so forth and so on.

I have not looked at this so I can't answer from a detailed perspective, but I have a feeling that if you went to a cooler repository there would probably be some changes in the underground design as well as the waste package.

BULLEN: One quick follow-on, and I--

KANE: And it might be the surface too, because if your method of getting it cool--which is one of the realistic methods--is aging the fuel, then you'd obviously need a rather large surface area to store this fuel. It loses essentially most of its heat after 1,000 years, 30 half-lives. Strontium 90, cesium 137 reduce, have 30 half-lives. After 900 years you would be way down on the curve.

BULLEN: Just go 10 half-lives. Don't go 30--that's way too much.

KANE: Okay.

BULLEN: But my follow-on question here is, if you're looking at the design as we see it now, it was or is the correct design if you're able to achieve a hot dry repository. Corrosion allowance barrier, corrosion resistant barrier, those are the correct selections.

And as we evolved in our site characterization, and as we understood the mountain and the flow paths and the drip and the seepage and the percolation flux and the pluvial periods more and more, it looked like it wasn't going to be hot and dry.

So the question I have for you is this is the preliminary design and this is what we had in VA and you analyzed it explicitly. Is this the design that you would carry forward based on your knowledge of the mountain today?

KANE: We do not know that until we finish a couple of things: number one, evaluating our design alternatives, which is ongoing; and number two, until we finish characterizing the mountain.

We don't have to know everything, and if something pops up later as a surprise, one could--if one has incorporated some flexibility, and I think we have--modify the design as necessary to still be able to meet the requirements and meet the performance the DOE wants.

BULLEN: Thank you, and just in the point of closing, I don't want a Rolls Royce. It's a Lamborghini.

KANE: I guess we now know what the best car is.

COHON: Out of deference to our visitors from Sweden, I think that the optimum car we have to use is the Volvo.

Debra Knopman.

KNOPMAN: Knopman, Board. I want to reinforce Jerry's point, the best is not the operative criterion here, because we are dealing with multiple objectives.

But the real point, I think, is not the question of how will we know if we've got the best. It's how will we know whether the design, whatever it ends up being, is consistent with observations and actual performance. And that gets into the whole question of confirmatory testing.

And as you're going through the alternative design process, there are all sorts of things you can stick in there, in the emplacement tunnels, or consider that; and certainly the linings and the backfill fall into that category. But you also then start, I think, significantly interfering with some modes of confirmatory testing that would tell you about the single most thing you're interested in, which is seepage.

So I think you've--I hope you'll recast your questions here about how will we know if we've got the best design to the question of how do we provide ongoing accountability and monitoring of how this current--whatever the design ends up being--how it is consistent with hypotheses about it. And that's got to be--that goes on from now on.

There's no one particular point that you start worrying about that, and I just hope that that point is emphasized in the documentation and the whole--it's a big part of transparency that's going to be part of the site recommendation, the accountability issues here of whatever design is chosen, and the means in which those hypotheses are constantly tested are going to be a very important part of this process.

KANE: Yes, ma'am. I agree.

KNOPMAN: Okay.

KANE: Thank you.

COHON: Any other questions from Board members? (No response.)

We're going to move on to the public comment period then, and others who might have had questions now can ask those. I'm going to come up there.

Thank you very much, Mr. Kane.

KANE: Thank you.

COHON: Has anybody signed up for public comments? Perhaps you could share that information with me. While I'm getting information--I think this is a question for Tim Sullivan. Tim?

John Bartlett wanted to know why if precipitation is expected to go up by a factor of 2 or 3, is infiltration expected to go up by a factor of 7 to 20? You have to get to a mike. You can come up here if you want.

SULLIVAN: There's not a direct relationship between precipitation and infiltration. The way I view it, as rock or soil becomes more saturated through increased precipitation, more water is available for infiltration, and the infiltration value is based on the modeling that we've done. It will go up much more than the precipitation.

There's another factor here, and that's the evapotranspiration. With a larger plant cover we would--the water will again be trapped in the upper part of the soil profile and available for infiltration.

COHON: Thank you. So it's a complicated physical process that transforms precipitation into infiltration. You shouldn't expect a completely linear or proportional relationship.

We have four people who have signed up, and let me read their names again to make sure we didn't miss anybody. Sally Devlin, Tom McGowan, Judy Treichel and Jim Williams. Have we missed anybody? (No response)

Because our time is limited, and I know you all want to eat lunch, we're going to limit each speaker to seven minutes. I know that's a little bit short, but recognizing we have an additional for public comment this afternoon, I feel justified in doing so.

So seven minutes, and I will keep you to it. We'll start with Sally Devlin. Ms. Devlin.

DEVLIN: Thank you, Dr. Cohon, and welcome everybody; and I'm going to just go right into my little song and dance.

I just want you to know that everybody I've talked to in Pahrump and one in Amargosa has said what a considerate and good-listening Board you are. And that's what we need, because we're hardly ever mentioned; and as you know, we don't have any facilities.

I'm only going to say something because this came up in the course of conversation, and I think it's something that the Board can do; and it's nothing really directly with

Yucca Mountain, but it does affect Yucca Mountain. And that is the classification of low level waste and high level waste.

And I'm talking about it because the classification of fission bombs, 110 of them, is low level waste. The bombs done by the nuclear power method are high level waste. Now they're all done in the same areas. Everybody had a grand time doing them, from 1952 to 1992, but there is a differentiation. And I really, in talking about fission versus fusion, I feel that you're still dealing with the same hot stuff.

I don't know all the technical differences or if there is one, but of course this was set by Congress, and I really feel particularly in the Piute Mesa area and so on, where all that stuff is classified, we did fortunately get the trillium count. But nonetheless it's the same stuff going right into Yucca Mountain as far as I'm concerned.

And I'd like to know what you think of it, but I think it should be Congressionally changed; and I think you are the ones--maybe never thought of it, it's come up many times in our NRAP group when we're talking about the different levels of radiation.

The other thing is really a mea culpa when I was yelling at the Navy, because I was angry because they said they would declassify for me. And I'm just a little old lady living in Pahrump, and I really felt if they were going to declassify for me they should declassify for the world, and what are they hiding?

Did you hear the word? This is what we civilians question--what are they declassifying? Why should it be classifying? I will not allow whatever it is in my mountain. I want to know what you're putting in there and I want to know how you handle it.

And then again with this topic of the low level, high level, I understand that in the Naval fuel, and I've no idea what any of this stuff is, that of course there's mixed waste--whatever mixed waste is, chemical and radioactive waste or actinides or something.

But you hear, I'm the public, I have the general concept of this stuff, that I'm terrified about. So I want to know what's going in my mountain. You're not allowed to kill my pupfish and I don't know if I'm going to bring you back on my stage yet. But I'm going to tell you that I am concerned that these concepts that really aren't talked about anymore and yet they're very basic. So I hope it will be considered.

The third thing I have to say is really an apology to my friend Lake Barrett here, because I called him appealing to ignorance. What I meant by that, if you remember your philosophy, and that he to me was saying Yucca

Mountain's safe because nobody proved it isn't.

Now I realize that he's the one that puts the rules in motion, and does this and does that and all that; and I have great admiration for him. Whereas on the other hand the esoteric scientists--whatever you want to call them--on the other hand are doing all the testing and they're having a grand time for generations learning and growing, and wonderful--which is the best car?

And this is very confusing because if something does occur at Yucca Mountain and they do find the test site, Lake Barrett is the one that's going to get the heat, not the scientists, because he's going to be the one in the name and the group and the whole thing that says "Well we're going to allow EPA to allow two and a half people to die of latent cancers in 1300 miles of transportation." And I'm saying, "Gee I live on two and a half acres in Pahrump and I'm allowed two and a half horses." And that's the law.

So that there are so many different confusing things going on. So I do apologize, but I really do feel that way. We are very concerned, not knowing about meetings, not getting information and so on. But it is information--what is high level waste, what is low level waste, why is this low level waste? Why are you talking and putting things?

And I was terribly upset with this May 28 thing because we didn't know anything about this. So I feel the public needs to be far better informed, and having been a salesman all my life in many fields, I know you go to the people. How do you expect people to come here when they don't understand a word of what you're saying?

I mention in that one page there were over 18 acronyms. I've been playing with you guys for five and a half years, and I do talk acronyms. And I understand them. And the first thing I do when I get a report is look at the glossary, and I get the definitions and I use them and they become familiar.

But you must go out to the public, and this is what you're not doing. You're not--now I don't want you to sell this. This is not what I'm saying. But you can't expect the public to come here when they won't understand the language. You can go to the public and say this is what we're trying to do, and the public will get the impression, as I have known for years, that they're really trying to solve this problem.

And the one thing I would like solved, and I'm going to wind up right now, and that is I question whether there isn't science going on in this world, in this country somewhere, where we don't have to have a repository and spend all these billions and get all these people irradiated or whatever it is?

Why can't this stuff be transmuted, do something, or something--and as I'm on the Internet, barely, I'm getting abstracts that are saying we can transmute, we can this, we can that. And my concept is--wonderful, the microbes are going to eat the canisters.

Let's get some science, get rid of the rods and get rid of the plutonium. Put it all in one place, and we don't have the transportation Yucca Mountain problem. And that's my concept. And that's what I want to see. Mike, you're out of a job.

Thank you.

COHON: Thank you, Ms. Devlin. You covered many topics, and I have no intention of responding to most of them. But one thing I do want to say, we recognize the technical nature of these meetings. That's unavoidable. The Board can't do its job if it doesn't get into technical detail. That doesn't justify unclear or poor presentations however, and I think working with DOE we've had to attain a much higher level of presentation. And I think the results show.

I would also point out that we have heard from DOE today that they made a special effort to make the Overview volume of the viability assessment understandable and accessible by anybody interested in this project. I've read that Overview volume twice. I think they achieved that, and I think they achieved it very well.

And I would encourage you to convey to others who have not had your experience with this program that if they want to learn about the program and where it is, recommend that they read that volume. I don't think they'll be disappointed.

Tom McGowan, who's waited patiently for a day and a half, and now I'm nasty enough to limit you to seven minutes. But you're going to do it, I know, because you can do it.

McGOWAN: I recommend that you do not remove Director Lake Barrett. God knows who would be in his place, first of all. Better to deal with a known than a bunch of unknown.

My name is Tom McGowan for those who are from Sweden, here for the first time. And I would start like this: I'm a member of the public which is intimidating enough. Do you mind if I smoke?

SPEAKER: Go ahead.

McGOWAN: Thank you for shedding the standard of absolute zero. Now there's no more reasonable uncertainty. I know exactly what it should be. You have said it; and let me put it this way. I want to start out by sincerely--and you can take it because it's objective anyhow on your part--I sincerely commend DOE, OCRWM/YMPO, the M&O--whatever that is--NRC--whatever that is--and everybody concerned with this process for your diligent effort.

You have been exhaustive with these reports called the New York phone book over there, which I refer to as the expert uncertainty assessment; and I refer to the page 36, the three paragraphs which are unparalleled in recorded history, for containing 22 or more ambiguities and uncertainties--any conclusions; and ends with the DOE confident assertion that UE believes--can interpret that whatever way you please--that the project can proceed.

Well you know, there's this little thing about statutory silence does not constitute statutory license. I would find your belief system more credible if you were to back it up with some of kind of justification basis, and certifiability by independent verification, as valid and reliable; not because it's you but because it pertains to all of us.

By the way this concept of all of us being together here, working on this project so diligently with all kinds of integrity, et cetera, I would find that more believable if somebody from the future was here and able to speak, with poignancy so to speak. And they had no idea who you are or who I am or what we're doing here or why, what the outcome will be. And this is a democratic process--how come you haven't included them?

So let's remember, this is not exclusive. This is not eminent domain. That's not what it is. It's about mankind, and that is the litmus test we must pass. We are the current generations of the leading scientific, academic, technological minds of our time; and this public is the one you get, the one you see, including Ms. Devlin, myself and all the other people. I put myself last in that group--Bill Vasconi, Judy Treichel, others far more eminent than I who have been involved in this for a long time.

You have a responsibility and so do we. It has nothing to do with the repository. It has to do with the quotient of human integrity. That's where we're coming from. In Sweden were asked the question who formulated this master plan. Fact is, I did. But my iteration was summarily rejected for some reason.

What you got instead was the OCRWM/YMPO. What you'll have to do is close enough for jazz, is that correct?

All right, where was I? Oh, by the way where is EPA? And why? Better yet, why not?

Your concept of the semantics of mind vary grossly. You use terms such as show stopper, and if Nye County's a show stopper we've got a problem; because they are digging wells, ditch diggers in other words. Congratulations, Nye County, offsite--did a great job. Soon somebody will tell us where the warm water came from, maybe. Find out. They said in about a month and a half. I thought that's rather accelerated, but it's okay.

The fact is the uncertainty assessment--I shouldn't do that to you, Lake. You guys did too hard work on that--you really did work hard. It's not uncertainty--it is your best. That may be the ultimate statement.

Consistent with the Peter Principle it's been suggested that we all eventually reach our own level of incompetence, which I'm fast approaching. And very possible that the viability assessment will do the same thing. That's the real danger. The closer you get, more incisive investigation, the closer you get to the awful truth, which is this simply can't be done.

But the problem is why don't you tell that to the Congress and the President and the American people, the people of the world who will emulate what you do in the assumption that reasonable assurance is quite all right. Try that at an Italian wedding ceremony when discussing the virginity prospect of the bridge--reasonable assurance. You think that'll work? I don't think so.

And again let me say that somebody mentioned the automobile as an analogy. I happen to have had the opportunity to purchase for $50 a used auto. It's a very fine auto; all it has to contain is me. And it's called a Chevy-Oldsmobillac from a four-car collision. And if I can find another one I'll get you one.

Yeah, we begin to get the idea what it is we're talking about here. Why are we talking in circles? Why don't we go to the fundamental crux issue? The crux issue is not waste, not nuclear--never has been a problem, never will be. The problem is human nature. That's us. We happen to be the current iteration of it, the Congress who aren't here, along with EPA who isn't here.

NRC is here, to their credit, ultimate credit--yes, it is. They're on the hot seat, they're going to have to be consistent with whatever EPA's Yucca Mountain uniquely specific relaxation standards are. They're going to have to somehow justify relaxing their criteria accordingly.

They were told to do that by law. How do you like that? And--what does this mean? Another seven minutes? I've had seven minutes--be honest with you, far too long. So is 300,000 years. But none of that. That's much too long.

I want to say then in closing up I made recommendations that there are three prerequisites to a safe, secure--some of you who I've talked to can tell the rest of you about it. I maintain they are readily attainable, that you're not addressing any of the -- and probably won't.

Second point is the utmost importance to this process, the desired litmus test is our attainment to a higher idealized standard of ethics, morality, reason, integrity, responsibility--but above all, conscience.

Why do I bring this up--and Dr. Barrett, I think you would essentially agree with what I'm saying if you had your druthers. But you're not an independent member of the public such as myself, so you have certain boundaries and parameters. I break all the rules. I make some rules -- follow them. Right? Sit down. What are you doing?

(Laughter)

I want to thank all of you, and again I commend DOE, everybody highly for their exhaustive work. There's no question about that. That's not in question. The question is stand up and tell the Congress, the President this fellow--what do you do here, by the way? Excellent stance. I was going to start it off like this, Ladies and Gentlemen, for the hearing impaired. Can't do that, right? Can't do that?

Let me just wind up with this politically incorrect statement. I'm sure he's adult enough to appreciate the humor of it, because you got into a discussion with Don Kane. Bear in mind, two Wongs do not make a Wight. Understand that clearly. I love you, doctor. Love every one of you. Good luck and God speed. You will require each and both.

Now you'll probably--this is your last appearance with me. As a matter of fact more people -- thank you.

COHON: We do appreciate your limiting your comments, Mr. McGowan. I mean that. I mean he had a lot to say. And just to show you I was listening, and as a gesture of appreciation for limiting it, I will recite his three points.

Keep the water off the waste, take out the longest lived products--problematic--and in recognition of the long lived nature of the repository and the importance of societal oversight, create--I don't want to do injustice to your concept, but for lack of a better phrase, a nuclear waste priesthood, which--okay. So there you are.

Thank you for limiting your remarks, Mr. McGowan.

Judy Treichel.

TREICHEL: I need some clarification, because this 963 came as a real bombshell. And I may be incorrect in what I'm thinking, but I think it's interesting for the Board too, because part of their assignment is to see that Department of Energy is doing its job correctly. And you need to know what the job is, and if this site--as in Steve Brocoum's presentation--is complying with 963, you know, it's very important to know whether that had changed.

And I want to know from you, like is it just the number that's changing, just strictly the numerals?

BARRETT: Barrett, DOE. The program runs under the existing rule, which is 960 as it stands.

TREICHEL: Okay.

BARRETT: It has not changed, and we are considering if we're going to change it or not based on the comments that we receive. So for Steve's plan, he calls it 963. That is what some of the current thinking is, that we will need to change it to--maybe change some of it, maybe not change some of it, depend on how the EPA and the NRC comes out.

So it is presently 960 as it is and if it is changed it will go through due process, and the Department has not decided to change it.

TREICHEL: With Federal Register hearings--

BARRETT: Federal Register hearings--

TREICHEL: --all that kind of stuff?

BARRETT: --the Secretary will be briefed, et cetera.

TREICHEL: Okay, on page 14 in that same presentation there is a Volume 2 of the site recommendation, and it says "Compliance analysis with respect to the DOE siting guidelines based on TSPA, SR," and then under that "represents site suitability analysis."

There is nothing in there about whether it meets all the qualifying conditions or has none of the disqualifying conditions. You never say that, which is the basis of 960. All it's talking about is TSPA.

BARRETT: At the time we do this, we will address all the criteria of 960 or 963 if it changes, whatever those are. Presently that has much more than the TSPA.

TREICHEL: Okay, but still when it shows this little waterfall thing, it just talks about various TSPA stuff going on, and there's never a point that's clear here, where you have to show that it has met all of the qualifying conditions and does not indeed have any disqualifiers.

BARRETT: Barrett, DOE. All--this is a summary chart, upper level summary chart, it's page I think 16--you pulled the page of that. That is an upper level. There is 4000 node schedule below this that would have for example USGS saturated zone, unsaturated zone, all of that kind of work would be there; in addition the basic science would be used for whatever the 960 or '63 requirements are. If the ground water travel time is there it will address the ground water travel time, whatever those are.

TREICHEL: And ground water travel time will be there until there's a complete public process on it.

BARRETT: That's correct, it will stay--

TREICHEL: And so it probably won't be complete on June of '99.

BARRETT: June of '99?

TREICHEL: Yeah, page 18--

BARRETT: Page 18--what was June of '99?

TREICHEL: Complete 10 CFR 963--

BARRETT: That's correct--I doubt that's going--that will not be changed by June of '99, and it may not change at all.

TREICHEL: All right, thank you.

COHON: Just to make sure I'm not confused, is it correct that 963 refers to the proposed guidelines that this

Board and many others have commented on, which is basically a performance based, dose based siting guideline? Just to make sure I've got the nomenclature right.

BARRETT: 10 CFR 960 is the current rule.

COHON: Got that.

BARRETT: It remains the current rule until it is changed by due process, if it is to be changed at all. The present thinking--and we're sharing that with the Board, okay--following the EPA and NRC, is that--the NRC is going to retain part 60 which goes along with our old 960, which has site comparison guidelines, if you are screening multiple sites and others.

Then under following the statutes, which said have a Yucca Mountain specific standard, National Academy of Science report, followed by an EPA standard, followed by a site specific NRC rule, which the NRC has chosen to call 10 CFR 63, we are planning--though it is not a decision--we are planning to prepare a proposal internally with NRW, to propose that we would change current 960 to 10 CFR 963 to follow the NRC, which would have the appropriate siting guidelines under statute.

If we change--if, which will only be done through due process, public comment, et cetera, then it might become 963. If you were to ask the scientists at Yucca Mountain what is their best guess now in planning, it is 963. We know it will have heavily the TSPA probabilistic aspects to it no matter what. It's in the current 960. So we know we're going to do that for sure.

If we need to do ground water travel time and some of the other subsystem requirements and things like that, those would be there, if they're still there; if they're changed, we'll do whatever it is.

So when it is time to do the site suitability recommendation, then it will be against whatever the appropriate rule is at that time. And it will be either 960 or 963.

COHON: Thank you. Are we straight on this? Staff? Yeah, okay. Good, maybe you can explain it to me later.

Jim Williams.

WILLIAMS: Yes, I'm Jim Williams, and my comments are personal. They have not been discussed or cleared with Nye County or other state and local governments that I've worked with over the years on this project.

What I wanted to do was to pick on two small pieces of two very, very substantial documents, and perhaps this is a little bit unfair--but--in picking on these two small parts, but I think they are related to each other and related to the issue of equity.

The first small piece is the--on page 2 of the Overview, of the viability assessment, which says that one of the three advantages of the Yucca Mountain site is its location, which is described as a place 100 miles northwest of Las Vegas on unpopulated land adjacent to the Nevada Test Site, where 900 nuclear tests have been conducted over 40 years.

Now that description of this as a locational advantage of the Yucca Mountain site does not mention that there's a local government there, named Nye County. It does not--in saying that the area is relatively unpopulated now, it does not explain whether the implication is that it should remain unpopulated for the next 100 years, 1000 years, 10,000 years. And in making reference to the NTS it does not describe that the cumulative effects of the radiological burden that this area is--that is implied in that.

