UNITED STATES
NUCLEAR WASTE TECHNICAL REVIEW BOARD

FALL BOARD MEETING: SITE-SUITABILITY ISSUES

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Alexis Park Hotel
Las Vegas, Nevada

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Dr. Clarence R. Allen, Session Chair
Dr. Garry D. Brewer
Dr. Edward J. Cording
Dr. Donald Langmuir
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I N D E X

P R O C E E D I N G S

DR. JOHN CANTLON: Good morning. If you'll take your seats, we'll get the session under way.

My name is John Cantlon, and I chair the Nuclear Waste Technical Review Board, which we hereby declare open and ready for work. It's a pleasure to welcome you here to our fall board meeting.

With me today are Clarence Allen. Clarence is a Geologist and Professor Emeritus at Cal Tech. John McKetta over here on my right, Chemical Engineer and Professor Emeritus, University of Texas.

Ed Cording. Ed is a Geotechnical Engineer and Professor at the University of Illinois.

Gary Brewer. Gary is a Political Scientist and Dean of the School of Natural Resources and Environment at the University of Michigan.

Don Langmuir. Don is a Geochemist and Professor Emeritus at the Colorado School of Mines.

Also present are Pat Domenico. Pat is a Hydrologist and Professor from Texas A&M. Dennis Price, an Industrial and Systems Engineer and Professor from Virginia Polytechnic. Ellis Verink, a Metallurgical Engineer and Professor Emeritus, University of Florida.

My own field is Environmental Biology and I'm

former Vice-President for Research and Graduate Studies at Michigan State.

As most of you know, the Nuclear Waste Technical Review Board was created by Congress in the 1987 Amendment to the Nuclear Waste Policy Act created to assess the technical and scientific validity of the DOE's efforts in designing and managing their radioactive waste system, including site characterization and transportation and storage of high level waste.

We're happy to have with us today J. Van Miegroet. Mr. Van Miegroet is the Manager for Research and Waste Disposal at ONDRAF/NIRAS, the Belgian agency dealing with that country's radioactive waste. The Board had the pleasure of meeting with Mr. Van Miegroet during our trip to Belgium in 1993, and we're looking forward to his presentation this afternoon.

The main topics today are the site-suitability determination and the role of engineered and natural barriers. We will hear more about these topics later from Clarence Allen, who will be chairing that session. Garry Brewer will be moderating a round-table discussion following those presentations.

Before we get started on these topics, however, we'll hear from Dan Dreyfus, Director of the DOE's Office of Civilian Radioactive Waste Management, on OCRWM's FY 95

program and outlook.

Dan, thank you for taking the time to meet with us.

DR. DREYFUS: Thank you. I'm pleased that you invited me to be here this morning.

Just this past week, I completed one year as Director of the program, and that in and of itself is probably an accomplishment.

My last formal meeting with the Board I think was just shortly after my confirmation, and at that point, I gave you my early appraisal of the problems that I thought confronted the program.

My experience and the new developments since that time have confirmed some of my early impressions and changed some others. I'd like to share with you today some of my current views on where the program is, where it is going and especially the near-term situation.

I believe that we can continue to pursue site suitability and subsequent licensing of a repository within the general statutory and regulatory parameters that we now already have. And I'm convinced that the effort can be performed in a scientifically and socially defensible manner while meeting the requirements for cost control and political requirements to make demonstrable progress and to maintain meaningful targets.

I contend that we have already taken the

initiatives that are necessary to put the program on that basis. It will, of course, take a while for those initiatives to ripen into work in progress.

Now, I don't mean to imply that I'm confident of the ultimate outcome. This undertaking is fraught with uncertainties. The physical characteristics of any geologic setting are inherently complex, and the technical challenges of very long term predictive models that we are undertaking here are unprecedented.

More significantly, perhaps, the ultimate objective of this program is to provide adequate assurance to society that the permanent geologic disposal of high level waste can be met with acceptable standards of health, safety and environmental protection. And I would stress the word acceptable. In the final analysis, the test of adequacy must be and will be a social judgment that will be made in a political setting. So we cannot have certainty that the judgment will be favorable, even if the technical attributes of the undertaking meet our scientific notions of acceptability.

Our mission is to do an honest and competent job of collecting sufficient data, doing rational analyses and making the showing that is necessary for the regulatory and political decisions to proceed.

I think we can do that, and do it within the

constraints of time and money that will be allowed us. The alternative, of course, would be to abandon deep geologic disposal as an option by default before a social judgment on the merits can be made.

In the face of limited resources, we must concentrate scientific work first on essential factors of site suitability determination, and next upon the additional support required for regulatory determinations. In order to manage the program and demonstrate progress, we must set forth explicit tasks, associate the tasks with target dates and costs, and then we must control progress against those measures. I don't know any other way to manage a program.

I believe we have captured those objectives in the approach we are taking. Steve Brocoum and members of his staff will be describing that approach in detail to you today, and that is your principal agenda item.

I want to reiterate something that I think I said the last time. We are not making a choice here between continuing the program as it was or moving to some new approach for expedient reasons. The continuation of the program as it was was not a viable option when I was sworn in. External criticisms of the anticipated delays, the glaring inconsistency between the project work plan and the available resources could no longer be ignored.

The initial reception of our revised approach I

think has been encouraging. Most participants and most reviewers, while rightfully cautious, have taken a constructive attitude toward helping us accomplish our objective.

The Congress, acting on the faith that we can and will accomplish it, agreed to the Administration's proposed 40 per cent increase in funding in '95, despite severe, government-wide budgetary restrictions. I am hopeful that the future year funding profile that was proposed with our '95 budget can be realized in the face of what are much more restrictive deficit controls across the government in the years ahead.

In '94, we continued to operate in a very severely constrained funding situation. We have found that '95, despite the large increase, that the program still requires tough priority choices and severe cost control to maintain the targets that we have set for accomplishment.

Most of the additional funding we received in '95 will be allocated to the Yucca Mountain Site Characterization activity. Progress will be made on evaluation of site suitability, on the National Environmental Police Act compliance, on the resolution of licensing issues, and on the acquisition of information to support each of these.

In the coming year, we plan to finalize our site suitability evaluation process reflecting stakeholder input

and the input of reviewers such as this Board. We will prepare technical and compliance documentation to support decisions on five higher-level findings for guideline conditions related to surface processes.

We'll begin the formal NEPA process and will initiate scoping activities for the statutory Environmental Impact Statement needed for the repository. In the licensing area, we will complete the next revision of our Annotated Outline for a repository license application and we will issue that as a DOE document for the first time. We also expect to complete a topical report on seismic hazards, the second in a series of three on seismic issues, for submittal to the Nuclear Regulatory Commission for review.

Data acquisition and analysis activities will support progress in achieving our near-term milestones for suitability and licensing. These activities include both surface-based testing, and construction and testing in the exploratory studies facility.

With respect to the ESF, we started test-phase operation of the tunnel-boring machine last month. We plan to commence round the clock operations within the next few days. Over the next twelve months, we'll continue tunnelling to support our fiscal '96 milestones related to site suitability.

We expect to continue surface-based testing at

about the same level as in fiscal '94. We will emphasize testing and monitoring in existing drillholes. We will focus on long lead critical path activities. As part of the approach, we will be re-examining every investigation in our technical program to assess if the program is meeting the needs of suitability and licensing.

A major priority for '95 will be to assemble, analyze and qualify when necessary our existing data. Our principal objective is to demonstrate measurable progress towards a decision about site suitability during the year.

Waste acceptance and near term storage activities in '95 will concentrate on the multi-purpose canister and compliance with NEPA. In support of this initiative, we plan to conduct scoping meetings in advance of preparing an Environmental Impact Statement for the decision on deployment of the canisters, which would be made in the 1998 time frame.

We'll finalize a topical report on burn-up credit for storage and transportation and submit it to the NRC staff for review. I expect to address this issue with the Commissioners when I give them my semi-annual status briefing in December.

We will be evaluating the technical and cost proposals for the MPC design and certification that were called for in June. We would expect to complete review of the proposals during fiscal '95 and award one or more

contracts.

We placed a high priority on several aspects of program management. We intend to continue to clarify and complete the clarification of organizational roles, and making the participants more responsible and accountable for their work. We expect to achieve major benefits with the consolidation of our major participants under the technical direction of the M&O contract.

Effective last week, SAIC joined the M&O team and we'll be pursuing further integration and rationalization of contractor arrangements. I expect by the end of the year, to have the headquarters office and the Yucca Mountain office fully integrated, both across the organizational lines and across the geographic separation.

Now, beyond the immediate programmatic activities, I expect that during the next Congressional session we, and probably you, will also be involved with significant public policy debate concerning national radioactive waste policy. Judging from the existing lawsuits on waste acceptance, the public expressions already made by key members of Congress, and the extensive lobbying efforts that are already under way, there is little doubt that Congress will address radioactive waste policy next year. There is a lot less certainty about what the result is going to be.

The dimensions of the debate are taking form.

There is a need to relieve the constraints imposed upon the use of the Nuclear Waste Fund due to the caps on discretionary appropriations. I expect the Administration to propose again an approach to remove those constraints. There is a very broad consensus in the government and outside that a solution should be found to the waste fund issue. The problem of course is the deficit control is a very strong political imperative throughout the government today, and the way out of the current impasse is somewhat elusive.

The nuclear utilities and many reactor states have made clear their intention to seek an aggressive interim storage initiative. They proposed that Congress instruct and authorize the Department to take possession of spent fuel at the earliest possible time. The physical facilities to accomplish this goal, and especially the siting of those facilities, are somewhat less specific in the proposals.

It is certainly timely for the Congress to address the issue. The program needs guidance and it probably needs new authority to define its role in the near term management of commercial spent fuel.

A related issue is that the national policy does not now include a contingency plan should Yucca Mountain prove to be unacceptable. This Board and many other reviewers have called attention to that situation. If the site is rejected, we will confront at least a period of

several decades while another site is chosen and explored, and in some conceivable circumstances, a negative decision about Yucca Mountain might imply suspension or even total rejection of the geologic disposal strategy.

The national policy ought to include a Congressionally authorized and mandated contingency approach to address those possibilities. Reliance upon extended at-reactor storage for many decades would, in my view--and this is my own view--be a serious public policy failure. In any event, it should not become our national waste management strategy by default.

I expect these issues to be discussed in the next Congress. I hope that my office will make a substantive contribution to the debate, especially by providing sound advice on the practicality of the proposed options. I hope that this Board will be called upon and will come forward and do the same. It would be a tragedy if Congress were to spend a considerable amount time and effort on this policy and come up with something that proved to be unmanageable or infeasible.

Meanwhile, we have to establish confidence that the mission that we now have is being pursued in an effective and efficient way. We have quite an extended set of presentations today. I hope it will help build your confidence that we are heading on a course that is both

efficient and capable of succeeding.

We believe that many of your earlier comments have been incorporated in the approach we have taken, and we need your help in refining it.

Thank you, Mr. Chairman. I'm at your mercy, or service.

DR. CANTLON: Dan has agreed to take questions. Are there questions from the Board?