So what we have is in addition to the Nevada Test Site and the 900 nuclear tests there. We are also looking at the Nevada Test Site as a major site for disposal of DOE's low level waste from across its complex, and we're talking about the nation's spent fuel inventory in high level waste. So those are three aspects there.

The second small piece that I would want to bring up is from the NWTRB's November '98 report, and your cover letter there in which you mention--make reference that the common goal--this is of Congress and DOE and the nation and the NWTRB--is to further safe and cost effective management of spent fuel and high level waste.

And the analysis of that is that it doesn't mention equity in this, and some suggestions are two: one with regard to DOE in discussing the locational advantages of Yucca Mountain as a site, I would suggest some additional care in describing how this location as described is one of the key advantages.

And with regard to NWTRB I would suggest that it's fine to focus on safety with a consideration of cost, but that should be combined with an acknowledgment that the NWTRB is not taking on the question of equity--which is at the core of this program from its outset in 1982; and that its focus is on the repository itself primarily, to a 90 percent degree, rather than on many other aspects of this program, the tangled issues of transportation, interim storage, community acceptance, community futures.

COHON: Thank you very much, Mr. Williams, for your very well stated remarks. You're quite right, and your points are well taken with regard to the Board. That and many other policy issues are beyond our purview, and we should be clear on that whenever we have the opportunity to do so.

I do want to point out that transportation is very much within our purview. However again, as with everything we do, the focus is on the technical aspects of transportation; and we certainly acknowledge that there are distributional and other issues related to transportation as well.

Thank you all very much. My thanks especially to our speakers this morning, starting with Mr. Barrett all the way the end, to Mr. Kane.

We stand adjourned until 1:00 when we will reconvene. Thank you.

(Whereupon a lunch break was taken.)

A F T E R N O O N   S E S S I O N

COHON: We turn now to Volume 3 on Total System Performance Assessment and the ever eloquent--elegant and honest Abe Van Luik who will make the presentation. Abe?

VAN LUIK: Well, I miss out on a couple of those Es today, but just give me an E for effort.

There's a couple of questions that came up this morning that I think I'd like to address before I go into my talk. Actually, there was one that came up yesterday about the Nuclear Regulatory Commission and their requirements. I was wondering if the Board had looked strongly at the IRSRs that the Nuclear Regulatory Commission is preparing because they are the ones that give us a cue as to what they want and I think there is much wording in there about a full and serious disclosure of the basis for every assessment and of the uncertainties underlying every assessment, etcetera. So, I think perhaps, you know, at some future meetings maybe the NRC can be invited to go through the IRSR total system performance assessment, for example, which is not an easy document to dismiss or deal with offhandedly.

There was a question this morning about how much water flows in the matrix and how much flows in the fractures in the current model. I just spoke with the TSPA modeler from Sandia in charge of this, Bill Arnold, and is typical of a TSPA modeler, there is not a straightforward answer. If he was forced to cast it as a wrong number, he would say that for the present climate state for most of the mountain, the ratio is about 1 to 7; 1 volume in the matrix and 7 in the fractures. When you go to the next climate state, the long-term average which would be a pluvial state, it's more like 1 in 50. There is 50 times more volume going through the fractures than there is through the matrix. But, then, he cautioned me and said, you know, this is a 3-D model with variation both over the area and over depth and it's also calibration dependent depending on which version of the model is used, and how it's calibrated to temperature and a lot of other things will give you slightly different numbers, too. So, there is definitely a huge 3-D matrix with the answer to this question and he thinks that 1 over 7 is a good one for the dry climate and 1 over 50 is a good one for the pluvial climate. Obviously, we can revisit this if you want to examine it in detail.

There was also a question this morning about seismic. I want you to know that the base case does include expected level seismic events and the few little rock-falls that that can cause. I think the little Squaw Mountain quakes that we had over the--was it yesterday that we had one? Yeah. As far as I've been able to tell from talking to people that have been at the mountain, you could not feel it underground, but you could at the surface which I think is a typical illustration of the fact that earthquakes release their energy at the surface and conduct it through the underground. So, with no further ado, I'll start with our talk on Volume 3. I just wanted you to know that seismic events are in the TSPA of the type that we've just experienced.

What was the purpose of Volume 3? It was to report the results of the total system performance assessment analyses that we did. Now, I think personally I'm very pleased with the TSPA/VA; and I'm using the acronym because, you know, it's the same, total system performance assessment for the viability assessment is a lot of words. TSPA/VA, I think, is a very fine product not only because we did an excellent job in putting together everything that we knew from science and engineering and from our modeling experience, but because I think we did a very good job both in the VA itself and in the technical basis document disclosing our uncertainties and discussing them. I think, you know, I am very pleased that this a good model for how we would build a license application. It is not the license application, but you will see pretty much what you saw in the VA except expanded in the license application is my vision of it.

We did a deterministic base case. We did a probabilistic base case. We looked at volcanism, human intrusion, and nuclear criticality as disturbed events. We did comparative analyses and we did design option analyses in a limited way in the VA.

We provided an overview of all the component models and we provided input--and this was a big purpose for doing this analysis in the first place--for the license application plan which is found in Volume 4 and also the--did you say 4000 node, Lake--the 4000 node planning document has gotten direct feeds from TSPA's information needs. It identifies the most critical components and parameters and provides guidance for prioritizing future site and design work. Now, I didn't say that it said what we had to do for future design and the site work. It provides guidance because obviously TSPA is only one input to the total picture.

We did a deterministic base case, also called the expected value case, which was a single realization. We sampled all the uncertain input parameters of the mean of their range. And, why did we do this? Well, the usefulness of it is to illustrate the relative influence of various components or sub-components on individual dose results and we would not use or even attempt to use such a case to meet a regulatory requirement.

What we did which I think is the more interesting part of TSPA/VA, we did a fully probabilistic base case. Used linked deterministic models with their relative parameter uncertainties propagated using a Monte Carlo technique. The multiple realizations are used to define the range in the dose rates. We did 100 runs. For a couple of simplified examples, we did 1,000 runs to check on whether or not the mean was stable and we found that the median was extremely stable and the mean was acceptably stable. It is this type of probabilistic analysis that we'll ultimately use to develop the safety case for licensing; not this analysis, but this type of analysis.

We have already discussed with the Board several times what the analyses were and what the results were. So, what I'm going to do is take a slightly different tack so that I'm not boring you to tears if you've already heard this and take time snapshots and tell you what's happening in the modeling. I would say what's happening in the repository, but let's never forget that this is a hypothetical repository simplified into a model.

From the time of closure to the first several thousand years and pay no attention to the time equals 100,000 years picture there--that will show up two slides from now; I've got the wrong one in--look what happens. Well, we know that thermal output causes heat and the surrounding rock to rise above boiling until about 1,000 years and it dries out the rock about 10 meters into the drift wall. We begin the degradation of the outer carbon steel layer at several hundred to several thousand years. The inner Alloy-22--that's our corrosion resistent material layer--in those cases where temperatures are modeled to drop more quickly also begins to degrade. We have assumed and this is not a modeling result. This is an assumption based on discussions with people, you know, that are worried about the manufacturing difficulties, etcetera, we assume that one juvenile failure occurs. And, we really have no dose consequence, at all, in the first several thousand years.

If you go to the next slide, now we're looking from several thousand years to 10,000 years. During this time, the drift walls have returned to the ambient temperatures and fluid flow is re-established. Dripping water occurs in some locations, but not everywhere. Waste packages continue to corrode and some inner layers are breached about 1 percent of the total in the expected value case. Water enters the packages, mobilizes radionuclides, and carries nuclides to the 20 kilometer boundary where we have placed our individual dose recipient. The peak does rates or the expected value calculation is .04 mrem/yr. The range from the probabilistic calculations goes from 0 to 3 mrem/yr; mainly from technetium and iodine. The waste package cross-section shows that we have quite a bit of eating away the outer barrier, a little bit at the inner barrier, and some things happening with the waste form itself. I believe that these pictures are very good to discuss, you know, the evolution of the system over time. Therefore, you see them in the VA and you will see them in most all of the outreach materials that we are now preparing.

If we look at the 10,000 year period to 100,000 year period--now, first, I must say why we do this. The NRC and, I believe, the EPA also because of precedent will tell us that 10,000 years is about what they want to go quantitative in licensing on. But, I believe, that there has also been an indication that there's an interest in knowing what the peak does is. The National Academy of Science has recommended that we look at it and so we looked at it. We have disclosed it in the viability assessment and we plan to disclose it in the draft EIS which will come out this year. So, what we are looking at is peak doses. I think it's important to keep in mind that somewhere between 10,000 years and a million years, you go from science to science fiction. You know, the basis for these calculations diminishes in credibility in my view anyway as we go farther and farther out in time.

I was recently reviewing some work by another country that calculates out to 10^8 years and they fully acknowledge that by that time the sun could very well go super nova. But, they're only addressing a regulation and the point that they made to me was regulations have no reality constraint. Regulations are just stylized calculations that have to be performed.

So, anyway, if we look at what happens over the next 100,000 years, we have climate changes occurring. As they climates change, the percentage of waste packages seeing seepage out of the drift wall will change. It goes up when the infiltration goes up; it goes down when we go back into a dry climate. I believe that one of the conclusions that we have come to from the climate modeling is that about 80 percent of this very long-term future, we are spending in a pluvial state. Now, I just say that we are re-evaluating this whole climate modeling business this year and you may see something different for the site recommendation. But, this is a caveat I should make on everything that I say. We are evaluating this design given this modeling and this basis and the basis is changing and the design may be changing and the models, of course, keep pace.

Waste packages continue to be breached and now we are calculating up to about 6 percent of the total of the waste packages where you have water actually able to access waste. The expected value for the peak dose rate at 100,000 years at a 20 kilometer boundary is about 5 mrem/yr and the range from the probabilistic analyses is between 0--quite a few hits at 0 still--to 300 mrem/yr. Now, neptunium is the dominant contributor to dose.

If we carry these calculations even farther up to a million years, packages continue to be contacted by seeps and continue to corrode and fail and we're up to about 30 percent of the total that has been contacted by seeps and has failed. Some of the packages that have never been contacted by seeps also being to fail because of just general moist air corrosion, and 1 to 2 percent in the probabilistic case is what corrodes at that point. The peak dose of 20 kilometers from the deterministic case is 300 mrem/yr and it ranges from .1--which is about the 5 percent probability--to 3 rem or 3000 mrem/yr which is also about a .5 probability if we're looking at the total probability space. You can see from the picture that we expect that many of the waste packages at this point will be corroded, that the waste form will be accessible by water, and that basically we have reached a steady state or the doses are falling at this time.

Another way to show these same types of results and the reason I show this viewgraph, this next one, is to look at the time variation and the statistical descriptors of the calculated dose rate distribution. If we go to the 10,000 and 100,000 year cases, you see a 95th percentile mean which is very close to the 95th percentile median which is way down there, about two orders of magnitude lower, and then a 5th percentile which does even show up on the 10,000 and 100,000 year graphs. And, for a million years, the 5th percentile finally shows up at about, what is that, 750,000 years. But, as I say, you know, to think of these things very quantitatively beyond one significant digit is doing a disservice to what we've done here.

The reason that I show these curves though is these are plotted, they're calculated and plotted, as 100 year time averages and this is the advice given to us in the NRC's 10 CFR Part 63 as posted on the internet. It has not yet been released in any other form. You can see that the 10,000 year case shows the doses as I was speaking of just a few minutes go. But, the peak does in this way of showing the result is somewhat lower than the 95th percentile that I quoted just a minute ago. So, the reason that we think that this move which is being recommended by the NRC, which has also been adopted by the Canadians and a few other countries, is that this gives a more realistic picture of if a person were living in this location at this time and lived 100 years, what would be the average does that person would see; rather than what is the average of all peak doses over all time which has no reference, at all, to any kind of individual.

So, we think from a gut feeling this is a good way to show the results so that it's somewhat meaningful in a human type space.

If we look on the next viewgraph, you see what the dose contributions are. I've already mentioned iodine, technetium, with a lot of 0 dose hits. This is out of 100 hits. For the 100,000 year time period, you start to see neptunium play a big role and neptunium completely dominates in the very long-term. With plutonium, because of the model that we have adjusted given the experience at the Nevada Test Site, we have worked with those people and created a colloid model and so we do have plutonium moving as a colloid. Of course, there is additional work needed to assure that that model is correct.

Now, we did comparative analyses and the goal for these analyses is to look at the sensitivity of the results to the uncertainty and the parameters in the models. Now, where there is a lot of uncertainty in the parameters, we were able to do regression-based sensitivity analyses. However, in some cases where we had a model with very little uncertainty, the regression analysis would not show any importance to that model even though we knew it was very important. So, in those cases, we did one-off sensitivity analyses and I'm not going to show you a lot of results because these are all in the package from the previous TRB meeting where we explored this in some detail.

But, if you go to the next viewgraph, you can see that for all of the principal factors, the principal factors that control the functioning of the repository, we attempted in many cases to look at the uncertainty analyses in different ways. In some cases like the integrity of spent fuel cladding, we looked at uncertainty, the uncertainty in the modeling itself as part of the base case, but we also did a comparative analyses where we did it with and without cladding. And, I think, because the Board asks a special consideration be given to explaining the cladding model, which we'll get into in a moment, that this is an important point. The regression analyses did not show that cladding was very important, even though we know it's very important because the range of uncertainty assigned within the model would not wag the tail of the distribution owned dose very much. So, what we did is ran it with and without cladding or with cladding set at very different parameters than was done and it showed, indeed, that it's an important parameter and we need to spend some time bolstering the bases for this analysis. But, the main purpose for this viewgraph is to--and you've seen this one before--is to show you that for every principal factor, we did address uncertainty in whatever way was appropriate.

The regression-based sensitivity analyses were performed on the results of the probabilistic case, sampling for all uncertain parameters simultaneously. All parameters retained their assigned range of uncertainty and interactions among the various parameters were maintained. In other words, this was not a blind Monte Carlo simulation; this was a simulation which respected the fact that if you adjust some parameter upward, others are physically impossible that they also go up. They must stay where they are. So, those things are in the modeling and we respected that in doing this analysis. Otherwise, you would come up with a spurious relationships that would show that some things are maybe not important because other things that are physically impossible are canceling other effects.

We looked at scatter plots, regression analyses, and contributions to variance type plots. I'll just show one plot. This is a plot that we would expect would be scrutinized if this were a licensing action; it would be scrutinized in great detail by the regulator. But, this is the 10,000 year dose rate history, all pathways 20 kilometers. And, you can see that out of the 100 realizations plotted here in this, what we call, a horsetail diagram, 28 of them have no waste package failures and no doses. So, 72 are what you see contributing here.

If you look at the most important uncertain variables for the base case for that period, you can see that the very largest one is a seepage fraction. That's a natural system effect. The very next one, you know, looking at the longest bar and then the next longest, is the Alloy-22 corrosion rate which is an engineered system effect. Then, it was very important in the first 10,000 years whether or not we had more than one juvenile failure. This was sampled between 0 and 10. Also, what was the saturated zone dilution factor? It's interesting that the Board also asked me to expound a little bit more on the saturated zone modeling that was done for these analyses. But, the point is that if you look at the impact on peak dose variance, it gets up to just a little bit above maybe 17 percent of the dose variation that you see on the left side is explained by seepage fraction; a little bit more than 12 percent is explained by the Alloy-22 corrosion rate, etcetera. So, we don't have things that completely dominate here and give you like .88 type results where one parameters sways your whole analysis one way or the other.

If we look now to the specific questions that were asked, one of the changes that has to be made is that these were not panel questions; these were full Board questions and I apologize, but at 10:00 o'clock last night when Steve was reviewing these viewgraphs, I think I was asleep already. We were asked to talk about an assessment of relative uncertainty and conservatisms in TSPA/VA models. This is an unfair question to ask us because when I looked in the VA document, we did not specifically address this question this directly.

We were also asked to talk about the cladding model assumptions, saturated zone flow, and transport model assumptions and some statement of the relationship between the TSPA/VA and what your panel saw the other day in terms of defense and depth.

So looking, first, at the TSPA model of conservatism and Holly Dockery from Sandia helped me put these viewgraphs together and she predicted that we will get stuck in this section and never finish the rest of the talk. I'll be most pleased if that's the case.

The goal of our development of the TSPA/VA was to match information that we have and to be as realistic as possible. This was not a licensing calculation where we think that we will be forced to be somewhat on the more conservative side. However, no model was included if it was judged to be clearly non-conservative. So, in the table that you will see next, you will not see NC for non-conservative next to any model because, for example, the saturated zone model that we began the VA with, we judged to be non-conservative. We could have kept it in and defended it, but rather than that, we took a more simplistic model that we thought was not as non-conservative.

I want you to know that within the project, even within the PA team, we have a range of opinion on whether some models are conservative, realistic, or non-conservative. There is not a monolithic mind behind DOE that says every word in here is believed by everyone to have the same meaning. However, we sat down because this was not directly found in the VA. We sat down as a team and worked out a table of what we thought. The table in some places has two answers because we could not agree, and in some places, there was hesitant agreement, although some people felt it could also be the other way. So, there's a question mark behind it.

And, of course, the objective of future work is to address these areas with the most uncertainty that also have the most influence on performance. We have some things where there's great uncertainty, but we have shown that it really doesn't matter. You can bound it one way or the other and it doesn't make much of a difference to dose.

So, with great hesitancy, I put up the next table which is new information for which only the performance assessment crew including myself are responsible. This has not gone through the same DOE review as other materials in the VA. This is not in the VA except for the confidence judgment in the models that come from the VA. Of course, where we have a 4 or a 5, we are not going to do much work between now and the site recommendation to address those models further. Where you have a 1, 2, or 3 and there is great significance to performance, of course, we will address those.

When we look at precipitation and infiltration of water into the mountain, some of us felt that was pretty realistic based on some pretty good paleohydrology, paleoclimate, and other studies, and others of us are aware of the fact that within the DOE community, meaning GS and other places, some people feel that this is a very conservative approach. I like being called conservative, but I really have a gut feeling that this is not that far off probably from what we can expect. Nevertheless, we have some ongoing work even though this is a 4 to try to come to a closer agreement within the community on this one.

If we look at percolation to depth, it's based on direct observation of studies done in the ESF. We feel pretty much in agreement that this is a realistic approach. If we look at seepage into the drifts, we bound that. So, we think we're being somewhat realistic, if not conservative. There was people in both camps on that one.

If we look at the effects of heat and excavation on flow, it says a 1 to 2. That's about the lowest confidence ranking we've given any model on the model. It is somewhat significant to performance. Some of us felt that we were somewhat realistic and then we were challenged by others who said how can you be realistic when you have no confidence in the model? Well, I didn't think that was funny at the time, but I think it shows you that we did put some thought into this. How can you say something is realistic when you acknowledge that you still have a lot of work to do before you can have confidence? So, that's an R?

Dripping onto the waste package, this is a very contentious one. My personal feeling is that it's very conservative which is why the C is there. Most of the crew thinks it's pretty realistic based on both testing and observation.

Humidity and temperature at the waste package, we think we know that one. It's not that important to performance anymore given the design that we have and we think it's pretty realistic.

Chemistry of the waste package, this is another one where there's a lot of discussion and that's why there's a question mark there. We think we have a pretty good handle on that. We think that it is somewhat important to performance. And, yet, some of us feel that it's realistic because it's bounding and then others felt by definition that's not realistic; that's conservative. So, the majority opinion was realistic and I put a question mark behind it because there was some question mark. But, no one thought it was non-conservative because if you look at the chemistries that we use for the actual corrosion modeling which is crevice chemistry, it's quite aggressive.

So, if we look at the integrity of the outer waste package barrier, I think we know that one is realistic. If we look at the inner waste package barrier, every important to performance, we have some work left to do there. It's probably a realistic approach, but because of the uncertainty in the near-field environment, we gave it a question mark. If the uncertainty in the near-field environment is realistic or conservative, then the modeling is probably pretty good. It's not the modeling that's in question here, but it's the context in which the model is applied.

Seepage into the waste package, again I have a whole bunch of Rs coming up with question marks meaning that most people thought it was an R and some were leaning towards somewhat conservative. I think one that I should bring out as an example of a solid R is the dissolution of UO_2 and glass waste forms. We think that because of the experimental work done in this country on our behalf and also elsewhere, we've got a pretty good handle on that and we're being pretty realistic.

If we look at the solubility of neptunium-237, this is one place where we feel strongly that we are being quite realistic and we know from discussions with the NRC that they feel quite strongly that we're not being realistic and that we're being non-conservative. So, it's an R? in that case because we know of the outside opinions of the modeling.

Formation of radionuclide-bearing colloids, we still have some work to do in the modeling. It's somewhat important to performance. We think that we're being somewhat realistic; however, the verdict is not in yet on how applicable the date is that we're applying to Yucca Mountain. There are still some questions as to the meaningfulness of the NTS data to the type of situation that were created at Yucca Mountain. But, it's in there and we think that if we are judging solely on the basis of what we know, we're being realistic.

Transport within and out of the waste package, I think most of us felt that that was quite conservatively handled. Some of us felt that there's really no basis to judge which is why there's a question mark. Transport through the unsaturated zone, we think we're being realistic. Some people within the complex feel that it's conservative. The same with transport in the saturated zone.

Dilution from pumping, that was an easy one. That's conservative because we don't consider it. It was real good to get agreement on something.

The biosphere transport uptake, we think that given the information sources that we have, we are doing a very realistic job there of assessing that. Now, there is still some controversy within the overall scientific literature. I think I've heard some very astute people say that typically all of the modeling done in this area which is all basically done the same way is conservative by at least an order of magnitude, but I'd rather have that kind of ground swell than the other kind. So, we feel that we're being conservative.

You were wrong, Holly. Nobody wants to talk about this.

If we go on now to the next subject, you wanted to know what the basis was for the TSPA/VA cladding model. And, I'd like to make a speech here. The cladding model that we're using is one that we are working on giving a better basis to for the SR and the LA. It is an open discussion within DOE whether or not we want to pursue cladding credit for the license application and I am part of that discussion. My input to that discussion will be--and I may not prevail; I often don't, you know, which gives the whole project hope--but that we should take credit where we have a basis and that what we should do for the NRC, since, no doubt, the NRC will make us do it, is evaluate it both with and without cladding credit. Now, the analyses that we're going to be asked to put in the NEPA documents, the EIS which goes out to peak dose by NEPA rules is our best expectation of what will really happen. My guidance there would be take credit for cladding to the point that you have a basis for doing so. There is no reason not to if you feel that you haven't. So, that's why even if we decide not to go into the LA with cladding credit, it's still important to have a model and to have a basis for that model.

Two types of cladding are included in our analyses. 1.15 of the total commercial spent fuel load is going to be stainless steel cladding. We write that off. We take no credit for it, at all. Zircaloy for the other part of the commercial spent fuel is the primary cladding. It has three failure mechanisms that we've been able to determine: juvenile failure, defects at the time of waste acceptance; corrosion failure, meaning generalized, localized corrosion in the repository; and mechanical failure due to rock-falls from events such as expected seismic--what's it called? It's the expected level of events. We will also, of course, look at the unexpected seismic events and their possible causing of rock-falls.

The failure analyses showed delayed hydride cracking, creep, generalized corrosion, stress corrosion cracking, and unzipping effects from pinhole and then subsequent oxidation are negligible. However, when we get to the corrosion model, it says that we did evaluate them, but we find that they are not as important by orders of magnitude as the general corrosion model.

The juvenile failure model, there's an early failure fraction due to defects introduced in the reactor during handling or storage and we have found by surveying different sources that to be about .1 percent. It includes the calculated effects of creep rupture, delayed hydride cracking, and hydride reorientation which I've already said are negligible. It looks at mechanisms leading to early failure that are not assumed to operate in the cooler repository environments.

We looked at distributions based on industry data from in-reactor, storage pool, and dry storage studies and the distribution that we are assigning is about twice as high as that reported in EPRI data. So, we believe, therefore, that we have a basis for the assignment and that we are being conservative.

If we look at the corrosion model on the next page, the corrosion rates are assumed to be 10 to 1000 times less than Alloy-22. For each realization, cladding corrosion is assumed to start at the time of the first penetration of the waste package itself. .28 percent to 40 percent of fuel areas exposed to be calculated is calculated to be exposed over a million years. So, you can see just by that that what we are saying is that somewhere between 50 and 60 percent of the fuel is still projected by cladding in a million years. This is why for the very long-term case, cladding is an important part of the modeling.

Now, what do we base this on? We have data available on generalized corrosion from numerous authors, numerous studies including Naval Nuclear Propulsion Program and EPRI. We have information on oxidation rates that predict 4 to 53 microns of zircaloy corroded for 10,000 years at 180 degrees C which we do not expect in the repository. At the repository temperature predictions, we see practically zero corrosion from this type of modeling. And, chemical conditions known to initiate zircaloy corrosion are not anticipated in the repository. Now, the caveat to all of this strong talk is that localized corrosion mechanisms and chemical conditions within the waste package are not well-understood and introduce significant uncertainty. So, we do by corrosion fail cladding over time.

The mechanical disruption model is invoked when waste package integrity is significantly disrupted. So, after about 100,000 years, you have quite a few packages that are susceptible to this. The mechanical failures assumed to continue linearly on a logarithmic scale from 100,000 to a million years--in other words this is an assumption driven progress rate--the fraction of fuel predicted to be exposed due to rock-fall ranges from .2 to 11 percent over one million years. The supporting data, structural analyses using measured fracture sizes to obtain rock-fall characteristics. The bottom line is that the rocks that we expect will fall as the repository cools, as the liner has broken down, etcetera, and from minor earthquake events are very small and would certainly not dent the waste package until after it's seriously been corroded.

If we move now to the saturated zone model that we used, the assumptions we made, the transport of the radionuclides from beneath the repository to 20 kilometers away occurs in six 1-D stream tubes. The flow paths in the saturated zone were derived from the 3-D flow model, the one that we thought as non-conservative and so we didn't use it in its whole manifestation, but we just used the flow directions. The dilution factor used to account for transverse dispersion is 1 to 100 with an expected value of 10. The groundwater flux scaled in response to climate change, the long-term average 3.9, super pluvial 6.1. In other words, these are the accelerations on the flux from the climate changes.

Supporting data, the hydrogeologic framework model determined the units encountered along the flow paths. However, there is significant uncertainty as to the location of the volcanic/alluvial interface and the Nye County drilling program that you heard about from Nye County--Parvis, I think, gave that talk, although I wasn't here--is investigating this very feature of the saturated zone.

Uncertainty in the dilution factor is taken from the saturated zone expert elicitation in which we brought in outside mixed with inside experts and got them to look at all of the information available and they gave us their best judgment. The groundwater-flux scaling factors were also taken from the saturated zone regional scale flow modeling results. As you have been told in previous meetings, I believe, the saturated zone regional scale flow model is in a joint revision with NTS and other Federal agencies that are interested in this region. There's, I believe, a five year program where we're into the second year of it of looking at the basis for this modeling and coming up with a unified model for all of the agencies concerned with this area.

Now, I was asked to make a statement about the robustness of the TSPA/VA results. I read somewhere in a newspaper that the first comment from the State of Nevada was that DOE was obviously proud of what they had done. I think that's a compliment. They read the document and said, yes, these people are proud of what they have done. I think we are proud of what we have done not because the results were so good, but because we did a good job fully disclosing all the uncertainties and fully disclosing what we know and what we didn't know.

If we look at that table that we looked at before, you know, the models were given 4s, 5s, 1, 2s, 3s.

Components with relatively low confidence like 1 or 2 are areas in which results could change significantly, but for most of these cases, we made a great effort to be conservative in the way we treated them. So, if the modeling is improved, we don't think it's going to give us any surprises and raise the distributions or parameters that we sample from greatly beyond the ranges we've already assumed. Where we had high confidence in the modeling, we are not expecting things to change considerably because we are pretty well-satisfied that we've got a good handle on that process.

Another thing that gives us confidence that we're pretty robust is if we look at our past TSPAs, our own as well as the NRC's, EPRI's, and even if you go back into the '80s by others, they all show the same components as important. The does rate history curves for more recent TSPAs are broadly similar. Yes, there are differences, but they're broadly similar in magnitude among recent TSPAs by ourselves, NRC, and EPRI and we understand the differences. So, we feel that we are creating a pretty robust product at this point.

I was asked to say something about TSPA/VA and it's very important we use the word VA here with TSPA and defense-in-depth. Volume 3 of the TSPA/VA explicitly acknowledges the need for defense-in-depth analyses, but also makes very clear that the TSPA/VA does not provide such an analysis. On

Page 6-2, Page 6-17, I have direct quotes out of the document. We acknowledge the necessity for doing these analyses, but we say TSPA/VA is not that analyses.

On the next page, defense-in-depth is being addressed as part of the enhanced design alternatives effort which is currently in progress and which some of you in the panel meeting have had presentations on. All TSPA/VA tools are being used to define the base case for those analyses. You saw some of the results from some of the one-off studies that were done. They are systematically neutralizing barriers and it's a first order approximation of that barrier's importance to performance. Of course, it is not a totally quantitative look at the effects of these barriers because in the modeling, these barriers are all linked together. There is no barrier that you can take out that would not have influence on the barrier above it and below it. So, these are stylized first order approximations of what the effects of those barriers are.

And, defense-in-depth from the EDA effort has been defined to mean that neutralizing any particular barrier still allows the system to meet performance objectives. So, TSPA/VA has a role to play in defense-in-depth, but you will not find TSPA/VA claiming that it makes statements about defense-in-depth. In fact, I'll show you two places where it says we did not do this.

I was also asked to say something about the uses of TSPA/VA and you'll see that the uses is a long list and the misuses is a short list. But, first of all, we wanted to provide insight into the relative importance of various components and the uncertainty in those components to determine what may be achievable in terms of systems performance. We, ourselves, wanted to look at how good is this system. We wanted to enhance our ability to communicate assumptions and results with various audiences. Hence, you see that we have put a lot of time into creating illustrations that can be talked from to a non-technical audience. We wanted to test our ability to produce traceable and transparent results. I appreciate the fact that the overview is transparent and traceable.

The real test, however, is if a member of the public who can speak some technical language can read this document and figure out what we did and why. It will be interesting to get feedback on that as time goes on. I'm glad to see that people are snapping up the overview with the CD-ROM inside it because if you're interested in any particular topic, if you can read the CD-ROM with the Acrobat Reader, you can search on words and you can follow the concept all the way through the document.

We wanted to determine where our strength and weaknesses lie in terms of data, assumptions, and models and the QA effort. As you know, we have a lot of work to do in all of these areas. However, TSPA/VA, again VA, cannot be used to assess compliance with the regulatory standard, real or conceptual. It cannot be used to demonstrate defense-in-depth. You cannot use it to assess the importance of small design changes; large changes, yes, but small nuances of change. When you look at the pyramid of models that feeds into the TSPA/VA, a lot of the detail and the process level modeling is stylized or abstracted for the system level modeling and so you can't use a system level model to look at the nuts and bolts of a problem. You can go back, however, to the process level model and look at a performance surrogate measure and evaluate that particular aspect of things. But, I think sometimes we expect too much from a top level model. And, you should not use TSPA/VA to determine system suitability or unsuitability. This was not the purpose of the VA.

We are currently making improvements to the model and the component models also are being--we think they are being improved. This will allow a future TSPA within a year or two to support a system suitability finding that will be part of the site recommendation report. And, all of our work, as Steve says, has now moved away from the VA and is working on preparing to do an SR that's defensible.

No questions? Thank you.

COHON: Abe, thank you very much. That was excellent and we especially appreciate your responsiveness to the questions we posed. You responded to every one and we thank you. That doesn't mean we don't have questions.

I need to have something clarified. The Table 17 with the Rs and Cs, I don't think this is significant because the new information in this table is the confidence and the relevant conservatism. But, that middle column, the significance of uncertainty, doesn't seem to agree with Table 6-1 from Volume 3. If there's simply a disagreement in--I mean, if we simply transfer your information incorrectly from one to the other, that's the end of that. But, if there is actually a shift here in the modeling team's view of the significance of uncertainty from what the table in the VA says, then we need to know that.

VAN LUIK: I believe, we have an answer to that question. I'm going to ask Holly to give us that answer because I think it depends on where you look at the VA.

DOCKERY: Holly Dockery, M&O. The significance to performance in this particular table was actually taken from Volume 4 of the license application plan. In Volume 3, the significance to performance was simply what do we show from the analytical results. In Volume 4, we started to introduce the uncertainty performance that was judgment.

COHON: No, I got what you're saying, but that's not correct. I'm holding Volume 4. This is Table 6-1 from Volume 3 unless I've screwed up with my access from the CD-ROM. This is from Volume 3. So, for example, it says hints of uncertainty of unsaturated--in the mountain is low, but that says it's--

DOCKERY: Is that the Table 6.1 from Volume 3?

COHON: Right.

DOCKERY: And, I'm saying that where the--there was two places in the VA that significance to uncertainty for performance shows up. One is in Volume 3 where we simply said the change that you would see based on the curves that come out of PA is one thing, but we said--this reflects Volume 4 because we were starting to say what kind of confidence do we have overall with our intuition, as well as our--

COHON: Okay.

DOCKERY: So, that's the disconnect.

COHON: Got it, okay. Thank you very much.

Questions?

CRAIG: Craig, Board. First of all, that was absolutely incredible. It was clear--

VAN LUIK: No, that's the wrong word.

CRAIG: Score another one for you. Anyway, that was a really class act. You're hot today.

That's actually the primary thing I wanted to say.

But, I do have a question because the other day we heard the one-off or neutralization discussion on the C-22 and that led to a graph that was already referenced here several times. Clearly, that's not part of TSPA/VA. So, in some sense, I can't ask the question. But, in order to tie it in with TSPA/VA and understand how to think about that one, your Graph #14, the one with the horsetail diagrams, you do have a discussion on what happens to the Alloy-22 corrosion rate and the fact that that is relatively insignificant in that particular Graph #14. It appears on the face of it to be somewhat inconsistent with the one-off neutralization. So, what I'd like you to do, if you would, is to discuss--help me to think about the difference between those two graphs, tables?

VAN LUIK: Okay. Could you put up #14, please? While he's getting there, this shows the four most important parameters from the regression analysis which, as I said, should have included cladding, but would not include cladding because we had very little uncertainty in that model.

The way that I would read this is not as quantitative as I might have suggested, but I would have said that the two most important parameters to determining does at 10,000 years are the Alloy-22 corrosion rate and the seepage fraction and the fact that they are a few points apart doesn't surprise me--I mean, doesn't bother me that much.

So, I think I would take some issue. This graph clearly says that one of the most important attributes of the system is how long that inner barrier lasts and I think that's what the neutralization also suggests; that there is a big jump, although not a huge jump, in those if you neutralize that barrier for 10,000 years because the outer barrier is very important for the first 10,000 years and that's left intact when you neutralize the inner barrier.

SAGÜÉS: Very good. Sorry that I was a couple of minutes late, but Don filled me in about your initial comments about medians versus means and so on. But, I have one question connected with it. Like, if we go to Item 9, Slide 9?

VAN LUIK: Yes, sir.

SAGÜÉS: Now, do I understand--am I reading those correctly then that the 95th percentile is about, oh, anywhere from 3 to 10 times higher than the mean in most of those graphs? Is that correct?

VAN LUIK: Yes.

SAGÜÉS: I see. Now, if we now go back to one that you didn't show, but you are paying for it because it was quite exciting, the same transparency that Paul mentioned in our repository panel meeting, in which they showed a maximum dose--or a dose of about 1 rem after 3,000 years in the case of neutralizing the cladding. Now would the--

VAN LUIK: Alloy-22.

SAGÜÉS: The waste package itself, right. Now, in that case, what would have been the 95th percentile in that case? Would it have been also about 3 to 10 times higher than that thing which I presume must have been the mean?

VAN LUIK: The reason that I can't give you a straight answer to that is because we have not done that type of analysis probabilistically. What we have done is taken the deterministic case that I explained first and just done on the one-offs for the defense-in-depth off of that case.

SAGÜÉS: I see.

VAN LUIK: The one that you're referring to with the huge spike is the one where they neutralize both barriers, is it not? So, basically, you have naked waste in the geosphere?

SAGÜÉS: Right.

VAN LUIK: Right.

SAGÜÉS: You still have the cladding, I believe, but they didn't take credit. So, now, when you have the deterministic case, do you get something similar to the mean in these graphs?

VAN LUIK: The deterministic case is not the mean that is shown in this graph. The deterministic case was a mean input case which was used only for the one-off studies.

SAGÜÉS: I see. Sure.

VAN LUIK: These right here are the results of different--

SAGÜÉS: This is different, right.

VAN LUIK: Yes.

SAGÜÉS: But, what I'm saying is is the result sort of comparable to the one that you gave--

VAN LUIK: Yeah, it's about that much different. It crosses it in a few places for some realizations, and for other realizations, it's not that much different for-- especially for 10,000 years. It gets a little bit more different for the very long-term.

SAGÜÉS: I see.

VAN LUIK: But, there's a big difference between mean inputs and then the dose that comes from that and then doing a mean of the 100 output realizations which is what these are showing. So, you know, they're both mean cases, but one is a deterministic input case and the other one is an output case.

SAGÜÉS: Sure. But, the actual numbers wouldn't be terribly different?

VAN LUIK: They wouldn't be terribly different, no. I think there might be a difference like 300 to 100 or 200 to 100.

SAGÜÉS: I see. We could expect then considerably the equivalent 95th percentile case would be expected to be somewhat higher than that?

VAN LUIK: Oh, yes. Yes, I think so.

SAGÜÉS: And, maybe quite a bit higher because of the--

VAN LUIK: Yes. And, I think, the point should be reiterated that these are calculated along the lines proposed by NRC for 10 CFR 63 compliance type calculations.

SAGÜÉS: Yeah.

VAN LUIK: Okay.

SAGÜÉS: Okay. I have another question and this is something quite different which is the matter of the corrosion rates for metals which are in the passive state. Indeed, a lot of the effect of the inner barrier in the waste package is due to the assumption that the material will stay basically passive for extremely long periods of time. As we know, the use of metallic passivity for corrosion protection is a relatively very recent trick. Immunity to corrosion due to--stability of the metal itself is something that is documented by a number of analogs. We just don't have such a thing for passive metals; at least, not for particular alloys. And so, there is an assumption, a basic assumption, a basic mechanistic assumption, behind all this which is that whatever has happened in the last few decades from the point of view of metal passivity applies to behaviors that will take place over, say, periods that are enormously--there is, I will say, qualitative scientific problem, perhaps is the right term to use, to solve which I think that that should, at least in my own opinion, should figure permanently in how to address what needs to be done in the future. In that connection, if I look at your transparency--

VAN LUIK: So, you would support the continuation of our materials testing well beyond the license application?

SAGÜÉS: Well, in this case, it would be--that would be a different kind of problem which is to see what evidence is there that could convince everyone that passivity will be sustained over periods of time that will be much, much greater than any--distance can be conducted. And, for example, looking for natural analogs may be one of the more productive ways to go and, of course, looking at fundamental issues on what it takes to retain passivity for a long period of time. I mean, the connection, if we go to Page 20 or Page--which one is it--Page 20, yes. Yes. In 20, you mentioned under supporting data for zircaloy which is another case of the passive metal, it says information on oxidation rates predicts 4 to 53 micrometers of zircaloy corroded for 10,000 years. Is that in a liquid environment or is that in a gaseous environment?

VAN LUIK: I was under the impression this was in a liquid environment, but perhaps the metallurgist here is familiar with the Livermore work or is familiar with this--like Dave Stahl, for example. Are you familiar with this information, Dave?

STAHL: David Stahl, M&O. There were two calculations done; one for the atmospheric oxidation and the other was for aqueous corrosion. They're both very low and I'm not sure which one this rate applies to, but there's a lot of data out there from the industry, as well as from the Naval data. I'll have to get back with you later to confirm which of this is applicable to.

SAGÜÉS: Right. And, I don't have any problem if someone shows me a zircaloy rod that has been in a given environment for, say, 20 or 30 years or something like that. I mean, only a fraction of a micrometer. That's fine. Now, to talk about sustaining this over a period of hundreds of years or tens of thousands of years, it's quite a conceptual leap. We are talking about dissolution rates. If the numbers that we're doing here are right, they'll be in the order of maybe 1 atomic monolayer for every 10 years for the lower end for the 4 micrometers on 10,000 years. That is, of course, pretty much beyond anything that we can assert with present knowledge for very long periods of time. There could be all kinds of things such as, for example, suitability of zircaloy--in water. There might be limits that are no known and so on. So, I think that doing those numbers at this time and indicating that that may be a projection or a nominal projection or if things behave as if they would be doing such a thing, that kind of language perhaps is appropriate, but to view this as a prediction based on technical knowledge, I think that that is perhaps too much. I would like to know what you have to say about that?

VAN LUIK: Well, the impression I get from what you're saying is that you're the second Board member that's saying my talk is incredible. This is clearly an area where we are doing some concerted work to overcome exactly these kinds of what are perceived by some in the industry to be leaps of faith almost. And, as I have said before, if we have a basis that's defensible, we will go forward with a cladding credit. Of course, if we don't have a basis, we will not. And, I think that you're making a strong statement that the basis that I've shown here is incredible.

KNOPMAN: Knopman, Board. I have two questions, Abe. The first has to do with the bullet on your last slide which was Page 27. You talked about how you're trying to improve the TSPA and the component models to a support system suitability finding. Besides model enhancement or component model enhancement, what sort of structural changes are you contemplating for TSPA itself that would be quantitatively/ qualitatively different than what you've got for TSPA/VA? What do you think you need that you don't have now besides better component models to use it in a site suitability context?

VAN LUIK: Is the question whether or not the structure of the model itself needs changing?

KNOPMAN: Yes?

VAN LUIK: I believe that we are pretty satisfied with the structure of it. It's the latter part. It's the components such as the model that was brought up on cladding. It's the components and their technical basis that need work more than the structure itself. The saturated zone model, we are looking at, for example, getting a completely new, saturated zone model this spring. We will then abstract it and pull it in. That would not be, however, the first category of things which is a restructuring of the capability, for example, of the RIP code itself.