(No response.)

DR. CANTLON: Board staff?

(No response.)

DR. CANTLON: Audience?

(No response.)

DR. CANTLON: You lucked out.

DR. DREYFUS: Okay.

DR. CANTLON: Now Dr. Allen will take over the session.

DR. ALLEN: Thank you, John.

As everyone here knows, site suitability has become an increasingly important topic of discussion among those interested in Yucca Mountain. For example, the proposed program approach, so-called PPA, defines the determination of technical site suitability as the most important OCRWM effort in the next few years.

As we have heard, the DOE is presently engaged in further defining the process by which this decision will be

made. The DOE has already stated that it does not intend to revise the existing guidelines, 10 CFR 960, and will base its decision on technical site suitability on satisfying the qualifying and disqualifying conditions found in those guidelines.

The DOE has begun negotiating, as we understand it, with the National Research Council of the National Academy of Sciences regarding its participation in review of technical information reports related to suitability issues, site suitability issues.

To make the PPA operational, the Yucca Mountain Site Characterization Office is going through a progress of priority screening by which it will emphasize those studies in the site characterization plan most related to the DOE's determination of technical site suitability and eliminate or delay until license application those that are not.

In response to the Board's questions on the PPA, the DOE indicated that it is starting to identify specific tests and data necessary to support its technical site suitability determination and that the technical implementation plan for FY 1995 will be ready by September of 1994, currently rescheduled to October of 1994.

At the June, 1994 meeting of our panel on structural geology and geoengineering, for example, the Board heard of a DOE strategy for exploration of the Calico Hills

formation based largely upon what is found at repository level excavations. Apparently if the Ghost Dance Fault is found to be a highly permeable structure, exploration of fault properties in the Calico Hills formation would be considered necessary for technical site suitability determination.

When asked if thermal behavior in properties were deemed to be a site suitability issue, we were informed that they would be only if they challenged the DOE's ability to make bounding calculations with respect to different thermal loading scenarios. For its part, the Board has questioned whether the DOE will have conducted thermal and other tests sufficiently long by 1998 or 2001 to understand that which needs to be understood about the safe disposal of radioactive waste at Yucca Mountain, and to make suitability and licensing decisions.

Another issue related to site suitability is the extent to which engineered barriers can be used to minimize or mitigate adverse natural conditions at a repository. Strong opinions have been expressed on this matter. Some argue, referring to 10 CFR 960, that engineered barriers should not be used to mask site deficiencies.

Others maintain that trade-offs between natural and engineered barriers are logical and that total system safety should be paramount. Although all countries working on

geological disposal support the concept of multiple barriers, there are great differences with respect to how this concept is implemented, as we shall see later in the day.

A final issue is the apparent importance the DOE has assigned to peer review and peer judgment in assessing site suitability. The DOE has stated that it will be deferring some tests and data gathering to the post-construction authorization phase. The Board discussed the general topic of expert judgment in its most recent report in which it evaluated many of the important topics raised at the DOE's 1992 workshop on expert judgment.

Although a workshop report has been completed and distributed, the Board is not yet aware of any plan that the DOE has for implementing the Board's recommendations.

This meeting should serve several purposes. First, it should give the Board an understanding of the process by which the DOE hopes to assess its site suitability. Draft descriptions of this process are already available. As an adjunct to this topic, the Board would like to know what the DOE plans are for the use of expert judgment in assessing site suitability.

Second, the meeting should help us understand and clarify what the DOE views as the main technical site suitability issues at Yucca Mountain and, therefore, the DOE's priorities with respect to exploration, testing and

data collection. This topic includes a clear delineation of the DOE's current waste isolation strategy.

The idea of a waste isolation strategy, sometimes called the Safety Concept or the Safety Case, has been used successfully by other countries in articulating in a clear and concise manner how a proposed repository will safely contain and isolate harmful radionuclides from the public and environment under a range of conditions in the future, and the role of different barriers and sub-barriers play--or the role they play in waste isolation.

An important aspect of delineating this strategy and setting priorities is the further identification of those features and events and processes that could pose a serious challenge for the site's viability, and the ability of testing and exploration to identify those potential disqualifiers.

A related topic is understanding the DOE's distinction between data analyses that are needed for the determination of site suitability and those needed for licensing.

Third, the meeting should form a forum for an expanded discussion of the roles assigned to natural and engineered barriers and the extent to which engineered barriers should be considered in evaluating site suitability. Of particular interest, of course, is the possibility of

trade-offs between engineered and natural barriers.

A detailed outline of the topics we'll be discussing can, of course, be found in the meeting agenda. We'll start off this session with a presentation by Steve Brocoum and Jane Summerson of the DOE on the process of site suitability determination, including a discussion of what the DOE means by site suitability, technical and otherwise, the use of 10 CFR 960, review procedures, stakeholder involvement, and the use of expert judgment.

We have also asked Mal Knapp of the Nuclear Regulatory Commission, Steve Frishman of the State of Nevada's Nuclear Waste Project Office, and Steve Kraft of the Nuclear Energy Institute to provide us with their perspectives of site suitability.

After lunch, Jean Younker of the M&O will discuss the DOE's priorities in testing and data collection. It is hoped that this presentation will be a springboard for an extended discussion on the DOE's waste isolation strategy, site suitability issues, and those features, events and processes that could pose a serious challenge to the site's viability.

The last part of the meeting will be a round-table discussion on natural and engineered barriers and their role in assessing site suitability. This round-table will be preceded by a short description of foreign programs which

have somewhat divergent views on the relative importance assigned to natural and engineered barriers.