KNOPMAN: I ask this because it leads into the second question. That has to do with what I think is a divergence of view here between DOE and NRC on what the definition of defense-in-depth is. And, since TSPA/VA explicitly did not come to grips with the defense-in-depth, it was to be left for later analyses, I'm wondering how you will adapt TSPA to accommodate what appears to be the NRC view which is not this one-off analysis approach. Now, I may be wrong about that, but that's what I was trying to get at.

VAN LUIK: Yeah. I think I would love to get a statement from the NRC as to what their view is, but I think what I heard yesterday was that they want us to make a statement about defense-in-depth, but they're basically leaving it to us to define what that means and then they will look and see whether that's acceptable or not. I think as time goes on, we will probably have more of a dialogue with them. We have exposed them to the method that we're using at this point. We didn't ever get feedback from them on the spot that either showed that they were thinking this was wonderful or terrible. But, we did get some feedback from the ACNW to whom we were presenting it that it was positively received at least by them. So, I think this is something that as the dialogue continues we will certainly find out what it is that they like or don't like about the approach. But, I think if the implication is that we are going to quantitatively model defense-in-depth to the same defensibility degree that we're modeling the licensing calculations themselves, I think that was never our intent. Our intent was always that this would remain a scoping, almost qualitative look, and I think we have people lined up to either help me out or contradict me here.

DOCKERY: I wasn't thinking you were heading into defense-in-depth, but some of the specific total system improvements that we feel the need to make, for instance, our waste package degradation model is external to the total system analyzer. We want to bring that inside so we can sample better. The disturbed events, volcanism, seismicity, nuclear criticality, most of those models were run independently and then we did some kludges as far as how we analyzed that. And, how did rock-fall effect the waste package degradation and then how did you get that into the total system? So, there's some lack of seamlessness right now in analyzing the whole suite of models and that's where I think we'll put most of our total system model development is to try to make sure that the models are all internally consistent and run from the same analyzer so we don't run into inconsistency problems as we did, obviously, in the VA. And, I think I wouldn't change what Abe's answer was on the defense-in-depth. That's something that is still evolving. We're still trying to understand exactly how to utilize that and what's the best method to go forward with that. But, I think we'll be doing some--we'll continue to do them in a stylized manner rather than fully probabilistic.

KNOPMAN: I just want to make sure I understand then the first part of your answer that there are model interactions that you can't quite do very smoothly now because you have certain models that are kind of external?

DOCKERY: Yes.

KNOPMAN: You plug in their output into the--so that you'll be able to get better modeling of component interactions in an upgraded TSPA?

DOCKERY: Correct.

KNOPMAN: Okay. Then, that should play into defense-in-depth analyses, presumably?

DOCKERY: Yeah, well, it certainly will in an indirect sense feed into all aspects of how we utilize the TSPA and how we compare. But, we did find that we introduce inconsistencies. When you run things externally and then try to kludge them in, it certainly doesn't take care of all the interactions you'd like to take care of. So, this will help run some of those models more effectively.

VAN LUIK: But, let's not make promises here. When we have the model with all of these things incorporated fully, it's still basically the same umbrella at the same level of detail and to neutralize a part of that is going to be somewhat less quantitative than analyzing that part because of all the feedback loops to the barrier above and the barrier below. That, by definition, has to be a less quantitative type analysis and a first order approximation, no matter what your model structure is.

Did you want to change anything in this answer, Dennis? Is that okay to bring him up? He's the author of the work on defense-in-depth.

RICHARDSON: Dennis Richardson, M&O. I'd like to just address just for a short minute the difference between NRC and us. I don't believe we have really any major difference. We're going above and beyond right now what we understand

NRC requirements are. But, we want to insure our methodology also meets what they require in terms of identification of principal barriers, how the barriers contribute, and things like that. Now, where we go above and beyond what they're requiring is to help us insure we do come up with, what I call, a robust design and everything. But, what we're doing in terms of what you saw in the defense-in-depth presentation is not being required by the Commission, but it's in part to support their needs and also to support our needs in terms of what we're trying to do.

The one question you asked about the difference between what you showed for the waste package and what we showed, when we do the neutralization, we totally neutralize the effect of the waste packages in keeping water off the waste form. Now, of course, when they do the sensitivity on this, they're staying basically within the bounds of the probability distribution function. So, it's two totally different viewpoints of looking at something for two different purposes. So, you don't want to be confused on that point.

BULLEN: Bullen, Board. As you move from viability assessment to site recommendation, maybe this is a semantic difference, but I don't think you should use the word "cladding credit". The reason I say that is because Dennis Richardson defined for us earlier in the week "principal barriers" and a principal barrier which he defined is either one that lasts 1,000 years which is a fair fraction of the 10,000 year potential regulatory time frame or one that limits the release rate to 10^{-4} per year which is a fraction of 10 times more than the 10^{-5} per year that was a previous regulatory requirement. In using "cladding credit", you're identifying cladding as a principal barrier that you have to have a QA pedigree on. My major concern with that is that you're not going to have it. I have no concern with you using "cladding credit", but not by that name, as maybe waste form degradation modeling or however you want to do it. I know that sounds like just semantics, but waste form degradation modeling doesn't in my estimate call cladding out as a principal barrier that has to meet NQA-1 standards for fabrication, even though the cladding did when you originally manufactured it. I don't know the history after that and I don't think we want to spend the money to get the history of cladding on, I don't know, millions of spent fuel elements that are going to go into the repository.

So, in your modeling effort, if you don't call it out as a principal barrier--and I don't know how we're going to define that as you continue to do your SR TSPA--whatever model you develop that addresses Alberto's issues of is there localized corrosion, do I have pinhole failures, as an egress-resistance, cladding is probably an excellent material and identifying what fraction of the clad is wet or dry or whatever is very good, but I don't think it's a principal barrier. I've said that many times. I just wanted to be very explicit in this instance why I don't think that you're going to get a license for cladding credit. You can get it for waste form release, but not cladding credit, per se. I think that was a soliloquy, not a question. I just wanted to let you know that's the way one Board member feels, not the Board policy, as Chairman Cohon tell us.

VAN LUIK: Thank you very much. In our ongoing discussions, we will definitely take this under advisement.

RUNNELLS: Runnells, Board. I know, Abe, that you don't want to get into the details of your table on Page 17 because it could take the rest of the week. Therefore, I'd like to get into a detail on the table on Page 17, but try to keep it less than a week. Okay?

The reason I get into it is because I think the designations that you've used there on transport in the saturated zone miss what could be so profoundly important in the long-term. I mean, I would make your half circle there, the half dark circle fully black and very, very large because if you get into the long-term, 100,000 year to a million year time frame, you're talking about neptunium and plutonium, plutonium in the colloid form. And, knowing how those are transported in the saturated zone is so critical for that long-term and specifically it's a technical detail, but I want to point it out. The redox chemistry, if it can be demonstrated--if it can be discovered, if we can show what the redox chemistry is in the saturated zone, whether it's mildly oxidizing, mildly reducing, strongly reducing, it has a profound impact on whether or not neptunium will move. And, in many of the modeling efforts that are--many of the modeling results that have been shown to us in the 100,000 to million year time frame would be changed profoundly, if neptunium enters a reducing environment. It will not move. And, I'll say the same thing about the absorptive properties of the alluvium through which the water would have to move down-gradient. The work on transport through the alluvium in the context of both neptunium and plutonium colloids could change the entire prediction in terms of the long-term.

So, again, that's certainly not a question. I see you nodding your head up and down. So, I think you're saying yes. I would urge the appropriate people to think very deeply about the importance of transport in the saturated zone.

VAN LUIK: Yes, I'm one of the appropriate people and I think that the mark here signifies that the current--if the ongoing work supports the current modeling view, then it's of somewhat less importance. However, I am personally very eager to see the results of the Nye County drilling program and of the testing that we will do on the material supply to us because I'm very interested in the redox potential and in basically the chemistry as we go from the volcanics into the alluvium. Just where that contact is is very important and what the properties are of that material is also very important. That's why I think at this point, given what we know, we're being reasonable or conservative. We may be doing something very conservative if it turns out that it's strongly reducing.

RUNNELLS: You know, I agree with on, I think, that VC would be appropriate if it turns out to be strongly reducing. It would be very conservative.

VAN LUIK: Yeah.

COHON: Abe, a point of clarification, is the table up on the screen now for the 10,000 year period only?

VAN LUIK: When we had our little deliberations, the column on the right side was not for 10,000 years only because--

COHON: What about the significance of uncertainty?

VAN LUIK: Significance of uncertainty, I think, no, it was significance--it was the peak significance for 1 to 10,000, 10,000 to 100,000, and 100,000 to a million.

COHON: This is somehow an amalgam of all?

VAN LUIK: It's an amalgam. Whichever one it was highest in, that's the one that was shown here.

COHON: Okay. Thanks.

CHRISTENSEN: Christensen, Board. This is just a short question. On the table around Page 14 where you rank the relative importance, what are the units there? Are those just--

VAN LUIK: Oh, the units, it's like the R squared of a regression analysis. So, you can say that--for example, the seepage fraction, I think that's close to 17--that's 17 percent of the variance and the dose is attributable to the variance of the seepage fraction. Although I was a statistics minor in college, I have learned since then that sometimes I misspeak these things, but that's the way I interpret it. That's why I said, you know, if that was .88 or something, then you know, we would definitely have a one parameter repository. But, it's .17. So, there are other things that are also important to determine in performance.

Can I have Holly add something here?

DOCKERY: Yeah, it's the R-squared law. So, basically, as you run your analysis, if you run it again taking that variable back out, how much does your variance decrease as you take each individual piece out? So, you're just seeing how much uncertainty does that parameter contribute to your overall analysis.

CHRISTENSEN: Just maybe one follow-on to that. Then, if that's the case, it also has an uncertainty associated with it; that is there's a--

DOCKERY: It is the--yes. What you're seeing is how the uncertainty in this parameters affects the overall does rate history curve. And so, when you take that parameter out, how does the spread in those horsetails collapse?

VAN LUIK: And, it's taking the uncertainty of the parameter out, not the parameter itself. You set the parameter and then you see what the difference is.

DOCKERY: Yes. You can't take all the parameter out because obviously it would be non-physical.

VAN LUIK: Yeah.

CHRISTENSEN: I see, thank you.

COHON: We have four people who still want to ask questions and I haven't gotten my chance to ask my 45 minutes of questions. So, I would ask--and I won't. But, I would ask my colleagues to limit their questions, please, and let's not get a long dialogue if it's not of the utmost importance.

Priscilla Nelson?

NELSON: Nelson, Board. Okay. I'm trying to do this. You mentioned--indicated the use of TSPA/VA shouldn't be applied to really assess the importance of small design changes. So, relating to that, TSPA is going to be used to the EDA process to try to evaluate them. Are features such as under discussion considered small design changes, and accessory to that, how is the thermal pulse load consideration included in TSPA? Is it in there now?

VAN LUIK: The thermal pulse is in there and if a design change affects the thermal pulse, we can evaluate that quite quantitatively and quite directly. If another design change affects one of the major processes included in TSPA/VA, of course, then we can analyze it on the basis of the change in that process. However, if we are looking at some nuance of geometry or some nuance of something on a very smaller scale that does not really change the broad brush processes that are captured in TSPA/VA, then we need to drop down to the design analysis models that the designers use and look at a surrogate performance measure and judge the viability of that change. I think, you know, the Board was right to call us on this a year ago and said you're being rather cavalier about how you're going to use TSPA/VA and we found out from experience that you're right. That where major perturbations and major processes are concerned, we can give a very good picture. Where you're talking about small nuances of change, this is too gross a tool to look at those kinds of changes. We need to just drop back to the process level.

COHON: Good question. Thank you.

Jeff Wong?

WONG: Abe, there's rumors that there's some QA problems out there and I want to know if you could tell us which one of these items might have the biggest QA problems or if you have a column that ranks them 1 to 5 in terms of QA problems, least to worst?

VAN LUIK: Now, you have me on something that I'm speechless on. It doesn't happen often. I would not be prepared to make up a ranking on QA problems at this point. All I can say is that we have such a list of the date inputs and the status of the QA pedigree for all those inputs. We have, I like the word, "concerted effort" in place to make sure that that pedigree exists within a year or so. Beyond that, I mean, you know, you would have to give me a very specific example because these broad categories involve information from both science and design, some of which has a QA pedigree, some of which does not. So, what you see in the VA where it says QA indeterminate is that we recognize that maybe two inputs had a QA pedigree, the third one did not, but therefore, we ran it through an analysis and by definition it becomes, you know, indeterminate.

So, I am not prepared to make such a table, but we could if we had to. I think that we have a comprehensive catalog in-house of where we need to put our QA effort to address this problem.

COHON: While this is up on the screen, Abe, do you feel that the areas where you have relatively low confidence match up well with the areas of continuing research?

VAN LUIK: If you take relatively low confidence and also look at the impact on performance, I think, they're almost a one-to-one match in Volume 4 which Carol will get to. In fact, this is the basis for making those judgments where further work still needs to be done in a hurry.

COHON: Thank you. Dr. Forsling?

FORSLING: Listening this morning about the presentation about site characterization and now TSPA, I couldn't hear one word about microbiological activity or bacteria. You haven't included that, at all, in your modeling and I would like to know why?

VAN LUIK: Just because I didn't mention it does not mean it's not included in the modeling. It is included in the process level modeling which we have abstracted into the total system assessment. We have ongoing work in this area because, frankly, in the waste form and waste material testing that we've done, there was never any effort made to exclude bacteria. So, we feel that we need to do some work to assess what bacteria were present in the work that we have done as already captured in the modeling and then we also have some work where we're extracting bacteria from the rock of Yucca Mountain, growing them, and seeing if they have any impact on the materials. This will result in modifications of the modeling. But, we believe that right now we have pretty much captured, you know, the range of possible influence that that can have. There's a discussion within the VA itself that goes into this in some detail, especially in the technical basis document.

FORSLING: I can foresee some horrible movie from Hollywood when some mutated creatures coming out of Yucca Mountain.

VAN LUIK: The mutated creature is not a naturally occurring one. So, it becomes a different event.

COHON: Are there any other questions from the Board? Dr. Rydell?

RYDELL: In your cladding model, you omit or overlook one failure course and that is internal over-pressurization from helium. All cladding will ultimately fail since alpha decay result in helium production. The question is how long time it takes? It's truly no concern in the 10,000 year time zone that NRC indicated today, but if you extent the analysis to 100,000 and one million years, you can't neglect it. We know more about boiling water active fuel than pressurized water active fuel, but boiling water active fuel is likely to start to burst in helium over-pressure at around 100,000 years and pW pressure water probably holds longest since they have an initial over-pressurization anyhow. So, the helium contribution is smaller, but I think you should include that in your analysis.

VAN LUIK: I will check and see if that is included. I thought that we had included it and Dave Stahl is shaking his head yes. Is there some response you'd want to make from the work that you're familiar with?

STAHL: As part of our literature survey, we have looked at the helium pressurization issue. I'll have to go back in and look at it, but it's my recollection that it's not a concern. Certainly, the temperature is dropping significantly in the first few thousand years and then beyond are ambient. So, we don't expect a problem, but we can confirm.

COHON: Last question is Leon Reiter's.

REITER: Abe, this interesting table there, this just--for example, I'm a little puzzled about the chemistry and the way the waste package--again, 6.1, this was shown to be a very significant factor and what they pointed out was the problem of pH as a result of concrete. There, according to your own calculations, I guess, you made the assumption that the concrete in the liner would collapse and have no effect on the pH of the water. But then, you showed that if it did have an effect, I think a pH of 11, the dose increased in the first 10,000 years by three orders of magnitude. How do you call your modeling realistic or conservative? I've forgot what you say there?

VAN LUIK: Well, the reason that we called it realistic is because we folded that in and probabilistically sampled the occurrence of either the high pH water or what we think is the more likely pH water. So, we think that we have covered it in the range of things that we sampled from.

REITER: So, this is your probabilistic case?

VAN LUIK: The probabilistic case. We feel that we were sufficiently broad in the conditions that we assumed and modeled over that we capture the somewhat less likely scenario of having high pH waters.

REITER: Okay. Well, the deterministic case then, you assume that it had no effect on the pH?

VAN LUIK: In the deterministic case, we assumed no high pH water, that's right.

REITER: But, on the other hand, you assumed that the cement on the invert was retarding all along. That the cement on the invert, the concrete of the invert, remained there and retained its retardation characteristics all along?

VAN LUIK: Right. Right. And, when you see in the defense-in-depth calculation that when you remove that effect, you change very little. That's a very small effect.

REITER: So, is that a conservative best estimate?

VAN LUIK: I think it's a best estimate. It would be probably not conservative.

COHON: Thank you, Abe. We appreciate it very much. Don't let this go to your head, though.

VAN LUIK: No, if Holly thinks that I just misspoke, she ought to correct me.

DOCKERY: Before we get to the MIC, there was just one point of clarification I wanted to clear up. That is when the expert panel on waste package degradation was elicited, they believed that the nickel alloys were not very susceptible to the corrosive behaviors of microbes in the chemical--or chemical and temperature environments were not conducive to initiating much corrosion and mostly it changed the crevice density and initiation and corrosion rather than substantially changing. So, for the base case, MIC, although it was considered, it was not actually included in the base case because of the guidance by the waste package degradation expert elicitation.

COHON: Against my better judgment, Abe, I guess you've done such a good job, we don't want to let you go just quite yet. We'll entertain and it has to be the last question from Alberto Sagüés.

SAGÜÉS: The last word, not quite. Humidity and temperature and the waste package is given a very low importance rating. However, I think that that is because of the uniform corrosion rate temperature dependence is not very important dependence in the--but it will have a tremendous importance in something such as the initiation of pitting or crevice. Indeed, if you go above a critical temperature, you have localized corrosion. If you're below that one, you're not likely or a lot less likely to have it. Indeed, I would view that as being one of the most important reasons to go to a cool repository when looking at the alternatives. Indeed, I would view that as perhaps not the most important, but certainly one of the very most important ones. What do you have to say about that?

VAN LUIK: I would say I'm glad that Dave Stahl hasn't left the room. But, it's my impression from speaking to the people that did the analyses that over the ranges that we considered, we don't think an improvement in the model would do anything to throw us into an even higher state of pitting initiation or other things. But, we basically in this model have realistically captured the possible range of temperature and humidity. Now, you are very well aware of our modeling, and if you disagree, I guess you will let us know. I believe that's the reason that we came up with the realistic is that even if you refine the model, you are not going to change the results that much. When we look at the--for the EIS, we're looking at calculations at lower thermal loads. The corrosion is not that important to determine and of the difference between the high and low thermal load which is counter-intuitive because I felt the same way that you did, but somewhere in the modeling, other factors come into play that make a difference.

COHON: Take it outside if you want to--

BULLEN: He won't make it outside. I'm going to talk to him right after--

COHON: All right. Thank you very much, Abe.

VAN LUIK: Thank you.

COHON: We'll take a break now and reconvene at 2:50.

(Whereupon, a brief recess was taken.)

COHON: We move now to Volume 4 of the Viability Assessment, the license application plan. The presentation will be given by Carol Hanlon.

HANLON: Good afternoon. I'm Carol Hanlon and I'm pleased to have the privilege to speak to you this afternoon about the license application plan which is, of course, Volume 4 of the viability assessment. My discussion today is focused around the points that the Board has asked us to consider in preparing this talk, and therefore, it's not comprehensive. You'll probably thank me for that.

COHON: Excuse me, Ms. Hanlon. Can I ask people to, please, be quiet. If you want to talk, please, go out in the hall. Thank you.

HANLON: Also, one of the topics that you had asked me to address is corrosion. I do address that in my talk because of its importance and the concern today. Dave Stahl is going to give some extra additional information on long-term plans and the status of corrosion.

So, I'd like to begin with the purpose. To put the presentation in context, I'd like to go back to the purpose and the specific guidance that we received in the Civilian Radioactive Waste Management Plan, as well as in the Energy Appropriation Act for the purpose of the license application. That is to identify the remaining scientific investigations and engineering information needed to complete the license application with the goal of submitting a long-term docketable license application to the Nuclear Regulatory Commission. In addition, another goal was to identify the costs associated with securing this information.

There were considerations that we were asked to look into as we went forward with the license application and, as was previously mentioned today, give us an opportunity to assess a revised approach. We drew on our available models and data describing the natural system, the repository, waste package design. We drew on and coordinated with the total system performance assessment. We closely correlated with the repository safety strategy and we considered the performance confirmation program which is, in fact, one of the elements of our postclosure safety case.

So, I'd like to discuss the use for which the license application was intended and uses for which it wasn't intended. It was intended to provide an understanding of how DOE has identified and prioritized major areas of work remaining to be completed during the next four years, to describe that work and the major areas. It was also intended to generally discuss statutory and regulatory activities and necessary supporting work and to present the schedule and costs for the work identified. And, as always, the goal remained a docketable license application.

License application plan was not intended to provide lower level detail on work activities identified. That lower level of detail is available in the detailed information on work activities in the annual plans and the multi-year planning system. Lower level detail is also available in work plans and procedures which are identified in individual work packages and they are available in the record system. It was also not intended to provide extensive detail on statutory, regulatory, or support activities such as the quality assurance program, preparation of site recommendation, and license application. Details on those specific areas are provided in separate management documents for each area; for instance, the license application plan.

So, to illustrate how the license application plan meets its purpose or objective, I'd like to briefly discuss the organization. I'm not sure if you can hear me if I step away. The license application draws from the site description presented in Volume 1 and the reference design presented in Volume 2, also the performance assessment in Volume 3. It has, of course, seven sections.

I'd like to call your attention to the overview.

The overview, as Jerry King said this morning, may be the only thing many people read, but it provides a very comprehensive and I think a very good treatment of the whole volume. It's very useful.

The two most important items in the license application plan are probably the rationale for work needed to complete the license application and the technical work itself. And, of course, that importance comes from the fact that they take us forward to our docketable goal, our goal of a docketable license application.

I've highlighted--you can see, but I cannot--the fact that in the rationale, there are some areas that we also consider to be of even more importance. That is the postclosure safety case with the 19 principal factors discussion. Also of great importance is the technical work plans. Statutory activities; considerations of EIS, environmental compliance, site suitability, and so forth are addressed in the fourth section. Support activities that support the work to be done, such as field construction, operation, information management, and so forth are in the fifth. The cost for the license application according to the summary schedule are in the sixth section. And, the schedule is in the seventh.

In terms of areas of emphasis, as I've mentioned, we have emphasized the rationale for the technical work. We have emphasized the postclosure safety case. We have emphasized the expected postclosure performance. We've emphasized the principal factors of postclosure performance and the technical work plans.

In going back a bit through the more than 15 years of information that we have been developing about the site, we have used that information to bring us to the point where we have developed our site and design process models. The information and understanding there we have used for the TSPA/VA and that has led us to develop the repository safety strategy with its four attributes which are the major concerns that we believe are the major important attributes conceptually of the repository. Also, the repository safety strategy gives us our framework for integrating the site, design, and performance assessment information that we have and will accumulate.

Also, that understanding has led us to develop both our postclosure safety case and the preclosure safety case. Here in this slide, I've just identified the five elements of the postclosure safety case which are the assessment of expected performance with the 19 principal factors of repository performance; design margin and defense-in-depth, consideration of disruptive processes and events, insight from natural and manmade analogues, and performance confirmation plan.

In considering those, I just might say that I believe those first three elements of the postclosure safety case really work intimately together and actually cannot be separated. In order to understand how your site is expected to perform, you must understand your design margin, your defense-in-depth, and you must understand your disruptive events and processes. The fourth and fifth elements of the postclosure safety case are rather different. The insights from natural manmade analogues give additional supporting and confirmatory information to support what we have come to believe about the expected performance and the performance confirmation plan works through time to insure that that understanding is correct.

Also, we identified that the understanding and the information that we developed through our site characterization has allowed us to develop the preclosure safety case and it has four elements which are similar. The first, systematic evaluation of design basis events, actually really is very similar to assessment of expected performance.

So, with all of those elements, both of the postclosure and preclosure safety case, we have taken the steps of discussing the current status. We have identified information needed. We have discussed priorities of the information. And, we have presented technical work plans to acquire that information all of which leads us to our goal, hopefully, of the docketable license application and is the reason we spent a great deal of time on the rationalization.

With the postclosure safety case, we took another step and we rigorously looked at the 19 principal factors. those principal factors come from our understanding of the site and they also come from sensitivity studies identified in the TSPA. With those 19 principal factors, we prioritized them to identify the technical work with the best potential to reduce uncertainty giving considerations to factors which the peak dose rate was most sensitive to. This work has consequently received priority funding and resource allocation.

We had really four considerations in prioritization of principal factors and I'm sorry they're not all on this same slide. They were, first, the significance of the uncertainties to total system performance assessment and the effect of the uncertainties on the peak dose rate calculations. Those were categorized as high, medium, and low.

Secondly, we looked at the current confidence, whether or not our current representation was believed to be realistic and whether or not that current representation captured the entire range of conditions which we believed were important to performance. We rated that from 1 which was low to 7 which was high in order to get a spread.

The third element was the confidence goal, that which we wished to have at the time of license application. In terms of that, we looked at first what was desirable in significance to the total system performance assessment and important in defensibility to our technical basis. We also considered whether or not it was feasible to be accomplished in time for input to the site recommendation and to the license application. And, again, the confidence goal was rated from 1 low to 7 high.

The priorities then were a simple subtraction; confidence goal minus the current confidence.

The next slide shows principal factors with the three considerations; significance of uncertainty, current confidence, and confidence goal. And, the following slide gives our priorities for each one and you can see the ranking there.

Moving forward to the next slide, in bold, I have identified those particular principal factors which were considered to be of relatively highest importance and which, therefore, we're focused on in the LA. Because these are the principal factors, work will be done in all of these areas, but this gives the priority and the 2s and 3s are the highest priority. I'll come back to that point a bit later.

In terms of technical work plan then, our technical work was identified based on this prioritization effort in concert with the multi-year planning effort to look at what things we were considering and what should be ongoing coupled with the prioritization effort to make sure that we had the emphasis in the proper places. The technical work was organized by functional areas of site investigation, design, and performance assessment.

I would like to give you two examples of technical work we've done. They are natural analogs and corrosion testing. These are both interesting examples that you've chosen because they're quite different. The natural analogs, insights from natural and manmade analogs are the fourth element of the postclosure safety case. In this particular instance, the work that we will be doing is basically of a literature search and survey and analysis of existing information. It's, therefore, confirmatory and supporting. It's actually a relatively new program for Yucca Mountain. We've taken over the international program from headquarters. It's moved back to Yucca Mountain and, therefore, it is a new program. Studies will be continued in the national analogs during performance confirmation period.

Natural analogs are addressed throughout the license application plan. They are considered in the site area under geologic framework and disruptive events. They're considered in unsaturated zone processes, saturated zone processes, and near-field environment and coupled processes.

They're also considered under design in waste package materials and testing and modeling and in performance assessment under model abstraction.

Each analog study will include the following. As I've said, a careful review of available data to understand the analog system and a comparison of the process of that system to the specific characteristics at Yucca Mountain. Also, an assessment of previous modeling studies and how the application of the analog information may apply to Yucca Mountain processes and the qualitative or quantitative application of that for improving confidence in the behavior.

Other uses of natural analogs for the Yucca Mountain Project are to build confidence in our modeling process; to understand long-term behavior of waste package and other engineered barrier materials, such as metals and cements; to develop confidence in our design, such as stability from old mines and other underground workings; and, for public information and education.

In 1999 and 2000, our analog work will consist of a comprehensive review of existing analog information. Specific points that we will consider are seepage into the drift that will be conducted from data at Rainier Mesa and Hell's Half Acre; infiltration studies at Rainier Mesa; radionuclide solubility and specification; radionuclide transport, Pena Blanca, Cigar Lake; coupled processes in geothermal fields; colloidal transport at the Nevada Test Site and INEEL; EBS materials; a scoping study of vertical uranium transport in unsaturated ash flow tuff, modeling of fracture flow and saturated zone dispersion, and study of coupled thermal-mechanical-hydrological-chemical processes in Russia. I've included a map of the natural analog sites that are under consideration.

Corrosion is a relatively different example. Here, I'm going to see if I can turn on the overhead projector. Corrosion is an interesting example of technical work because it relates to the first and second elements of postclosure safety case. That is expected performance and defense-in-depth. It also illustrates our prioritization of principal factors and at least six of the highest priority principal factors relate to corrosion in some way or another, some of them more strongly. Those are percolation to depth, drift seepage, dripping onto the waste package in terms of water moving through the mountain; specifically for the packages, chemistry of the water on waste package and integrity of the inner corrosion-resistent waste package barrier and integrity of spent fuel cladding.

Corrosion is addressed extensively throughout the license application plan, throughout the site; geologic framework again and disruptive events; unsaturated zone processes; thermal testing; near-field environment and coupled processes. In design, it's considered in surface waste handling, subsurface design, waste package, and waste package testing and modeling. Performance assessment is considered in model abstraction, unsaturated zone flow and transport, near-field environment, and waste package.

For a summary of status of long-term corrosion study, I think we're fortunate to have Dave Stahl and I'd like to give him a moment to go through that particular status.

STAHL: I'm David Stahl. I'm from the M&O, manager of waste package materials department. I'd like to give you a very brief overview of the current status and plans of materials testing and modeling.

The first chart talks about the container materials work that we have underway. We have a broad range of conditions expected at the repository including concrete-modified water that was identified early-on. We have a broad range of materials under test. We have corrosion-allowance materials which are mainly iron and carbon steels. We have intermediate corrosion-resistent materials which are mainly copper nickel or nickel copper alloys. We have a whole host of corrosion-resistant materials; nickel rich, nickel base, and titanium alloys. These tests have been underway for a long time, approximately two years, and we're evaluating general and localized corrosion rates. As I indicate here on the bottom, for the corrosion-allowance materials and the basis of our one year tests, rates have been about 100 microns/yr which is consistent with the predictions and the literature values. For the corrosion-resistant materials, we measure less than a micron/yr; again, consistent with predictions.

This shows the facility at Lawrence Livermore Lab. This is the long-term corrosion test facility. Over here, we have 24 tanks under a variety of conditions, acidic and basic conditions, 60 and 90 degrees Centigrade, with all of those classes of materials that I mentioned. Eighteen of those tanks contain specimens, as indicated here. We have both crevice specimens which are these square specimens. We have weight loss coupons. And, then we have U-bend specimens. This shows iron specimens after about six months of testing. As you'd expect, iron does rust and we have measured the corrosion rate that's indicated from the previous slide.

Over here on the right is an Alloy-22, a square crevice coupon and you can see some discoloration, but very little attack. In the middle at the top is a panel which was taken from Kure Beach. This is compliments of Nickel Development Institute. This is after 56 years of exposure in that saltwater environment. As you can see here, we still have a mirror finish.

Now, we have other types of experiments going on.

We have crevice corrosion testing. We have a small setup that's looking at the chemistry in between the crevice. In the last year or so, Dr. Farmer from Livermore has developed a model for crevice corrosion and what this device is attempting to do is to examine the crevice chemistry as a function of time as the corrosion process continues. There is also another interesting and very inexpensive technique making use of pH papers to confirm the results that we've achieved in fiber optic tests. We have also going long-term relative humidity tests again at a variety of conditions 50 degrees C to 85 degrees C with your relative humidities, again about 50 percent to about 85 or 90 percent. The surfaces of the iron examples, for example, have salt slightly oxidized and we know from our experiments with the critical relative humidity work done in a TGA, thermal gravimetric apparatus, that the critical relative humidity is a function of that surface condition. So, these longer term tests will confirm those thresholds and also provide input to the corrosion models.

Now, what we've just set up, indicated here in the last bullet, is an apparatus inside that relative humidity chamber which is looking at the effect of water dripping onto the surface and we're attempting to study the electrochemistry and follow corrosion processes over time.

Now, related to that is the top bullet here is that we're doing currently in a hood, we're looking at the concentration chemistry of J-13 water as it evaporates. At the same time, we've done a model calculation using EQ-6. And, basically, we get good correlation until the code breaks down as you get to higher and higher electrolyte compositions.

As was mentioned earlier, we are doing some microbiological influenced corrosion tests. They've been underway, as I indicate, over a year. As far as the carbon steel effects, those have been minor, but as I reported previously, about four or five times the rate of the abiotic case. But, we're now studying corrosion-resistent materials, as indicated here, on the low and high relative humidities. We're also looking at nutrient requirements and biofilm generation. As indicated earlier in a comment, I believe, by Holly, work that was done by Brenda Little as part of the expert elicitation, is pretty well convinced that in Yucca Mountain we didn't expect to see much in the way of microbiological influence. It might, however, impact the time at which corrosion starts, but have very little influence on the corrosion rate itself.

One other area that we're looking at is ceramic coatings on carbon steel as part of our alternative program. We're looking at various oxides; magnesium oxide, aluminum oxide, titanium oxide, and zirconium oxide. The front runner is magnesium alumina combination which has very good properties and can give us dense, impermeable coatings. And, we have samples under test in our long-term corrosion test facility.

Now, we have a whole host, as I mentioned, of the long-term and short-term tests. We have a whole suite of electrochemical tests going on both with single metals and with coupled metals looking at the rate of corrosion and comparing that with the long-term corrosion results. That material--the results are input to models and they also address some of the key materials issues for the new designs. Many of the new designs involve Alloy-22 and titanium-Grade 7. So, these are the principal degradation modes that we're concerned about; crevice corrosion between those two, stress corrosion cracking of both of them, and hydrogen attack as far as the titanium alloys are concerned.

Here's a picture of a waste package design. Unfortunately, I must have been asleep when I proofed this because the title is correct, but it's the wrong picture. The picture that I did give them showed an Alloy-22 outer barrier and a titanium inner barrier. But, conceptually, it's the same design. In this case, it would have been a 10 centimeter and a 2 centimeter inner barrier. In the case of the Alloy-22 over titanium, we're looking at a variety of different designs; one, for example, with an outer wall as thick as about 50 millimeters and inner barrier of titanium at around 15 millimeters, about half an inch. An alternate design has a thinner Alloy-22 outer barrier, but inside which would not be shown in this chart would be a stainless steel structural member to make up the difference.

Now, I should mention here that in Dan Kane's presentation, he noted this is really an unshielded package. It's unshielded in the sense that it's not protected for human observation, but the current design, the VA design, has about a surface dose of anywhere between 10 and 100 r per hour. The balance to provide the radiation protection is provided by the transporter. With this design, that is the 22 over titanium design, we have a thinner wall which means we'd have to put more of that shielding back into the transporter. And, that's a little bit of a tradeoff.

We've done a study in response to the question by Professor Bullen of the Board as to what happens under radiolysis conditions. This was a study that was undertaken by Dr. Shoesmith of AECL. He's now with the University of Western Ontario. He found in his survey that for the VA design or for the alternative design, radiolysis effects are not a problem.

One of the issues that is important with Alloy-22 is phase stability. This is being evaluated. There are several parts of that evaluation. We do have full-diameter of waste package mock up. This is going to be sectioned to take samples of the weld area and then we're going to examine that as welded and then as welded and aged to look at the possibility of secondary phase formation.

Now, in addition, we have some samples that were provided by Hanes, a long-term aging study, about 40,000 hours at 427 degrees C. We are evaluating that material to look at secondary phases and we have observed some of them. The question, of course, is what impact does that have on the corrosion resistance of the material. We believe that it will be small, but that's going to be confirmed in corrosion tests.

We have model development underway of all of these degradation mechanisms for the current VA design materials and for the materials that we would use in some of the alternative designs. These models will be provided to TSPA for the site recommendation and later for the license application.

We did do a literature survey on natural analogs. We were particularly interested in container materials. At that time, the emphasis was on the VA design. So, we did look at materials that might be available from iron or steels, such as cannonballs, the Roman nail situation, and the Indian obelisk, to name the three principal ones. There isn't a lot of data in regard to Alloy-22 which is a high nickel alloy. The best we can do there is to look at some of the meteorite data which is nickel-iron material for the most part. And, there are some minerals that might be available in streams that have been suggested by Professor Sagüés and we're going to be looking at that, as well.

We also have, of course, in the natural analog area spent fuel which we compare to uraninite and some of the ore bodies and some--glass which we compare to some of the natural glasses.

The last chart deals with zircaloy cladding, testing, and modeling. Abe Van Luik in his presentation covered a little bit of that. I just wanted to bring you up to date on what we're doing in regard to the testing. Certainly, we're evaluating cladding performance as part of the performance of the spent fuel waste form, as suggested by Dr. Bullen. We have ongoing at Argonne National Laboratory vapor exposure tests to defected cladding. This is fuel rod segments that have drilled holes in them. And, we also have under testing some drip testing through rod segments. And, again, here, we're looking at what impact it might have on fuel alteration. As you know, fuel oxidation can lead to clad splitting. We don't believe that's the case for vapor hydration or dripping water, as evidenced by some of the experimental work that's out there in the literature. The project many years ago, Wilson, et al. had done some tests with defective cladding, did not see any interactions that led to clad splitting. Also, the Germans and Canadians have also done some testing in this area.

There are two areas here that we do need to further investigate. That's hydrogen attack and crevice corrosion and we do plan to do some tests there to confirm that the conditions expected at Yucca Mountain are outside the range where we would get any attack. And, lastly, models are being developed for these important degradation mechanisms.

Mr. Chairman, you want to handle questions at the end?

COHON: I think so.

HANLON: Thank you, David.

So, one of the considerations the Board had asked was how have our priorities in this testing and site characterization evolved from previous plans? Basically, over time, we have evolved from an effort to develop the knowledge base for Yucca Mountain to confirming that knowledge base and reducing uncertainties. And, we have evolved from an emphasis on scientific investigation and new field work to an increasing emphasis on design and performance assessment.

As you can see, hopefully, from this slide, the Department has established higher confidence goals for the engineered system in the license application plan than it has previously. The goals for this engineered system are as high, as you can see here from the box that's outlined, as high or higher than goals for the natural system. These goals provide higher priority on several aspects of the engineered system than we have in the past. Another point is that our ability to improve our understanding of the natural barriers is diminishing, and therefore, overall, our efforts are shifting from the natural system to the engineered barrier system.

With regard to funding, the Department has defined a program of funding in the license application plan that we believe has fidelity and it will lead us to a docketable license application. The license application plan established a funding level and a funding program that will allow us to carry out necessary tests to acquire the information we need. Shortfalls in that funding will cause slips and delay in the schedule. Some work plan for 1999 has already been carried forward into 2000. Examples of that are some types of surface design work and testing in the cross-drift. So, we do feel that the funding that we have identified, the funding levels identified in the license application plan, are important.

So, with that goal in mind, I think that the license application plan has, in fact, put together a program that we can follow to obtain our goal of a docketable license application plan and I hope that there will not be great chagrin when I say that we actually didn't use worker bees or any palominos, at all. Thank you.

COHON: Thank you very much. Questions from the Board for Carol Hanlon or David Stahl or both?

BULLEN: Actually, I have questions for both, but I'll start with Carol Hanlon. If you go back to one of the diagrams that shows your confidence and goal and your priorities, maybe #14, does that sound good? I guess, I have a question with respect to #6, humidity and temperature on the waste package. It looks like you know everything you need to know and you don't have any priority, at all, with respect to that. Although I would think that humidity and temperature on waste package would have a great deal to do with the water chemistry on the waste package, and should the waste package be cool, then that uncertainty or my confidence would go up greatly with respect to water chemistry and I wouldn't have to be as worried.

And so, I guess, I see that this is a very useful tool in trying to determine the steps and priorities that you set, but it's the interrelationships between the two that may have been missed there. Could you comment on that?

HANLON: Well, first of all, for your first point, there is work that remains to be done on all of these. They are the 19 highest principal factors. And so, they have high priority and there is work identified for all of them.

On the specific example that you asked on the importance of humidity and temperature, I'd like to turn that over to Ernie Hardin.

HARDIN: I'm Ernest Hardin. I'm with the M&O. The current TSPA/VA model was used to generate the significance of uncertainty to PA and use as the basis for the assessments that went into current confidence and confidence goal. If you peel that onion and look at how the TSPA/VA model uses temperature and humidity at the waste package, it's primarily a timing issue. For that reason, given the type of design that the VA was and is, that there is low sensitivity to the outcome of peak dose rate and particularly at long time durations. After the CAM fails, after you've initiated failure of the CRM, the effects of temperature and relative humidity at the waste package are not seen in the out-years.

BULLEN: I understand that, but I think that you might have a better or a more accurate evaluation, particularly if your outer barrier is not a corrosion-allowance barrier when you worry about accumulation of minerals and the like. So, I'm assuming that subsequent to that analyses when models change and the PA is redone, reprioritize the rankings and goals. Is that a safe assumption?

HARDIN: I'm going to try to answer the first of your questions. Yes, there are plans afoot to improve the nonisothermal nature of the TSPA model. And, as far as reprioritization, I'm going to pass that one back to Carol Hanlon.

BULLEN: Okay. Well, then, actually if the design evolves, will this be reprioritized or is this figure sort of cast in--well, I won't say concrete; that's probably a bad one.

HANLON: No, the figure is not cast in--you know, it's as the design evolves, this was based on the reference design as the design evolves and we add additional options or we look at an evolving design. Then, we would look at an evolving design. Then, we would look at this prioritization and see how that new design affects it. And, of course, it will be evolving.

BULLEN: Thank you. I have one quick question for Dave Stahl and then I'll be done. On the radiolysis study done by Shoesmith, first off, does the Board have that? Okay. So, Claudia, can we have that? Okay.

The next thing I have is did he study an open system or closed system, and did he study the Climax Mine results?

STAHL: And, the answer to the first question, yes. I'm not sure whether he studied the Climax. I think he did. I think those are in there, as well.

BULLEN: Okay. I'd just be very interested in seeing that.

STAHL: Yes.

KNOPMAN: If we could just go to Slide 28, I want to give you a chance to clarify what you mean by the second to the last bullet right there; ability to improve our understanding of the natural barriers is diminishing. I'm sure you'd like to qualify that a little bit in two ways. One, from my perspective, we're just beginning to characterize the saturated zone. So, the learning curve is very, very steep there and I wouldn't say we're anywhere near diminishing returns. The second point has to do, obviously, with seepage, and that being such an important driver and there being some very important studies currently underway, I think you want to--you may want to explain a little bit more what you mean here.