J. Van Miegroet will describe the Belgian program, which places heavy reliance upon the natural barriers. Ed Patera, a Los Alamos scientist who spent several years working with the Nuclear Energy Agency in Paris, will describe the Scandinavian programs, which place heavy emphasis on the engineered barriers.

At the conclusion of the round-table, we will open the floor for public discussion. Garry Brewer will have more to say about the round-table later in the program.

The first presentation this morning is by Steve Brocoum and Jane Summerson, and I assume, Steve, that you will lead off.

DR. BROCOUM: Good morning. My name is Steve Brocoum.

I was going to talk about the background and overview for development of proposed site suitability evaluation process. Jane Summerson was actually going to talk about the process we are planning on implementing and later on this afternoon, Jean Younker will talk about the data needs and the uncertainties and what we know, what we still need to know on site suitability.

I'm going to give a little bit of history to kind of put it in context. In 1982, the Nuclear Waste Policy Act directed DOE to develop siting guidelines to assist the

siting process, and they had to have qualifying and disqualifying guidelines. They were developed by the consultation required by the Nuclear Waste Policy Act, and they included concurrence by the NRC.

One of the people that was very involved in doing that is here today, Carol Hanley. I'd like her to kind of stand up for a second. Is she here? If we have any questions about the guidelines and their history and the role, she is here, I know she's here--there she is, back there in the back of the room. It was a two and a half year process or so and DOE issued guidelines for recommending repositories in December of 1984.

Congress directed us to employ these guidelines as part of a screening process to identify multiple sites in various geologic media that would be suitable for further characterizations. Sites that were suitable for characterization would have been compared among each other and the three sites in different media were going to be recommended for characterization.

After completing site characterization determining the suitability of each site for development as a repository, the sites would be compared to each other and a single site was to be chosen and recommended to the President.

Now, the next viewgraph I am told is not in your package. But this viewgraph has been used many times in

front of the Board. It's just to remind ourselves that 960 has 24 guidelines. They fall into four groups, post-closure performance, environmental, socioeconomic and transportation, pre-closure radiological safety and ease and cost of siting, construction, operation and closure. This is just a reminder. These have been discussed before. All of these have qualifying conditions. Most of them have disqualifying conditions.

When we talk about technical site suitability, we are talking about implementing this set of guidelines, that set of guidelines, and this set of guidelines. Those having to do with environmental, socioeconomic and transportation will be handled through the NEPA process. And the SCP addressed these three sets of guidelines.

How have the guidelines been applied? The guidelines were used, as required in the Nuclear Waste Policy Act, it originally nominated five sites suitable for characterization, and then recommending three of those sites to the President as candidate sites to be characterized for the first repository. Each site that was nominated was accompanied by environmental assessment in 1986 that included the evaluation of the suitability of that site under the guidelines, and four higher level findings were made for the Yucca Mountain site in the 1986 environmental assessment in the areas of dissolution, a qualifying and disqualifying

condition in the areas of population around the site.

Then a separate evaluation of each of the other sites was also required.

In May of 1986, the President approved the three sites recommended for characterization, including Yucca Mountain. However, in December of 1987, an amendment to the Nuclear Waste Policy Act eliminated the requirement for consideration of multiple sites and only provided that characterization would proceed only at the Yucca Mountain site to determine its suitability for development of the repository.

So DOE did prepare an SCP in accordance with the Nuclear Waste Policy Act for the Yucca Mountain site. The siting guidelines were identified as the criteria, as required by the Nuclear Waste Policy Act, to evaluate the suitability of that site. The SCP described how DOE proposed to address the guidelines and it also pointed out that those environmental, socioeconomic and transportation, those that required generally non-geologic or earth science data that were not covered in the SCP would be covered in the Environment Impact Statement. As defined by the Nuclear Waste Policy Act, the SCP was addressing more or less the earth science type of guidelines.

The SCP was submitted to the NRC and the State for their review and comments. It also identified the provisions

that were no longer applicable based on the 1987 amendment, and those kind of provisions had to do with comparing sites, multiple sites, with regard to performance or cost, because there were not multiple sites to be compared any more.

It identified the guidelines and how they would be handled. The implementing guidelines provide that before DOE can make a decision that a site is suitable and can be recommended to the President for development as a repository, the evidence should support findings by DOE that none of the disqualifying conditions are present and all the qualifying conditions are met and that based on the information DOE has at hand, based on their understanding of the uncertainty and based on all other information that can be brought to bear, that those conclusions are not likely to change with the collection of additional information. That is a higher level finding.

Other than the four that I said were higher level findings, were lower level findings. They met the first condition, none of the disqualifying conditions are present, they met the second one, that all the qualifying conditions are met, but they did not necessarily meet the third one. In other ones, we did not have enough information, we did not have enough understanding of the uncertainty that we had the confidence that that conclusion would not change in the future with additional data.

In the guidelines, a finding is defined as a conclusion that is reached after evaluation. There is no explicit provision in the guidelines requiring findings of a favorable or potentially adverse conditions. The reason is it was thought that it would be, based on the voluminous data that would be collected during site characterization, it would be possible to directly evaluate site performance against the qualifying conditions of a system and technical guidelines.

So when 960 was originally written, it was thought that these would be early indicators, and as more information became available, the qualifying conditions would be the more accurate, if you like, indicators because they would address the performance of the site.

However, 960 does say that the favorable and potentially adverse conditions will be considered in balance as part of the evaluation of a qualifying condition of the technical guidelines prior to making findings. So they're not ignored, but they're not explicit findings made against them.