HANLON: Well, I think you have answered the question. You have identified the two examples I would have given on where important work is ongoing. Those are two areas where work will be continued. And, on other things, as we have conducted data gathering activities over the last 20 years, we're beginning to understand the system better. So, there are a few of the areas, as you identify, that remain outstanding and where we can appreciably increase the difference. So, as we continue to evaluate our reference design then, as we do PA, as we identify information that must be acquired, we will get that.

KNOPMAN: If I could just follow up quickly?

COHON: Of course?

KNOPMAN: Perhaps, you could just enumerate for us which key areas you think we're sort of doing well enough on our understanding of the natural barriers. And, as you answer that, if you could--this goes back to a point I was trying to make earlier, that notion of sort of diminishing returns implies you have some idea of what your limits are to knowledge; spatially, temporally. And, I'm wondering if you can--how explicit you've gotten within the project about defining what those limits are in certain areas of the natural systems. It would be helpful for us to know if you have that kind of information or you're working with those sort of bounds in your own analyses of priorities.

HANLON: I'll be glad to get back to you on that separately. I think that--you know, I didn't come prepared to enumerate that for you today. So, I'll be glad to get back to you later.

KNOPMAN: All right. Is there such a document? Is there a document that sort of goes through that?

HANLON: I think it's basically the process design, the process models, and the expert elicitations that took the site investigation information and put it into the process models that were operative in the TSPA, for the sensitivity assessments, and those things that were also used for the design.

COHON: If I have this right, what they're emphasizing is that this is all driven by the licensing application. They're self-driven by the licensing application. So, one cannot remove time considerations from these conclusions that traces other issues.

SAGÜÉS: Yes. The priorities, as you indicated, are driven primarily by what was found out here in the TSPA for VA. Supposing that there is a somewhat radical change in the design--for example, going to a much cooler repository--this is both for you and David Stahl--would it be then the logical thing to do to go ahead and re-elicit some of the areas--just, for example, corrosion--because I would suspect that if we are going now into a lower temperature regime, the opinions of the experts that led to the rankings that resulted in these tables may change substantially. Do we have any opinions on that?

HANLON: Well, certainly. As we identify additional areas, it's an iterative process, and as we evolve the design, as well as we go forward with our TSPA, we would consider that to be iterative and we would revisit it.

Dave, did you want to say anything?

STAHL: Yes, I just want to add something in regard to the models. We did provide two TSPA/VA corrosion models as a function of temperature and that was utilized for some of the sensitivity studies and also for some of the EDA studies that were identified looking at the cooler repositories. What we do need to do, however, is update and upgrade those models based on the new data that we've collected over the last six months or so.

PARIZEK: Parizek, Board. You have under the technical work plans this whole natural analog area which would support some of the geological uncertainties, as well as material behavior. That's a pretty important area, I guess, form a licensing point of view. NRC points this out as being important. How aggressive is that program within DOE currently just to search out the analog areas? You show a whole variety of places internationally and the work that's being done or could be done. In some cases, I'm not familiar how far that work has already been carried by others that you can either draw from or have to do on your own.

HANLON: Well, I'm not sure at this point that I would consider it a very aggressive program. As I have spoken, it's one of the major elements of the postclosure safety case, but it's also a literature search at this point. It's a relatively new program. So, I'm sure it will evolve.

Ardyth, did you want to say something about that?

SIMMONS: Ardyth Simmons, LBL and M&O. Carol is right. It's not a very aggressive program, but it's a moderate program. In addition to the literature survey, we have some active studies ongoing that will provide new information coming from the Pena Blanca site in Mexico and a couple of other sites, as well. The main purpose of this is to help improve the confidence in certain aspects of our process models. So, the point that I'd like to emphasize is that the goal of the natural analog work is not simply to provide literature survey of what's out there already, but it's to help us use that information to directly influence how we understand the uncertainties in our process models and then also towards the performance assessment models, as well.

PARIZEK: A followup question. You probably are working on some work products that will detail what might come out of some of these analog efforts and that will be released in the near future? I know you had this going on in the unsaturated zone workshop. I assume you'll be doing this at the saturated zone workshop coming up in February and on and on and on?

SIMMONS: Yes, it will probably be a part of all the performance assessment workshops because we want to tie the two together very closely. We'll have work products coming out in the form of the synthesis report at the end of this fiscal year, and as a part of that report, we will be incorporating the data that we collect along the way from these new sites that we're looking at. That will be updated again, God willing, in 2000.

PARIZEK: The reason it's useful to have a product early, it stimulates thinking and you'll probably get good suggestions from people who hadn't any reason to worry about this, but they have some great ideas for you including secret rocks hidden out in Oregon and so on.

STAHL: Dr. Parizek, let me add in regard to the container materials work, we do follow as a strategy ASTM 1174 which is a process that includes parallel testing and modeling effort. As part of that modeling effort, it describes the use of natural analogs. I've charged Joe Farmer who is the head of our modeling group to in this process of developing models for the container materials to include as much information as he can on natural analogs.

BULLEN: Going back to your high priority rankings, I see that we've put a lot of confidence goal on the #9, integrity of corrosion-resistant waste package barrier. And, I guess, I would wonder rather than putting all that stress and strain on one significant barrier, would you reduce your confidence goal requirement if you had multiple, redundant, or independent barriers and so we wouldn't have to hold it to such a higher standard than anything else that you may be considering?

HANLON: Well, I think multiple barriers have a role and also I don't think it is held to a higher standard than other things. There are several things that are considered relatively important. So, the answer is yes and no.

BULLEN: Then, I guess, I don't understand confidence goal. If the 6 isn't--I mean, if 6 is the only one there, is that not a higher standard than anything else that you've listed or am I mistaken there?

HANLON: Well, I was speaking in terms of the priority; so, in terms of the priority that we have given it.

BULLEN: Oh, no, I'm--you expect to have a whole lot more confidence, at least one step more confidence than anything else, on the waste package. And so, it seems to me that that's a significantly greater emphasis on waste package and I just wondered if, you know, if you really feel it is that important.

HANLON: Ernie, would you like to say something about that?

HARDIN: What that 6 represents is building confidence in waste package materials. So, it's an engineered feature of the system that we have control over and that we are actively generating data for.

COHON: Dan, the confidence goal includes their subjective reaction to the contribution to uncertainty, as well as the confidence they'd like to attain. So, confidence goal--confidence is confidence, not always the same in both cases.

BULLEN: Okay. Then, I guess, I'm a little bit perplexed here because I'd like to have confidence in the tunnel stability and confidence in the seepage and confidence in all the other things that I can engineer there, too. But, it looks like just one barrier gets the big brunt of I have to rely on this more than anything else which that's what--I guess, that's just what the representation says to me. Maybe, I'm misinterpreting.

COHON: It also says it's very significant for performance.

BULLEN: Yes, well, I agree, but lots of things might be more significant if they had different emphasis or different evaluations, I guess.

HARDIN: Two more points, please. Number one is the waste package is a very important part of the VA design, system-wide if you look at performance, as I'm sure you know. And, when I say that we're actively--I think I'm going to pass this one off to Dave Stahl. When I say that we are actively pursuing waste package material data, you've heard a summary of that today.

COHON: Other reinforcements here? Did you want to say--

DOCKERY: Maybe I can make just a little bit of refinement. I know all these terms start to blend together, but in this, it was--there were two constraints. What's important to performance and what do we think we can decrease the uncertainty or increase our confidence in 18 months the most? And so, with the ongoing corrosion studies and the input from the waste package degradation experts, they felt that they could significantly reduce uncertainties in specific areas. So, it's kind of the amalgamation of both of those. How important is it and how much do we think we can do rapidly to support the LA? So, that's feeding both into that number.

BULLEN: Just a word of caution then. If we really are worried about one atomic layer of corrosion or release or dissolution ever 10 years and we're going to have submicron scale work, then you may be putting way too much confidence in what you can get done in 18 months to justify it. And so, multiple barriers or something else that doesn't call upon the--you know, this is pointing to the waste package as potentially the panacea, but also as the Achilles' Heel. And, if you don't get there, you might have to do something else.

STAHL: Dr. Bullen, let me just augment my previous answer. Our corrosion tests are a combination of different kinds of tests. We're looking at surface condition tests, we're looking at accelerated tests, and ultimately performance confirmation tests. Some of the accelerated tests are looking specifically at mechanistic behavior to understand the level by level changes over time. The surface condition tests like long-term corrosion test facility, you miss a lot of that. So, you need that combination of testing in order to develop a model and give you better predictability.

COHON: I have a question. This goes to the priorities, but putting them in a longer term view. We're trying to get you to talk to us in that longer term view. Let me give you a hypothetical situation. Suppose you get to the point of submitting a license application and the NRC reacts and they say in the year 2003 we're going to approve this, but we're only going to approve the placement of 1,000 tons of waste, and we want to see what happens for 10 years. Would this list change if that was the scenario you were facing?

HANLON: As I have said, I think this list changes as our design evolves and as we get closer. So, we will be looking over this list. We've said that in the LA plan.

COHON: I'd ask a different question then. Suppose the design is exactly the one you've got today, but what changes is the time period over which you have to produce results. Would that, do you think, create change in the priority?

HANLON: Yeah, it may have something to do with confidence goal because one of the factors in the confidence goal was the amount of time that we had to acquire the information. Mostly, we took into consideration--don't forget the performance confirmation plan. So, it is true that if we had a longer time to do it, then that could change and it could alter it.

COHON: Does performance confirmation enter into this list? Is this influenced by performance confirmation?

HANLON: It ties into performance confirmation, but that was not a factor in this.

COHON: Okay. Any other questions from members of the Board?

(No response.)

COHON: I have a couple of questions from the audience for you. One, I think, was sort of addressed by Abe, but I'll just say it anyhow. William Quapp wants to know, a number of the areas identified for improvement include parameters which affect the model predictions in the post-10,000 year time period, after 10,000 years. Why spend resources to acquire this data when the licensing time frame is likely to be 10,000 years?

HANLON: Abe, would you like to answer that?

COHON: Well, if we're just going to appeal to what Abe said before about why longer term, that's good enough. I don't think you've got to--the record is clear on this.

Mr. Tiesenhausen, maybe you could come to the microphone and ask your question? I'm having a little trouble reading it.

TIESENHAUSEN: My question is to David and I was just wondering if there will be any attempt to look at radiation-induced segregation and its effect on corrosion?

STAHL: I'm sorry, radiation-induced corrosion, what?

TIESENHAUSEN: Radiation-induced segregation and its effect on corrosion?

STAHL: Well, certainly, this depends on the materials ultimately selected for the SR. Certainly, most of the materials that we're considering are pretty immune to radiation-induced segregation, but there may be some selected that could be. For example, if you look at titanium, that's not going to be a problem. Carbon steel, not going to be a problem. Alloy-22, not likely, but it could be and that's something that we are looking at.

COHON: Dan Metlay has a question.

METLAY: Lake made the comment earlier today that the priorities that DOE has arrived at are very similar to a sense that the Board gave in its November report. I guess, I'd like to go one step beyond priorities and ask the question where are the dollars? And, maybe, you're not the person to answer this, Carol, but Lake is. How do these priorities that you develop structure the funding that are given to various projects and, in particular, is there any clear and obvious relationship between the priority a particular area got through this process and the amount of money it received?

BARRETT: Barrett, DOE. The answer is yes. This drove the VA, the work to complete LA, the numbers are in the VA, and that drives our '99 work plan. It drives our 2000 budget request and will drive our, you know, 2000 work plan. So, they will all integrate together and this was the driver and what started as to how we would judge things. So, the answer is yes.

METLAY: Is there any way--I've looked fairly closely at Volume 4. Is there any way you can provide us with information in terms of how these priorities led to that kind of sequence because it was not clear to me in Volume 4?

BARRETT: Yeah, in the generation of the work plans and the budget request, that is what drives it in in the project is they basically get as much money as they basically can for the project. They allocate them between the engineering, the science, within the subcategories, how much is in corrosion, how much is in design, etcetera. So, I mean, these are in the project planning activities which uses the planning documents as a feed as they go through that internally in the project.

I think, Dr. Brocoum is going to comment on this.

BROCOUM: I shall add one thing here. You related to dollars. These priorities relates to work that had to be done. We try to make sure that that work had to be done to be covered by adequate dollars. But, it's unfair to say that something has a 3 and something else has a 2 if you have more dollars associated to it because one type of investigation-- you know, for other reasons, may cost more or less. So, relating dollars to priorities really isn't a fair relationship. It's to make sure we covered the work that had to be covered. I think, we can honestly say we covered the work that had to be covered.

HANLON: But, also, in another way, we tried to make a clear trace as we went through it. If you look at the discussion of the prioritization and the principal factors, you can see that each one of the principal factors has a discussion of the importance of work and work necessary. We've also identified, as I showed on this slide--I guess it's not this one, it's #14 with the priority. We indicated the ones that had the highest priority. The LA plan does show that those are the ones where the greatest resource allocation will be placed to have reduction in uncertainty and so forth. Now, those in the document are correlated both with sections in the technical chapter, Chapter 3, and they're also correlated with activity milestones. You can follow those activity milestones back through this schedule and through the costs. So, there is a clear trace if you take it through two to three to five and six and seven. So, they are there, Dan.

COHON: Thank you. Thank you both very much for your presentation.

HANLON: Thank you.

COHON: We move now to Volume 5 of the VA, the cost to construct and operate the repository. The presentation will be given by Robert Sweeney.

SWEENEY: Hi, my name is Rob Sweeney. I was the lead for the Volume 5 which represents the repository cost estimate.

Why a repository cost estimate? Well, first and foremost, the VA required by the Energy and Water Development Appropriation Act required some very specific things of us. The costs to construct and operate the repository in accordance with the design concept which is in the previous volumes which you all saw. Furthermore, the project need to update and approve on the past repository cost estimates given the latest design and operating scenarios and understanding of the concepts which we wanted to take forward. Furthermore, to have a useful tool to maintain as a current baseline and use it as we go along and refine our designs and options and also our operating concepts.

What were the results? I'll just get to the chase. I know it's late and let's get to the bottom line. But, we have up here kind of a detailed chart, but I'll hit the high points and let me just take this over there.

This is basically kind of the sum of everything that was done by a team of over 30 some odd professionals; cost estimators, project planners, engineers with backgrounds in costs and big projects. We have outlined this in several phases. We have five phases; licensing, pre-emplacement, emplacement operations, monitoring, and closure and decommissioning base. We have broken it out into five major cost elements; the surface facility, subsurface facilities, waste package, performance confirmation, regulatory, information, and management support. The team had to work with everybody on the project because this process covered all bases and it was an extensive effort and the group, as I said, was about 30 some odd people. We have also had this independently reviewed and I'll get to that a little bit later on.

Licensing phase covers, in essence, from March of '02, license application, to February of '05. The pre-emplacement construction phase will start in March of '05 and be completed in 2 of the year 2010. Licensing phase--let me back up here. Licensing phase is to complete basically all the activities post-license application, refine designs, and prepare facilities and the personnel to start construction phase.

The pre-emplacement construction is post-authorization from the NRC for construction which we expect, as I said, in March of '05. And, this will take us to the emplacement phase where, after that, construction will continue and we will have operations in place, emplacement begins with a phase and wrap-up of our waste emplacement activities.

Monitoring operations will be from 1033 to 210 where basically the surface facilities will be in a mothball state. The subsurface facilities will be maintained to insure integrity of the facilities. And, we will have staff on site during routine support, environmental testing, performance confirmation, and regulatory support.

The closure and decommissioning phase is fairly straightforward. We will be, in essence, cleaning up the facilities and preparing it for decommissioning and closure and release.

Here, we have the facilities, subsurface and surface, and waste packages in here as a function of each particular time phase. We have the surface facilities. During this, as I said, we'll be going through design. Most of this is all design work here, performance confirmation, looking at their program plan, etcetera, to insure that the regulatory requirements will be met. I believe we might have some questions on that later.

Regulatory, information, and management support is the area where we have a pretty much broad group of support for the project, licensing, regulatory, infrastructure such as information management, etcetera. Performance confirmation, waste package--excuse me, let me go back here. We have surface facilities. We'll be wrapping up the size and dimension in these three areas. Emplacement, construction phase, pre-emplacement construction phase, we will be--basically, this is the brunt of the project from a capital standpoint. We've spent a tremendous amount of money here from capital before emplacement to the tune of almost $3 billion.

Emplacement operations, we have a majority of our costs for the VA for the 18.7 billion. The majority of it is in the surface facilities and subsurface and the waste packages. Waste package costs, this is for the most part capital equipment of the waste package. Subsurface is the continued construction and supporting design work, and emplacement activities. And, surface is the emplacement and work of the surface to get packages ready.

Performance confirmation picks up and we have a continued level of effort here by the project in the various areas to support emplacement activities.

Monitoring phase becomes fairly dormant. This is approximately 76 years or so and we will be spending a fairly good chunk of the money during that phase; primarily, the areas of surface facilities and subsurface and the confirmation.

Closure and decommissioning is approximately $370 million and most of that is at the work to close up and do away with certain surface facilities and close up the subsurface. And, we have some support activities there. All in all, $18.7 billion.

This next slide shows the distribution over time of the costs and I'm not sure if these colors come out or your slides are in color, but this color here, the pink, is the licensing phase. We have the yellow as the pre-emplacement constructive phase, the emplacement phase. Monitoring phase, as I mentioned, quite a long time, and a brief period of six years at the tail end for closure and decommissioning. You'll see a tremendous of the money in the surface facilities, as I said. Surface facilities and, particularly, this area represents a pretty good chunk of our costs and it's primarily driven by labor costs.

We have expected peak here as far as the budget for construction at about 700 million at that point in time about the year 2007. We have some other highlights in the Volume 5, but I'm limited on time here. We'll go on to the next one.

I believe some of you have seen some of the previous estimates by the project. I just want to emphasize we've changed tremendously some of the ways we do business from a cost-estimating standpoint that led to some improvements, but we've definitely improved on our technical scope. The level of details there will be based on the VA design assumptions. We have more fully developed assumptions and we made sure that we had consistency across all the VA products. Furthermore, we had a greater body of knowledge and data to work from. In particular as an example, labor rates at the Nevada Test Site were used to make sure that we used up to date and validated and defendable numbers.

Schedules, we identified schedules for each and every element. At the sub-element level, this estimate went down to approximately 270 activities and we had provided schedule for each one and also this schedule shows an extended retrieval period of 100 years where the previous cost estimates had 50 years. So, we also employed competitive and fixed price contracts and strategies where we thought it was appropriate. We believe there's probably some room for further improvements there. Furthermore, the contingencies that we applied throughout the estimate improved and we had a better understanding of details, etcetera. So, we applied more appropriate contingencies and I can address those later on in more detail. But, the 1997 estimate was approximately $14.8 billion and this has now went up to 18.7, a significant increase because of the extended period.

Just to walk you through some of the key assumptions, the repository was designed, as I mentioned, to remain open at least 100 years from the initial emplacement which allowed some additional flexibility for future decisions. The waste source was limited. The Act advised that we use the 70,000 metric tons. So, the breakdown of that was 63,000 metric tons of commercial SNF and the defense high-level waste, approximately 4600. We had some of DOE special nuclear fuel for 23, adding up to 70,000 metric ton.

The costs for impacts beyond our control were not included. We felt that it would be improper at this point in time to assume anything. So, this is a pretty straightforward estimate based on the information provided and it's our best estimate. No interim storage was considered and all costs that I showed you or will show you are in costs of 1998 dollars.

One of the things that we felt was important because not only the magnitude of this cost estimate and its importance, but we were going to be independently reviewed, we wanted to make sure that the process that we followed to prepare the cost estimate was a solid and found process. Just to walk you through how we went through it, we identified the assumptions and scopes of work and the level of detail necessary that we believe was appropriate for estimating at this time. We prepared cost accounts and schedules by each of the elements. As I mentioned, it's 270 some odd elements and all the project phases. We determined what the appropriate technique was using good industry standards and practices, as well as DOE guidelines, and used as much available data from the project itself, as well as industry and the teams on the M&O that supported us. We built the estimates and applied the contingency. We conducted additionally internal checks and we had interface meetings to make sure that we didn't have overlaps in scopes or underlaps where we would omit something. We found that to be a very valuable source especially at the end to insure that we didn't fall on anything that was going to be a substantial or fundamental flaw with our cost estimate. The estimate also went through a significant review by the Foster-Wheeler Corporation which is the contract to the field management office. They came in and independently reviewed every cost element from every phase and every detail that we could provide. They found that we had done a reasonable job and had a--done a well job and quality was of high nature. Furthermore, they provided additional feedback that we used in our process, and where it was appropriate, we would use their information if they had a source, or if they found something that was fundamentally wrong, we would factor it in. We had some five reports from them. I think that the Board has been provided with a summary report. After all was said and done, prepared the Volume 5 cost estimate. We had also prepared documentation packages for each and every estimate which each manager that was responsible for those particular areas had assigned and we've backed that all up in some 26 volumes of documentation and somewhere on the order of 2 plus gigabytes of electronic files.