Now, we have gotten several letters, one I think from the NRC, one from NEI questioning this issue, and Dan has asked us to look at this again, and we'll be looking at this again. And so as we finalize our process for evaluating site suitability and publish in the Federal Register, we will

address this issue as brought up in the letters.

In December of 1990, in implementing the Secretary of Energy's 1989 commitment to Congress to focus on site suitability, OCRWM directed that an early assessment of the Yucca Mountain site be performed under 10 CFR Part 960, based on the data that was available then.

That assessment was intended to determine if information collected since 1986 indicates that the site should be disqualified. And the reason that was so important was every time someone asked should a site be disqualified, we would say we are not aware of any information that should disqualify the site, but no formal evaluation had ever been made. And also it was designed to help us focus and prioritize data for acquisition activities.

The results of this assessment and external peer review were published in January of '92 as a contractor report and issued by DOE for public comment. And this was presented to the Board in 1992.

Where are we today? Today we have a Program Approach. As of October 1st, the proposed has been dropped, so the PPA has now become the Program Approach. I need to announce that we had said at previous meetings and in various other forums that there was a five year plan being developed. There is a copy of a pre-decisional draft, actually a document really in progress on the back table, I believe.

There's 100 copies for the audience and for the TRB.

This document, we have had many requests for this document, so we decided to release this pre-decisional draft. It is a document in progress. There may be inconsistencies in it. There is one chapter which is not in here; a chapter on the NEPA section is not here because still within DOE there is a lot of debate exactly how to proceed within NEPA, so that section is not included.

However, it is a document, and for example, if you're interested in which topical reports the DOE plans to submit to the NRC in 1997 or 1999, that kind of information is in here. So with regard to suitability and licensing, the information in the schedules in terms of preparation of documents is in here.

A few words on the proposed approach. And this has been said before and I'm just summarizing. Basically, the characterization program as we originally described in the SCP and reflected in the approved baseline could not be accomplished with the projected funding level. The funding level was about half every year of what that approved baseline required. That was the baseline where we estimated $6.2 billion through the license application. And the Congressional expectations were for DOE to streamline the program to show measurable progress at a reduced cost.

So we are moving forward with a restructured

program within the existing legislative and regulatory framework. We think it responds to Congressional expectations. We think it is consistent with the original intent of the Nuclear Waste Policy Act, the guidelines, and 10 CFR Part 60 in terms of expectation of amount of information that would be available, both for the suitability decision, the license application. It responds to many of the suggestions from outside the program regards to a more effective management and a focused technical program.

So we basically have begun to implement a program that recognizes the key statutory and regulatory framework. There are four key things; whether the site is suitable, which is a DOE responsibility. If the site is suitable, to prepare an environmental impact statement, and to recommend the site for development of a repository to the President, and if the recommendation is approved, to submit a license application to the NRC for authorization to construct the repository. Those are the key goals, and our program has been planned around those goals. So this five year plan has chapters on suitability, has chapters on licenses, will in the future have a chapter on NEPA.

So the approach was developed to help ensure that measurable progress is made towards a DOE decision about the suitability of Yucca Mountain, there are what we call metrics in that five year plan, and if the site is suitable, that the

program is able to proceed with the EIS, the site recommendation, the license application, and if approved by NRC, the construction of a repository.

We're trying to emphasize the investigations and the engineering that are necessary and sufficient to support a technical site suitability determination in 1998. These evaluations are based on data collected, calculations, models intended to provide reasonably conservative estimates of the range of site conditions and system performance characteristics. That is our goal in doing technical site suitability.

The DOE decision on technical site suitability will be based on the technical input and evaluations of compliance with the guidelines as addressed in the SCP. So we're still following the strategies as they were laid out in the SCP.

The technical program will also provide information needed to support the decision on overall site suitability, which in addition to technical site suitability, requires the guidelines that relate to environmental, socioeconomic impacts and transportation. That is that four group of guidelines on that viewgraph that summarized all the guidelines. It will also support the preparation of the EIS and the technical program will also support the preparation of the license application.

We've had a lot of questions on how they're

related, how site suitability and licensing are related. So we have a few graphs that try to address that.

We have a single technical program that provides that information for technical site suitability and for compliance with licensing requirements. We're initially focusing on technical site suitability and the evaluations are being performed in a stepwise manner, as will be described by Jane in a few minutes.

The overall site suitability--that's the site recommendation--will also consider additional information related to environmental quality, socioeconomic impacts, and transportation, and those will be evaluated in parallel in the NEPA process. Again, that's the fourth group of guidelines on that diagram I showed earlier.

As we're evaluating technical site suitability, we'll also be interfacing with the NRC. We need to do that first of all so the NRC can provide--they're required by the Nuclear Waste Policy Act to provide preliminary comments regarding the sufficiency of site characterization information for a license application when we submit the site recommendation report, and also to allow us to be able to submit a license application that the NRC will find adequate for docketing. So basically, we don't see any decrease, and probably an increase of our interactions with the NRC.

This is just a diagram that tries to show you how

the data collection and the synthesis of that data, which Jane will talk in great detail, serves not only the suitability analysis and DOE's decisions on high level findings, but also serves the regulatory, from the licensing perspective, analysis and feeding the annotated outline, helping us with technical exchanges, providing information for topical reports, and perhaps leading to prelicensing agreements with NRC staff.

The 960 and 10 CFR 60 are not inconsistent. That language comes from--I don't recall, it's either the statement of considerations, 960 or 60--somebody can correct me. 960. So that language, that wording comes out of the information that comes with 960.

The same relationship that is between the siting program and the licensing occurs between site suitability and EIS. A single technical program provides the information needed for site suitability and preparation of the EIS.

The technical site suitability, again, I more or less said all this, but evaluates the areas covered by the SCP. The EIS will address the areas on the responsibility of NEPA.

So basically, overall site suitability will rely on the technical site suitability determination, evaluation with the guidelines related to environmental quality, socioeconomic impacts and transportation, based on

information developed to support the NEPA process.

So that's kind of the background on suitability and some of the history. At this point, Jane Summerson is going to get up and describe to you our draft process for evaluating technical site suitability.

DR. ALLEN: Steve, since we're a bit ahead of time here, it might be appropriate to stop and ask you questions right at this point, if you're willing to break for the moment.

DR. BROCOUM: Of course.

DR. ALLEN: Are there questions from the Board? Dr. Cantlon?

DR. CANTLON: Cantlon; Board. In connection with the distinction between the site suitability determination and the licensing, do you perceive any difference in the level of data that will be available for those two submissions?

DR. BROCOUM: There may be a difference in level of, first of all, the NRC has--about the level of data for license application. We have to pay close attention to NRC. We just had an interaction with them the other day on the two topical reports, and they gave us very good guidance as to the level of information they need, first of all.

Second is 960, in a sense, focuses on the site; is the site suitable. 60 focuses more on the total system. So it seems that for the license application, you have to have a lot more design and systems information than you might need

to have for the technical site suitability evaluation. So that's one area that perhaps more data is needed.

DR. CANTLON: I gather then from that answer that you don't perceive any substantial difference in the quality of the data and the analyses that will be brought in the geophysical, geological--

DR. BROCOUM: No, I don't see a substantial difference because we're trying to do many of these things in parallel, as this last diagram showed--it given give the time, but we're trying to use--as much as possible, we're trying to have the data collection and the synthesis feed both. So as we interact with the NRC and understand better their needs, we will be adjusting this.

So I would say in the end, there will not be too much difference between these two and the earth sciences. But still, NRC may have some special requirements that, you know, we may not have, so I don't think you can make an absolute statement on that issue.

DR. ALLEN: Other questions from the Board? From the Staff?

DR. METLAY: Dan Metlay, Board Staff.

Steve, as part of your EIS process, do you anticipate analyzing different technical designs for the repository?

DR. BROCOUM: I would have to turn to an EIS person, and

I think there is an EIS--is there an EIS person in the audience? There was supposed to be somebody here from EIS. Yes, why don't you come up to a microphone.

MR. MC CANN: Ed McCann, Environmental Programs.

I believe the question was are we going to look at several different designs. Was that--

DR. METLAY: Alternative technical designs for the total repository system.

MR. MC CANN: We'll look at alternative design features. There won't be multiple designs of the repository done. We'll look at different design features as it affects impacts. We want to focus on the environmental impacts.

DR. DI BELLA: Carl Di Bella of the Board Staff.

I have a question, a couple of questions actually about the five year plan that you handed out. One, I notice that there seem to be no numbers in thumbing through it, that is, no future funding requirements. Do you intend to add that at some point? And what is your timing for the plan, really?

DR. BROCOUM: There is a version with the numbers in it that we're using internally. For release, since it's also going to be used for our budget for OMB, we decided, so we can release it sooner, we would release it without the numbers. Okay?

The other point, to make this volume is a part that

will eventually be a larger plan called the Program Plan, which you'll have a first volume which will be an overview volume, and this will be the second volume, and the third volume will be the rest of the program. And so that whole document called the Program Plan will be issued, I'm not sure what the schedule is at this moment. A lot of that depends on other parts of the program and getting that Program Plan done.

What we're trying to do here is issue it a early as we can, what we have, because we've got a lot of comments from the--called the state assets, at the AUG meeting last time. So we've issued what we have available. It's going to change and it doesn't have the numbers, so we could issue it sooner.

DR. ALLEN: Dennis Price?

DR. PRICE: Steve, just a question about things we had heard earlier about the program approach about phased in of activities such as construction and receipt and emplacement of waste and so forth as part of the plan of the program approach, and I'm a little hazy now as to where that sort of thinking stands.

DR. BROCOUM: I would say that's all being thought about. The concept of operations of the repository; is that what you're asking? I'm not sure what your question is.

DR. PRICE: Well, earlier, there was some discussion

about how much do you need to know in order to start construction and how much do you need to know to be able to receive and begin to store and so forth.

DR. BROCOUM: That will be addressed in large part by Jean Younker, who is somewhere in the room here, at 1 o'clock in her talk, what the uncertainties are, what we think we'll get now, what we might get a little later. That's the third talk we're going to have today.

DR. ALLEN: Bill Barnard?

DR. BARNARD: Steve, this may be covered later by Jean, too. What's the relationship between the technical site suitability decision in 1998 and any progress that's made on underground exploration ESF?

DR. BROCOUM: It's thought that for technical site suitability we need to be able to go look at the Ghost Dance Fault.

DR. BARNARD: Is that all?

DR. BROCOUM: And Calico Hills, we're still evaluating, we have a system study to evaluate Calico Hills. The North Ramp extension, although it's in the five year plan, it's in the further out years because of budget reasons in that case. But that's all constantly being re-evaluated. So at the moment, we're basically looking at a ramp heading south and looking at some of the faulting at this point in time.

DR. ALLEN: Leon Reiter?

DR. REITER: Steve, I wonder if you could just step back for a second and tell us what you mean; what is the DOE going to be able to say in 1998 when it reaches a technical site suitability decision? The reason I'm asking this is we've heard this described at various times as merely an investment decision. We've heard it described as a very important landmark. Just give us an idea what do you think it's going to mean?