How do we use this information? Well, in addition to providing the information pursuant to the Appropriations Act, we used this to provide a basis and input for future planning and work activities. Also, to support budget developments and analysis related to them. Assist assessments of our enhancement activities, I think you heard earlier from other members of the team. Provide a decision tool for program and project level management what-ifs. Furthermore, the VA cost estimate provides a significant feed to the total system life cycle costs and the fee adequacy analyses.

So, maybe, it's a good time to emphasize what this VA cost estimate is and is not. This chart here shows how it all comes together with some of the other numbers you've heard. What it's not, it's not part of Volume 4. It's not a budget document. It's an estimate and it's an estimate specifically for the repository. So, these other elements, you've heard Volume 4 presentations before me, that's an estimate of approximately 1.1 billion. We've had historical costs, some costs, in year of expenditure basis, $5.9 billion. We've had the other pieces for the TSLCC outside the repository that had to do with the program integration and institutional costs and waste acceptance and those numbers provided there.

The repository was the major element, of course, and in addition to that, the team put together the incremental estimate for the additional fuel and high-level wastes that would be emplaced in the mountain. Those numbers provided approximately $4.5 billion in additional costs to handle the 89,000 metric tons and the additional high-level wastes and some 20,000 canisters.

In summary, the $18.7 billion estimate was developed consistent with the current VA design, guidelines, good industry practices and principles. The estimate reflects DOE's best projections given the scope and work identified and planned. Independent external reviews stated that the overall quality of the repository estimate was well-done adding confidence to our project. The VA cost and schedule information is going to be used to support the future planning activities, budget development, and assessments of repository enhancements, and alternatives and options.

That concludes my brief 15 minutes. I hope I didn't use it all up. If you have some questions, I'll be happy to answer them.

COHON: Thank you, Mr. Sweeney.

Let me go first just because I have the microphone. 18.7 billion is in 1998 dollars, as you said. What would that be in undiscounted year of expenditure dollars, total over the whole period?

SWEENEY: The 18.7 is the constant 1998 dollars.

COHON: Right, what would it be undiscounted?

SWEENEY: Undiscounted?

COHON: Yes?

SWEENEY: That analysis wasn't part of our VA, but I believe we can get back to you on that.

COHON: What was the discount rate that you used?

SWEENEY: The discount rate was not used as part of our analysis. It was in constant 1998 dollars.

COHON: No, no. What I mean is if I were to spend a dollar in the year 2010 and put that in 1998 dollars, I've got to apply a discount rate. Right? Isn't that what you do to get 1998 dollars?

SWEENEY: No. If we can go back to the slide that shows the cash flow, the second chart, I believe. All those numbers--all those costs are in 1998 dollars.

COHON: Hang on a second. If I spend a dollar--a dollar in 1999 is 97 cents approximately in 1998 dollars if I use the 3 percent discount rate. In my understanding of economics, it would not take long to exhaust that. Just to say it's in 1998 dollars means you took a future dollar and brought it back to 1998 using discount.

SWEENEY: No, constant 1998 dollars. So, we estimated--every year is estimated using costs for 1998.

COHON: All right.

BARRETT: Having gone through this a little bit, we basically assume there's no inflation. Now, if there was inflation--

COHON: No inflation and no discount.

SWEENEY: That's right.

COHON: So, you're assuming the two basically balance each other out.

BARRETT: 2116 is the same thing for the dollar as you do in 1998 because if you start trying to do year of expenditures 100 years in the future, it is science fiction again. And, it is a totally meaningless number that doesn't mean anything.

COHON: All right. People had their hands up. Norm?

CHRISTENSEN: I had a question related to Page 10. It looks to me like the additional 86,000 metric tons is really a bargain basement situation. That is the cost per ton is incredibly low or am I misreading that?

SWEENEY: Yeah, the 86 is total. Actually, that's 86 commercial. The chart should probably read 89. It's 89; the incremental is about 2.6 DOE SNF, but the incremental costs--let me just go through what makes up the difference there, if that would help. The incremental costs of 4.5 is broken out in several different areas. The surface facility because of the additional labor and additional time associated with that is about 1.1 billion; and, subsurface facilities because of the additional access and emplacement excavation activities design and support systems is another billion. Waste package, about 1.9 billion, okay, due to the extra packages. Performance confirmation and the regulatory information, add another about half a billion dollars. So, that is the basis for the incremental costs. Your question is that seems like a reasonable or maybe I should--

BARRETT: There is an error on this chart on 10. It is not 86,000 metric tons of fuel additional. Okay?

SWEENEY: No, no. Yes, sorry.

BARRETT: It's 63,000 metric tons of fuel, commercial fuel now, go into the repository within the 70,000 ton Congressional criteria. We expect there will be, what, 80--of the commercial fuel, it's 86?

SWEENEY: 86 on the commercial.

BARRETT: On the commercial. So, it's an additional 86 minus 63 or 20--20 is the additional--

SWEENEY: Yeah.

BARRETT: That helps a lot.

SWEENEY: That's a total inventory, yeah. Yeah, sorry if the slide is not clear on that. It's total inventory.

COHON: Priscilla Nelson?

NELSON: Could we go back to Figure 3? I'd just like you to expand a little bit because I was very surprised to see--and I haven't read it exhaustively--the monitoring operation period for subsurface facilities being up to 1.2 billion and performance confirmation at about 1 billion. What's going on? I can see the performance confirmation process, but what's going on in the subsurface facilities?

SWEENEY: Subsurface during that period?

NELSON: Yeah?

SWEENEY: The monitoring period?

NELSON: Yeah.

SWEENEY: It's primarily supporting the capital assets, the work that we have underground, the operations and maintenance activities, and supporting performance confirmation.

NELSON: But, isn't that in the performance confirmation budget?

SWEENEY: No. The PC activities are specifically to those tests and to the data analysis and so forth that goes with the PC program.

NELSON: Wow. Okay.

SWEENEY: Do keep in mind that those numbers represent some 76 years.

NELSON: No, I know, but it's--yeah, it didn't hit me straight on.

BARRETT: The infrastructure support for the science, if they run the fans, do your physics monitoring, do your air radon checks, it's expensive and it comes about $20 million or $30 million a year. I mean, it's not--but it's a lot of years.

NELSON: All right. But, it does not include anything like backfill or anything like--

SWEENEY: No.

NELSON: Okay. Just one additional question. Is this the model that was used to bring in the numbers that were presented as cost differentials during the first two weeks of January of the workshop on alternatives? I mean, was this the model that was exercised?

SWEENEY: What was the time period that these numbers came in? I'm sorry, I have not been here all week.

NELSON: During the first two weeks of January, there was a workshop considering enhanced design alternatives and, periodically, there were numbers discussed, almost always 4 to 10 billion over VA design for some of the alternatives. So, that seems very high to me and I'm wondering if this is the model that's being used for those analyses of costs of the EDA of the LADS workshop alternative considerations?

SWEENEY: As I mentioned earlier in one of the bullets, the VA cost estimate provides a database basis for taking what we currently know, what we've currently designed, and the LADS analysis will use what we know from a cost standpoint and schedule, and where things may not have been costed, we will have independent, separate, and apart cost estimates for each element and sub-element for those LADS. The data that will be used, for instance, if we have to extend the subsurface length, area, acreage, whatever, we would take those numbers, whatever the factor may be, be it per linear foot or cubic yard of excavation material, we would use those numbers to address each particular element and sub-element within the LADS. It's a body of knowledge that we're working from and we're using it as a tool to develop those LADS.

NELSON: So, you're participating in the next 22 days of trying to refine the cost estimates for all of the EDA alternatives?

SWEENEY: Yes, the cost individuals are working on it. One of the things I want to mention is that those are rough order magnitude, and as things are refined, this estimate was a little bit more refined and more detailed. It's an evolutionary process and at this point in time, I believe, in the last program, it's a little premature to be working with some solid numbers, but later this year, I believe there will be more refinement and fidelity in those numbers.

NELSON: Thanks.

SAGÜÉS: Yeah, a brief observation. It's possible not using the discount rate or using a discount rate of zero effectively, at least on items such as highway construction and highway repair, it's not uncommon to see a life cycle cost analysis over 60 years design service life or nowadays 75 years is the service life for most projects. The brunt of the costs are in the first 20 or 30 years and certainly over that time interval, it is perfectly common to do a life cycle cost analysis using a discount rate that would be certainly predictable with more certainty than the predictions that we've--

SWEENEY: Yeah, there's--you've provided a good example. However, across the entire project, not everything was as detailed and the fidelity might not have been as much as you would expect, but over time, we fully expect more detail and fidelity where we can get into those type of analyses. But, it would be very difficult to provide that analyses given the time frame. This estimate, I just want to emphasize, was a point in time. That further economic analyses, I think would be a difficult challenge given all the elements. As I said, there were several hundred elements that were part of this and we do take a look at some of those elements as part of the broader analyses in the TSLCC and fee adequacy.

WAGNER: This is Richard Wagner, M&O. We made some programmatic decisions early-on where the total systems life cycle cost was going to use constant '98 dollars to communicate to Congress, as we have in the past, what arrestment was. Once we made that decision, Rob and the project didn't get to vote. They were told to use '98 dollars. The way we've communicated with Congress in the past is constant year dollars. You could in industry and other applications do what you talk about, but we made a programmatic decision to communicate in constant dollars of '98. Once we did the program, Rob got directions and he followed them.

BARRETT: And, let me tell you where he got it from. He got it from me, very simply. We want this to be a scientific engineering estimate. We do not--I want to separate out the judgments on future inflation rates, rate of return on investments. That in our suite of documents that he's nested together, the VA gave the repository costs. The TSLCC gave the total program costs. The third report is the fee adequacy report where my income is constant, basically 1 mil per kilowatt hour, my big income from the utilities. That is fixed and that is very much subject to inflation and discount rate. In the fee adequacy report, all the judgmental aspects about what is the rate of return on our Government bond investments vis-a-vis the inflation rate because this thing--

then, the whole thing is swung by the delta between your investment income and your inflation rate and we look at a 40 year and it's all in there in a chart with a line. And, if we're at the left of the line, we have an adequate fee; if we're to the right of the line, we don't. All of those variables move, you know, independently, and--moved all that subjective information into one place over to the side and not try to have the engineers and scientists and cost estimators at Yucca Mountain dealing with discount rates. It was a programmatic policy call that was a religious gospel item.

CRAIG: I've got several of them here. Could you click over to #4, please? First is an easy one. How come there are all those little wiggles down on the time window from 2035 out to 2110? What's changing as you go along there in the monitoring period?

SWEENEY: Monitoring phase, right? I didn't hear the years, I'm sorry.

CRAIG: Well, they're not constant. So, something is changing from year to year. What's changing?

SWEENEY: We have periodically 10 years where we replace the PC monitoring.

CRAIG: Oh, okay. Now, getting onto something more substantive. In the work on TSPA/VA, they calculated they wouldn't have any failures, but they decided, well, we'll throw in a single juvenile failure. What the heck might happen? You might just have a situation where you've got to pull out a single canister. What does it cost to do that? You might have a situation where you have to pull out the whole pile of them. What does it cost to do that? Did you estimate those?

SWEENEY: Well, one of our assumptions was not an off-load type of situation. It's one of the assumptions I mentioned up front. It was that we accepted that things outside our control--and I think maybe you're getting into failure mechanism modes and things of that nature and--

CRAIG: No, I simply--a very simple question. I want to know what it's going to cost to pull out a single canister at some particular point and then I want to know what it's going to cost to pull them all out. Now, in the normal scheme of things, you won't have to do that, but in the rest of the TSPA they did at least assume the possibility of a single juvenile failure. And, this is the analog in your business of a single juvenile failure. You discover that somebody dropped the canister and didn't tell you about it. So, you've got to pull it out. What does it cost to do that? I think that's a question that you ought to have an answer to.

(No response.)

CRAIG: You don't. So, okay, we'll move on. The next one--

BARRETT: Let me add into this. No, we did not go and do cost estimates on unanticipated occurrences which that is. Now, could it happen? Sure. I don't think there's any mechanisms with ventilation and that that we're going to get a failure of a package, but it's possible we do. And, what would be the cost to do that? We have the surface facilities, we'd have the things there basically in a mothball condition, we'd bring crews back and do it. The costs would not be unlike the costs were to put it back in there. You have your pools, you have your dry cells, you have your fans up above in a mothball condition. So, the cost of this would--are not within the bounds to do things. Now, off-loaded off, it's a lot of money to off-load it all. No, we did not do specific cost estimates for that. I don't intend to start doing that because I've got more important uses of the money to use on the science and engineering not to go off on that sort of what-ifs.

CRAIG: Okay. The second to the last question has to do with the continued R&D. Now, you already have some projects that aren't going to come to fruition for a number of years like the hot block, large block test. You won't be getting data for a long time. But, we've talked a lot about how technological change is likely to occur over a time span--the kind of time span that you're talking about, even during emplacement and certainly after emplacement. Up to 20 or 30, there's likely to be a lot of time change of technological change. How are you handling the research and development budget that--particularly, the research end of things that is your best bet for learning about things that can help you to do the job better later on? Is the research budget built into this, at all?

BARRETT: No. We have performance confirmation into it. We are not funding new research other than performance confirmation on this thing. Just a point of correction, the large drift-scale tests, we're getting lots of data right now and we have since the day we turned the heaters on.

CRAIG: Do you plan, Lake, to have a budget that will look at the research and development program?

BARRETT: By statute, this is not an R&D program. I do not have R&D, let's say, to find these fundamentals in earth sciences that might go along parallel. I did not put that burden on either the defense payors or the rate payors in this program. So, no, that's not in the cost estimates. By statute, we do a specific job. It does have it for the NRC for doing all the performance confirmation monitoring, but it has no fundamental R&D for earth sciences and material sciences or that sort of thing. That is not in these budgets.

CRAIG: So, technology, basically from your point of view, is frozen as of the time you start going into the ground?

BARRETT: Of course, it's not frozen. We know if won't be frozen. Hopefully, the future, whatever DOE is, there will still be a basis science program, university programs, and all of that science will feed into this. We are not funding future general science activities in this budget or in these cross-testings.

CRAIG: But, again, just to drive the point home, as far as your program and as far as OCRWM is concerned, technology freezes as of the time you start to go underground?

BARRETT: Not true.

CRAIG: It's up to somebody else to fund that if it's going to be funded?

BARRETT: Not true, at all.

CRAIG: Not true. Why is that not true?

BARRETT: One of the reasons we went to the concept of monitoring geologic repository was to allow as other scientific things developed, which I hope science continues to evolve for the next 100 years like it has in the past 100 years, this will confirm things in some of these uncertainties that we're talking about as begin less or greater and society will take appropriate action, whatever that may be. So, we're not assuming freezing of technology or anything else. We hope that it would advance and we can learn from that and people will feel more comfortable, and the uncertainties, we'll be more comfortable with in future generations or less, as the case may be.

CRAIG: But, it's not your responsibility to do that job by definition?

BARRETT: It is not my responsibility to develop future sciences 100 years from now that might be of assistance to a geologic disposal program; that is correct.

COHON: Thank you, Mr. Sweeney. We appreciate it very much.

SWEENEY: Thank you.

COHON: We now move to our last presentation which will be somewhere in VA. Unfortunately, Russ Dyer was not feeling well enough to stay and Steve Brocoum will be substituting for him. Appreciate you doing this on such short notice.

BROCOUM: Russ really wanted to do this presentation. He apologized for not being here. He hung until lunch, but he was very, very ill with the same bug or similar bug, the one that Rick Craun had on Monday.

I just want to say one thing to add to Rob Sweeney's presentation. He showed you a TSLCC chart with a total dollars--year of expenditure dollars for this program from 1983 through 1998 of 5.9 billion. This morning, Dr. Parizek asked what we had spent on Yucca Mountain. That number for the record is 2.7 billion through the end of fiscal year '98; 45 percent of the total.

The last presentation here for the day is the viability assessment technical issues, our path forward, and the project's commitment to quality. That's the table of contents I'll talk about.

Some technical issues, I'll go through quickly because a lot of them have been discussed already and comments from the TRB. Then, I'll get into how we are moving into an owner, if you like, into getting ready for site recommendation and licensing if we get that far.

The VA identifies the critical issues that need to be addressed before an evaluation of suitability can be made. Some of this work includes more information on the volumes, the rates, the mechanisms for the water seepage. Water seepage always comes out as being a very sensitive parameter in the performance of the repository. And, of course, the groundwater beneath the repository, the unsaturated and saturated zone, we have a lot of discussion of that in the last couple of days.

Waste package materials also in the current reference design waste package is very important and testing of those materials as described by Dave Stahl and other alternatives. As we look at alternative repository designs, it continues to be important. The interaction because we're talking about a system, we're talking about a repository system, to talk about the site individually, or about the design individually is really a red herring. It's how they work together.

And, we also this year are preparing our draft environmental impact statement. We're publishing for public comment this summer in July and we will be finalizing in August of 2000.

The TRB did issue a report in November of 1998. We appreciate the Board's recognition of our progress and some of the comments that were made today by the chairman on the VA. The report provides us insight. It's the Board's concerns that helps provide recommendations that we take in as we plan our program and proceed forward. We believe that many of the recommendations for additional work are parallel to those we have identified in Volume 4 of the VA, the multi-year plan, and work actually going on for fiscal year '99. We are preparing a formal response to the Board's report. That is in draft form and we'll shortly be sending that to the Board.

Some of the issues that were brought up by the Board include the fact that the testing at Busted Butte to assess transport of colloids and other aqueous species through the UZ should provide enough information to reduce uncertainties. As you know, Busted Butte is moving very aggressively. We have completed Phase 1 of that work. Phase 2 which looks at the whole block is underway and that information will be available for the TSPA for site recommendation. We are also coordinating with the Nevada Test Site to study the plutonium colloids in the Buckboard Mesa area in a cooperative venture.

Another issue brought up by the Board is seepage under ambient conditions can be better estimated by experiments through proposed in situ experiments in the ESF, analog studies, and by numerical simulations and modeling. We are, of course--and we've had some discussion the last few days on seepage tests and we are planning efforts to accelerate those tests if we can into fiscal year '99 to put some alcoves in the cross-drift for seepage experiments. Also, on that last issue, that was ambient conditions. We also for the thermally-driven conditions, of course, we have the drift-scale test which is an important test program.

Another issue, geochemical issues of groundwater are needed to determine the extent to which reducing conditions may exist in the saturated zone, if there are, in fact, reducing conditions that limits the amount of plutonium and colloids that could be transported. We heard a lot about that yesterday. The Nye County drilling program and our work with Nye County to help understand if there are reducing conditions. Additional work is being planned to evaluate those conditions beneath the repository and downgradient.

Geologic, hydrologic, and geochemical data, including information about long-range colloid transport, are needed to improve and understand the saturated zone. The USGS is conducting investigations to refine the overall regional framework model, studies with Nye County which we had quite a bit of discussion on yesterday, and cooperative work with the NTS and with other DOE facilities to understand colloidal transport.

Research is needed to confirm long-term performance predictions, i.e. corrosion rates and phase stability. Dave Stahl gave a status of that program earlier, both short-term tests and tests to understand the corrosion mechanisms that will be underway for any materials we plan to use in the waste packages.

On zircaloy cladding, again Dave Stahl gave a nice summary of the status of that. So, we think we're addressing that.

Forces driving the need for change, we're transitioning from the viability assessment to a site recommendation and to the supporting environmental impact statement as our near-term objective. A paradigm shift to owner/applicant is underway. We're trying to instill a nuclear culture doing things right, doing them right the first time, having them traceable, having all the right documentation, and so on. So, the project must transition from a research and development orientation to a nuclear regulatory culture where we are the owner/applicant. We're focusing heavily on quality initiatives. We can be doing in a sense the best science, if you like, design in the world. If it isn't traceable, if it isn't reproducible, if the regulatory agency that's going to grant our license can't demonstrate that, we would not succeed. We're trying to demonstrate measurable progress on resolving quality assurance issues. We have to have a quality program to have a successful license application.

So, we are committed to demonstrating commitment to quality and demanding technical excellence. Being fully knowledgeable and accountable for all aspects of the project; we're owners. Demonstrating and constantly reinforcing a strong safety culture. Assuring that all products are fully defensible and the decisions are traceable so we can create a basis for having credibility. Complying fully with all regulatory requirements and commitments to oversight organizations. Creating a focused project team. And, focusing on continuous improvement. Each major product that we have coming has an owner. We have an individual identified within DOE and within the M&O who is the owner of that product. Some of the same concept was applied to LADS effort where the teams were the owners.

The transition to a nuclear culture requires education of its principles and full acceptance by DOE and all the project participants. We have tried to demonstrate as managers our commitment to this transition. We have held offsites to focus the need to change, at all, DOE and contractor staff levels. Russ Dyer and Dan Wilkins have visited all participants and have a several hour presentation they give. It's also been done here in Las Vegas to all the personnel here. We've reorganized to enhance our project oversight. We are having mandatory all-hands training sessions on the principles of nuclear culture and it's important to our success. We are emphasizing accountability for quality improvement and technical excellence. Project manager is holding his DOE managers accountable, the line managers for the quality program.