DR. BROCOUM: Well, I think what we're trying to do for 1998 is tell you our best shot at how we think the site is based on the information we have. I mean, we will do as many guidelines as we can. If we can do them all, we will. If we don't have the information, we won't. But we want to demonstrate progress at the best pace we can, evaluating the guidelines in groups, as I think we've said in other meetings, to give a feeling of what we think about the site and to let the outside world know and let them participate, as Jane is going to explain today, in how we think the site is and let them know what our thinking is.

So it's, in a sense, it's an investment decision, should we go on, do we see anything wrong. You know, it's something that we have invented, if you like, so we can demonstrate progress of evaluating suitability. Suitability finding is I think in the year 2000.

DR. REITER: Well, so 1998, you're going to make a

statement whether or not you have been able to evaluate--it's just a progress statement? You say you may not be able to evaluate all the qualifying and disqualifying conditions at that point?

DR. BROCOUM: I think what we will do is we get and evaluate each bucket of information. If the peer review says you don't have all the information you need to have, then we'll have to go back and reconsider it or collect more information. It's hard for me to tell you now what we'll be able to say in 1998. We have a plan, we have a schedule to go through each of the guidelines between now and 1998.

But if for some reason, budgetary reasons or scientific reasons or peer review reasons or interfacing with the Board here, the information is not adequate or good enough to make that finding, we won't make a finding in a particular area. We will have to delay it. I mean, I personally don't see a problem with that.

DR. REITER: Okay. So this is really an important point, because you're saying that the schedule is not critical. What's critical is the ability to make a statement about site suitability. Am I reading you correctly?

DR. BROCOUM: I mean, we have a schedule. You need a schedule to run the program. But if we don't--surface processes are something that Jane is trying to make next year. To make that finding next year, she has to do a

million things, which she's going to explain to you today in detail. If she can't get those things all done, we won't be able to make a finding on surface processes. We'll have to make it later.

So if you ask me what's more important, the technical finding or the schedule, it's the technical finding.

DR. ALLEN: Dr. Dreyfus I think had a comment here.

DR. DREYFUS: I think maybe I should have something to say about this.

The situation basically is at a level, people would like us to make the technical site suitability finding tomorrow morning. They wanted me to make it a year ago. I had a very, very long dialogue with the Congress one day that lasted two hours and 15 minutes on do we or do we not think that this site is going to work.

Now, there are a lot of ways to look at that. One way to look at it is say we'll let you know that when we get the answer from the Nuclear Regulatory Commission in two thousand and whatever, five, six, time frame. But I don't think it will wash. We are out there, and as the Department, we have got a decision to make. The Secretary must make a decision whether to recommend this site at an earlier time based on basically the technical aspects of the situation.

What we have done is basically contended that by

the '98 time frame, we would expect to have enough technical information to be able to make a statement that, yes, we think we do, or no, we think we do not have a good site technically to present to the Commission, which gives the world, the policy world, some notion of how long they've got to wait before they know whether we have found some disabling situation with the mountain.

Now, of course, we could find some critical fault, some critical problem earlier, but at some point, you take what you've got and you say I think it's okay. And we did that, as Steve said, a long time ago, based on various superficial data. We made a statement, yeah, right now, from what we know, we think it's okay.

This one would be more profound because at this point, we presumably will have looked at all of the things that we now expect to be critical, and we'll say we think we have a site.

Now, there are many reasons why that's important. One is because there is a tremendous amount of investment beyond that time in the regulatory process. So it's appropriate for us to give the President and the Secretary and the NRC and Congress and the public some idea where we stand before we engage them all in that kind of a policy debate. And this is basically the jumping off point; from the '98 time on, you're beginning to essentially engage the

policy process, decision making, and it's I think appropriate now.

How profound is it? It's not in the Act, so it's not a statutory requirement. But it's an end point that we can utilize to gauge convergence of all these processes into something that the world can address. It's also a sooner time to declare failure if at that point we say we don't think we have a sufficient probability of licensing to go forward. That's what it is. It's important, but it's not very profound. Until that time, we're probably going to be working on piecemeal data and unwilling to make definitive statements about the probability of success.

DR. ALLEN: I think in fairness to Jane Summerson, to give her adequate time, we ought to move ahead. We can come back to some of these same questions either following your talk or later this afternoon.

So the next presentation, or part of the same presentation, is by Jane Summerson.

DR. SUMMERSON: Am I audible in the back? I have never had to use a mike before because my voice projects. So if I'm too loud, please let me know.

I'm Jane Summerson. I work for Steve Brocoum here at the Yucca Mountain project, and I'm the team leader in charge of the site suitability evaluation.

What I want to talk about today is the process that

we are involved in. It's a process to develop a process of evaluation. It's a very sincere effort to get the public involved, to get the program involved, to get the stakeholders involved in working out a method of evaluating and of documenting our evaluations that people are comfortable with.

We're going to be looking at a quick review of the situation on the siting guidelines, and then an overview of the process in its draft form right now. Our public comment period ends in just a couple of days. We are already in the process of revising according to a number of the comments that we've gotten, and we still expect to be finalizing this process by November 15th.

In terms of the siting guidelines, Steve gave background. When I came into this position, a task force had been set up at the project to look at a range of options concerning application of the guidelines. And we expanded it, a little bit from talking to the affected units of government at their recommendation when they pointed out to us that this was a national issue, to a national comment period on the application of the guidelines.

The comments that we received did not reflect a clear consensus. They covered the spectrum of "do everything" to "do nothing", and the reasons were very varied. And so it wasn't clear cut oh, gee, all of our

stakeholders think we should do "X" so we should do "X". It pretty much left us with all of the debates that we had to begin with.