We've instituted a process validation and re-engineering effort, PVAR, where integrated product teams have been formed to validate, correct, or enhance key processes for doing work, writing reports, and that kind of thing. It's about, I think, 19 key processes. Those PVAR efforts are coordinated with our corrective action request response activities where we've had cards issued. Our QA program has been consolidated. The Office of Quality Assurance is integrated with CRM's M&O, but we have independent verification function within DOE. The QA program controls are now implemented for all areas of the program. You know, for the VA, that was the first time that the TSPA was under a quality program. So, TSPA-91, 93, and 95 were not conducted under a quality program. TSPA/VA was. It demonstrated a lot of areas that we have to work on to come up with a or to end up with a fully traceable TSPA by the time we get to the license application.

The project has been reorganized. Here's the overall OCRWM organizational chart. This is the project office here. These are the key organizational elements of the project. We have an Office of Project Control that worries about schedules and tracking, project support, all the normal business functions. An Office of Project Execution under Dick Spence. They worry about the day-to-day activities and the science and design and performance assessment areas. The Office of Licensing & Regulatory Compliance which is the office that's responsible for the EIS, the site recommendation, and the license application. Project Execution also has an operations division that worries about the site activities, you know, construction, drilling, and testing and ESF and so on.

Another way to show that, the next chart, we have a customer/supplier relationship, if you like. The ultimate customer within the project is Office of License and Regulatory compliance. That office defines the requirements, defines what it needs to produce EIS, the SR, and the LA. The Office of Project Execution must produce, if you like, those things that are needed; those technical documents, if you like, and information and these offices here are tools that serve the support office so that we can get our work done. This is the independent quality assurance program assessment team that audits or monitors to make sure we are, in fact, producing the quality products that we need.

This chart shows you the responsibility--the technical work is all in the Office of Project Execution which is under Dick Spence or the Office of Licensing and Regulatory Compliance which is under myself. This is designed to show you how we defined those responsibilities. My office is responsible for the EIS, the site recommendation, this box here, and the license application. What we've decided to do is to--in order to be able to categorize and compartmentalize work in reasonable compartments, we have created major technical reference products. These reference products will be the key supporting documents. This is not a complete list. This is an example; an example of the key supporting references to these products; the EIS, the SR, and the LA. So, as the manager of that office, I'm responsible for these products and making sure these products are adequate to support the EIS, SR, and the LA. Dick Spence in the Office of Project Execution is responsible for producing these products so that he can support these and producing all the detailed reports, hundreds and thousands of reports and analyses and studies and Level 3 and Level 4 and deeper products, to support these.

So, my span of responsibility is the licensing and regulatory products and the major technical products. Dick's span of responsibility is the major technical products and the detail, if you like; technical products including detail designs. That's why we have this overlap here. That's where we interface.

Path forward. We are trying to implement an effective project infrastructure, a customer/supplier organizational concept. In other words, go back a slide. If something is being done and we don't see why we need it, we have to ask the question, why are we doing it? So, planning goes from the left to the right. We define what we need and then it goes down in the organization. We have that independent assessment arm that reports through the Office of Quality Assurance directly to the project manager. If you go back two slides, this office right here, that's under Bob Clark. We have raised the standards for contractor performance and accountability. We have, as I said earlier, created a PVAR effort to improve all our internal processes of which we have 19 key processes.

So, priorities for '99, Russ Dyer's priorities, are to implement the more efficient infrastructure; develop defensible, traceable, reproducible technical baseline, and there is a lot of work to do this; complete our draft environmental impact statement; complete that activity that started under the LADS group to select the design concept and we're going to move forward to site recommendation; and conduct a detailed planning this year for site recommendation of which I gave you some examples this morning. Finalize our approach to evaluating site suitability, that's another way of saying what are we doing to do with 960; conduct site investigations and laboratory testing to focus on reducing key uncertainties and some of those have been identified by the Board and others; improve or revise our process models for the next iteration of TSPA and that's happening now; and complete the system description documents which will define our design for SR and LA.

A look ahead. We have the final environmental statement in August of 2000. On my chart, it shows a '99 milestone and Russ' chart is shown as a 2000 milestone. We defer those to Lake because that's really out of our direct project control. If the site is suitable, submit the site recommendation to the President in the fiscal year 2001. And, if that's successful, we'll submit a license application to the Nuclear Regulatory Commission in 2002. That is a programmatic issue and Lake can talk to that for waste acception and transportation services.

I think--is that the last slide or is there one more? Okay. That the picture we show again. We've shown that many times in the past. It's similar to what I've said already.

Thank you.

COHON: Thank you. Questions for Steve Brocoum?

KNOPMAN: This is kind of a philosophical question. What went into deciding to make this cultural shift now rather than waiting until the site recommendation occurred and a decision was made about suitability?

BROCOUM: Several things. It must have been about a year ago, several of us went down to the WIPP Project. They told us what it took them to get to the proper, if you like, culture to succeed in their regulatory environment. They said they underestimated by at least a factor of 2, what it took then. We also had WIPP people come to the project. We had Les Shepard come and he was here for several months helping us to start the shift. It took them about three years to make that shift, more or less. So, we realized we've got to start now.

Also, we need to get sufficiency comments from Nuclear Regulatory Commission, and to get sufficiency comments, we have to show that we have a program in place that meets the needs or the requirements of the NRC. We believe that we'll be unlikely to get adequate sufficiency comments unless we could put all this in place. So, that's what caused us to do that. In fact, Russ likes to say there are so many days left. He's got a number. He keeps track of the number of working days between now and SR, for example. And, now, there aren't very many.

COHON: How many working days are there?

BROCOUM: I don't know. It's like 300 or 400 or something like that, yes.

PARIZEK: This paradigm shift is another way to shake the bushes and the worker bees, some may fly away, you know. But, I see where a contractor responsibility of ownership can be beneficial in some respects. A group that's--I guess, one reward is if you're doing good work in one of the national labs, maybe you can expect to receive funding again next year to continue your responsibility. On the other hand, if you don't do good work, maybe that's the end of that. On the other hand, I can see when it comes to defending all of this before a licensing hearing, then you could probably count on that group to defend its, say, unsaturated zone model or flow and transport. That's what their job will be, right?

BROCOUM: That's correct.

PARIZEK: Back you up and make sure everything about it is in line as it needs to be in order to withstand the scrutiny of the licensing process. And, that would be true for each of these modular responsibilities. So, this does get very businesslike. I mean, it's definitely more like a private enterprise than it ever was Government.

BROCOUM: Yes.

PARIZEK: But, I hope the worker bees don't all misunderstand this and fly away and then you can't get the job done.

BROCOUM: Well, we're trying to explain why we have to do this. We're not just posing by fiat. We're trying to have a good transition. We're trying to have training and we're trying to show why it's good for them, as well as for us. So, we're trying to do it in a collaborative way. But, still, you have to get the point that we follow procedures. We document the information. We take the data, reduce it, and we put it in a technical database. Those things are a part of the condition of working on this project. So, if one decides they cannot follow those conditions, they will not be able to work on this project.

BARRETT: This is the second time we on this podium have been through this. We went through this in the late '80s on quality assurance and had stopped work on a lot of activities. And, we laid the requirements down, you know, discipline and things like that in place, but it did not get down far enough. We got the managers right, but we didn't get the individual scientists and stuff down. Just like we did in the very beginning of the tunnel. The tunnel was slow in the beginning because it's the same thing. Miners weren't used to doing Nuclear Regulatory Commission documentation. We finally got them where they did and they did it well once we got through some very hard meetings. We've had some scientists leave the program when we told them if you can't do it the right way, you ought to go find other employment and some have done that.

It's unfortunate that happens, but we're going to have another little shakeup coming and you will probably hear about it. But, we really want to have one scientific program that's good for the license application and it's also the same science for the suitability. I don't want to start to bifurcate the programs into two, a technical program for suitability and a technical program for the license application because it's complicated enough and we are very much making this like a business and accountability--

PARIZEK: In business, I mean in the sense what will withstand the legal debates that you know are coming? This is really getting ready to do the lawyer type thing that's going to follow. Without it, the whole program could be delayed and there would be all sorts of difficulties and embarrassments.

BULLEN: Lake, I think this is just a real simple question. All these deadlines and schedules and deliverable are contingent upon at least level funding and sort of stable budgets? If the stable budgets don't materialize, then this probably won't either?

BARRETT: That's correct. These are all contingent. In my talk, I think I said contingent on adequate funding. That's correct. The funding--this is so tight now because of the original things that, you know, funding reductions, we can't really bring the work down much anymore. So, it's going to probably to start to slip things to the right.

COHON: Any other questions from Board members?

(No response.)

COHON: Staff?

(No response.)

COHON: Thank you, Steve, especially for pinch hitting.

In this, our last public comment period of this meeting, we have two people who have signed up in advance; Bill Vasconi and Sally Devlin. Does anybody else wish to speak during this period that we've missed?

(No response.)

COHON: Okay. Mr. Vasconi, welcome back to the microphone.

VASCONI: I'd like to talk to you this afternoon as a member of the public. My views are my own.

Yes, I'm affiliated with the Nevada Test Site. I went out there in 1964 as a radiation technician monitor. I went into construction. I'm a construction electrician. Seventeen of the 35 years I was in construction was spent at the Nevada Test Site working with any number of the laboratories, working on a diagnostic facility, providing power, lowering ramps into the ground. I probably participated in one form or another in some over 100 nuclear events. I also worked as an appointee for the employee transition committee when we downsized. Keep in mind, we had 11,200 men out there in 1989, less than 2,000 today. I also served on your site-specific advisory board for ERWM measures, stayed on as chairman for two years. Presently, I work with the Nuclear Waste Study committee. Also, I work with the NTS Development Corporation, a private outfit, private concern, private businessmen, Government officials. The point is they want to diversify the Test Site, privatize the Test Site, bring on new industries, new technologies.

I'm also an AFL-CIO member and have 34,000 members in the Southern Nevada building construction trades that gave me the right to say let's talk issues and development of the Nevada Test Site. The intent is to maximize the benefits that can be realized by our community as a result of scientific and technological expertise that have been developed at the Nevada Test Site over the past four decades. Again, 1951, a shot called Able; 1992, a shot called Divider.

What got me going today was a news release. I'll be very brief on the news release. The Governor, less than a month governing under his belt, Kenny Guinn, is tackling Nevada's most feared subjects turning Nevada into a dump for high-level nuclear waste. The Governor will hold a summit meeting on nuclear waste with State and Congressional leaders February 16 at the State capital in Carson City. Put out just in time, wasn't it, folks, while you had your meeting? It upsets me some.

Eighty-eight years, 88 years from this nation's founding in 1776 to Nevada statehood in 1864. I'll suggest to you that Nevada's land, the Federal dirt of the Yucca Mountain Project, does not equal a measure of men's sacrifice for this great nation in those 77 years. Nevada, the first Governor of Nevada was Nye. He came from Massachusetts. Its two first senators came from New York State. Clark County, you're in Clark County right now; matter of fact, that Government who was Nye, Nye County. In Clark County, we've got 13 of the 21 State senators in Clark County; 26 of the assemblymen out of the 42. I attend a good many of these meetings and probably in error. How many State assemblymen are here? How many State senators? Your Governor is calling a meeting on a summit. Shouldn't you get familiar with the issues?

Some folks have time to listen; others only have time to talk. Politicians love to hear themselves talk, but damn seldom have time to listen. Nevada's politicians appear incapable of making scientific judgments on their own. Nevada politicians have lost national credibility by assuming an over our dead body issue, anti-nuclear agenda.

In defense of Nevada, Nevada is about the size of Italy. United Kingdom would fit inside Nevada, Wales, Scotland, Ireland, England; so would three Austrias, seven Denmarks, 10 Belgiums, 110 Luxembourgs, and we have a gentleman here from Sweden. You're two and a half times bigger than the State of Nevada. Where's Nevada's involvement in these meetings? That's just a question mark.

But, let's take for an example that this site was going to be situated right alongside of Rhode Island, Delaware, Connecticut, New Jersey, and Massachusetts. Would those states be involved? Damn right, they would. All of those states will fit inside Nye County, Nevada. The 13 original colonies would fit inside the State of Nevada, size-wise.

NTS was mentioned a little earlier. We've had 1,300 nuclear devices detonated by the United States of America; 928 of them was detonated at the Nevada Test Site. 928, 24 with Great Britain. Of those, a full third was detonated in your water table. 100 was delivered by air. We've got a history of nuclear and a good of bit of waste.

It's buried in water aquifers. It damn sure needs studying.

Transportation, some of those nuclear devices went down the road on a truck. Hell, we've got 1400 nuclear devices stored right here at Nellis Air Force Base, Cruise Air Missiles. I don't know if they got drip shields on them. I don't know who is monitoring them.

It certainly shows to Nevadans 41 percent are concerned about crime, 19 percent about traffic, 15 percent about (inaudible), 13 (inaudible), and the rest of it is water and jobs. Thirty-four of the 48 states, Continental United States, have nuclear power. Nevada accepts food, cars, steel, textiles, and more than nothing, money. Bring your money to Nevada. Let's not talk about those projects made with nuclear power; just bring your money.

The Nuclear Waste Technical Review Board was created by Congress and Nuclear Waste Policy Amendments Act of 1987. Its purpose is to evaluate the technical and scientific validity of activities undertaken by the DOE; this program for managing and disposal of the nation's commercial spent fuel and defense high-level wastes. The Nuclear Waste Technical Review Board should, beyond your Congressional mandate, respond to review all who perform scientific activities associated with the Yucca Mountain Project and their findings accountable by the same yardstick of good science including the State of Nevada. If the Technical

Review Board validity checks finds erroneous science, it should critique and respond to those findings regardless of where it originates. Credible oversight needs to identify and study real risk as Nevada's oversight program continues to remain scientifically and politically correct.

In conclusion, sound science, public input, health and safety issues, that's what the residents of Nevada are looking for. What's Plan B? I can ask every dang politician we got; what's Plan B? What if this comes here; what's Plan B? There's no Plan B. A good percentage of Nevadans feel that high-level nuclear waste should not come to Nevada, but a large majority of them feel it's coming whether we want it or not. The majority wanted to diversify economic dates. Equity, let's talk equity. We talked 18 to 32 to 22 billions of dollars; 18 to 22 billions. Is that 1,800 millions? Increase the monies to affected units of local Government for the nuclear waste funding, for local impact and environmental studies. They doing a good job. A lot of Nevadans are looking at those affected counties. Let them have an opportunity for oversight. True, there are equity issues. Nevadans want to hear about equity issues.

I'm almost done. Equity (inaudible) benefits. What's wrong with Premier Energy Research Facility at the Nevada Test Site? What's wrong with Federal funding for a state-of-the-art emergency response program? What's wrong with considering the water rights of Nevada? How about the Federal land transition? We're 86 percent Federal. Transportation systems, roads, university research facilities, educational funds, a stewardship trust for grants to state and counties for the YMP as a repository, during emplacement, as a monitored study area, as a closure equity.

I'd like to thank the Board for the opportunity to address you. I wish some of my State assemblymen, my State senators was here also. I'd like to thank the United States Government because, you know, they're coming up with a viable solution to this nation's nuclear problems. In Nevada, we have a mountain. We have a management orientated in nuclear. We have the manpower to do the job and do it right. Let's get on with it.

I'm open for questions if anyone would throw one at me. I've got it all off my chest. Thank you very much. I know a lot of you aren't involved in what I said, but maybe you can influence somebody that is. Thank you.

COHON: Sally Devlin? Ms. Devlin, we're still trying to keep to the 10 minute limit if we can.

DEVLIN: I won't go 10 minutes.

COHON: Okay. Thank you.

DEVLIN: Again, Sally Devlin, Pahrump, Nye County, Nevada. You heard about our size. The entire state used to be Nye County many years ago. And, Clements, what's his name, that wrote Huck Finn was his brother and that's how he came to Nevada.

So, anyway, I just have a couple of questions. That is from Carol. In your map, you have Yucca Mountain as a natural analog. Can you, please, explain that to me? I know Cigar Lake is, but what about--how do you come to put Yucca Mountain as a natural analog?

(No response.)

DEVLIN: Is she not here? Okay.

COHON: No, she stepped out.

DEVLIN: Okay.

COHON: Let me try a response and let me see if DOE agrees with it. I interpret that to mean that Yucca Mountain is just on the map to locate it so we all remember where Yucca Mountain is. I don't think they're proposing Yucca Mountain as a natural analog.

BARRETT: I think that's correct. To my knowledge, that would be correct. I don't think we have any natural analog work going on at Yucca Mountain.

COHON: Carol?

HANLON: Just to clarify, it's just a spacer to show that Yucca Mountain is on the map.

DEVLIN: Thank you very much. Sometimes, as you know, you don't even put Pahrump on the map.

HANLON: We'll do that next, Sally.

DEVLIN: Thank you. NTS forgot us on a huge EIS.

Anyway, and David Snell, on the use of nickel for the canisters--that is, I gave--William, raise your hand there. Tell them all the stuff I brought for everybody on scientific information. This is not just from me. I am the disseminator of all kinds of stuff, but my lead on the nickel says that if the microbes that lead the nickel get into the water table, I'll die. I didn't even know nickel was poisonous.

Mr. Sweeney, on your 6.7 billion for transportation and so on, I am a little bit fiscal at times and I got into this five and a half years ago when they were going to bring all the high-level waste through Pahrump. At that time, it was to come from Jean over to Smokey Valley, down through Pahrump to Amargosa and up to the Test Site. And, the cost five and a half years ago for that whole thing--and I think it might have only been the railroad--was 1.8 billion. I seen numbers of this sort for Carlin proposal and Caliente proposal and they were well over 2 billion and this was a couple of years ago. We have never talked transportation. So, I'm just wondering if that isn't a bit underestimated. And, of course, I have to say anything fiscally, who is going to approve of these enormous monies for this project? You've got to sell it to the public and to the Congress and to the Senate and so on. I hope that the figures are not quite so vague and that we can really see this value you've received.

In my very first meeting, I had a chart of--since the rate payors have been paying, and at that time, we had--I don't know, 2 or 3 billion and then it went up. Then, as the nuclear power plants closed, of course, the monies went down. So, I don't know what this is and how much is there now. I think the last number I saw was about 9 million. Is that pretty close? How much is in the fund?

BARRETT: The current balance is about between $6 and $7 billion in IOU Government bonds.

DEVLIN: It's that low? Okay. So, anyway, we understand we're (inaudible) about financing. I'm not going to tell you if you come down in your chariot until I see you all in Beatty in March and I promised Daniel Fehringer I'm not going to yell at 21 acronyms again. He's used to me yelling, but I promise you I won't. I now have 48.

I couldn't leave without a bit of humor because everybody knows I'm a very poor student, but I'm always studying. I thought I've got to bring a present for the Board for being so wonderful and so tolerant and taking my poor humor for really what it's meant because it's curiosity. That's why I'm always asking questions and always have my whole life. So, I brought a present. I thought I'd have them for you, but I don't. But, I'll show you. And, since you're going to send me the moon, I thought if anybody would like one of these, I will send it to them. So, let me know. This is my geriatric periodic table and it has all 106 elements and you can read it.

With that, thank you again for coming. If anybody wants my geriatric periodic table, I'll be happy to have it copied and send it to you. Come again soon and come to Pahrump.

COHON: Thank you, Ms. Devlin. I think we can all be confident this is the first time in history that the periodic able got a laugh.

STAHL: May I respond?

COHON: You want to respond to the periodic table?

STAHL: No, no.

COHON: Oh, sure, by all means. Mr. Stahl is going to respond to the issue of nickel and bacteria.

STAHL: Just a comment in regard to some of the preliminary biofilm studies that we're doing with Alloy-22. We do see, as we anticipated, small enhancement of chromium in the solution which you would expect because chromium exists at more than one oxidation state. We do not see an enhancement of nickel and I wouldn't expect to see it.

COHON: Just so you can plan ahead and get it on your calendars, I just wanted to point out that our next meeting, the Beatty meeting that Ms. Devlin referred to will be on June 29 through July 1. You all have something to look forward to, as we do.

I want to thank all of our speakers, especially those today. We're very pleased and very thankful for the way you responded to the questions that we posed to you. You did an excellent job of doing that and, as a result, I think I speak on behalf of the entire Board and probably all those who attended, we found today's sessions very valuable; in fact, quite remarkably valuable and very timely.

Our focus today, of course, was on the viability assessment. As I said at the outset, the Board is pleased to congratulate DOE on making this fine achievement. The VA represents a very significant milestone in this project's history. We were reminded at the beginning and at the end that VA is truly history to the program. They certainly haven't dwelled on it and they're well-beyond it. This may be the last time they talk about it for a whole day.

They're well into the site suitability determination or SR, as it's now dubbed, and we now have to introduce that into our language. Thank you very much, SR. It is an eye-opener, at least it was for me, and a sobering thought that Russ Dyer is actually counting down the days and, in fact, when we saw these charts, suddenly SR looked awfully close, indeed. What seemed to be tension in the past between long-term scientific studies and the need to make shorter term decisions, has gone well-beyond tension to direct conflict where the program has hard choices to make. They've made them basically and they're implementing it. And, we have to understand the implications of this for scientific understanding of the mountain, of the site, and of the design aspects of the repository, as well.

Thank you very much. We had our work cut out for us; we all do. And, we look forward to being with you all again. I want to acknowledge our staff, all of them, for their help in preparing for this meeting, but especially the two Lindas--wave--who did everything in terms of making arrangements and, please, do acknowledge them. Thank you.

We stand adjourned until Beatty in June. See you then.

(Whereupon, the meeting was concluded.)