There were a number of issues raised concerning rulemaking. At one point, some of our commenters said that the guidelines are not applicable to a single site. Steve made some references to this. Our counsel disagrees with that. They feel it's very clear that the guidelines can be applied to a single site. In fact, the precedent has been set in the EA, for Yucca Mountain, and the SCP.

Another comment suggested a rulemaking as a means to clearly define the role of the public. The role of the public--the very important role of the public in this process is mandated in the Act, and we felt that if we involved a rulemaking in this also, we would, in a sense, be tying our hands because this is a learning process for us. And I've already made a number of mistakes, and I've had to back up and make changes in how we're involving the public, and I think we're going to continue to do that in the next few years, and if we had a rulemaking that tied our hands to something that turns out is a mistake, then we would not be able to be as responsive to the needs of the public as we want to be.

There was suggested a need to be consistent with 10 CFR Part 60. Well, it's required in 960 that it be not

inconsistent with 60, and the NRC has already concurred in that. So, again, we didn't see that one as being compelling.

And then an opposition to the idea of rulemaking was expressed by a number of commenters, the concern that this would be taken as an opportunity to tailor the guidelines to guarantee that Yucca Mountain was found suitable and make it an easy solution for this national problem.

We concluded in our analysis that there was not a compelling justification to go forward with the rulemaking, and we did share the great concern that without that compelling justification, it would be seen or perhaps even an attempt would be made to use it to tailor the guidelines to guarantee Yucca Mountain was chosen, which would not be serving the best interests of this country.

Therefore, Dr. Dreyfus made a decision that we would go with the guidelines as they are currently written. This is, of course, subject to the statutory changes that have been made and would be consistent with the approach discussed in the SCP, and Steve went into that in some detail earlier.

And as he said, we will be re-examining. We had assumed, although I do not think we expressed it well, that we would implicitly address the favorable and potentially adverse conditions, and we will be going back and reviewing

with counsel to be sure that what we are doing is consistent with the guidelines as they stand in response to a number of comments that we have received.

Now, I'd like to move on to an overview of the process as we're developing it now. For people who find graphics easier to follow than lots of bullets, this process has basically three components; development and review of the technical basis, development and review of a guideline compliance assessment, and a number of Department of Energy findings or decision points that have to be made and documented. And these are interim, the diamonds represent interim DOE decisions. And what I'll do is to discuss each of these boxes in more detail.

As an overview of the process and sort of our general goals when we first started drafting it, the characteristics, we wanted it to be open and sequential. We wanted to have evaluation of the individual guidelines or groups of guidelines scheduled according to when the information, the analyses and the designs become available to try to make things as efficient as possible. We want to ensure that we have formal and recognized predecisional public input at a number of points along the way.

We want to have timely information and analyses for the DOE managers to make the very important decisions that they need to. We need to document the evidence and rationale

for these decisions so that in the future, if the individuals are not around who have been involved in this, we do have an adequate record so that they can be understood. And we have a goal to clearly separate and make a distinction between the technical information and the evaluation of that technical information and an assessment of adequacy to support a DOE management decision.

As I mentioned in the graph, this process has three main elements; the development and review of the technical basis, the development and review of the compliance assessments, and the various decisions that the DOE managers have to make based on the evidence that we are collecting, analyzing and documenting for them in this process.

So first we'll look at the technical basis. The general considerations; first of all, the data needs for each technical basis report are defined or derived by looking at the guidelines.

The DOE makes the evaluation of "we should probably know this to demonstrate compliance with this guideline, and these are the tests that need to be done". Obviously, the first and overwhelming step in this was the site characterization plan, but that is a huge document, that it was always assumed that as we learned more, we would be able to focus more on the important issues and the more important data needs. And so that is what the technical part of the

suitability group is looking at right now, is more specifically what data needs we have for each of these guideline assessments.

We are focusing at this point on the technical guidelines covered in the SCP. Those are the basis for this technical site suitability decision. Those are the post-closure related to waste isolation and pre-closure related to rad. safety and technical feasibility.

In separating this technical basis, this will help facilitate the technical review, independent peer review that we're negotiating with the National Academy of Science right now to manage for us.

These technical basis reports will discuss the available data analyses, present a current understanding of the subject area, and this includes the uncertainties, credible alternative models and interpretations, bounds on the conditions and processes consistent with the current understanding.

Each technical basis report will have an executive summary written for the lay person, and each one we expect at the present will be peer reviewed by the National Academy of Sciences. Now, that is a slight change. The original draft went out of this process saying we would ask the Academy to decide which ones should be peer reviewed. A number of commenters had problems with that, ranging from it's way too

cumbersome and complicated to then you have just another decision of whether something is going to be evaluated or not, why don't you just do them all.

And one of the first reactions to comments we had was to discuss it with the managers, and Steve and Dr. Dreyfus supported we will simply peer review each technical basis report, and that way we can plan right now, knowing how many we're going to have, what the subjects are, and it will actually simplify the management of the process and ensure that all of our technical material gets analogous treatment.

DR. ALLEN: I might just point out that it's--I assume it's actually the National Research Council, which is a group made up of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine. So it's not just scientists; there are engineers involved as well on these peer review groups.

DR. SUMMERSON: Let me see now. I am still confused by all of the acronyms in that organization, but the procurement will be with the Board of Radioactive Waste Management to manage it according to the National Research Council's peer review policies.

DR. ALLEN: That's right. I just point out that the National Research Council is made up of more than the National Academy of Sciences. It also includes the National Academy of Engineering, which I think is important in

visualizing what that peer review might consist of.

DR. SUMMERSON: Thank you.

To enlarge a little bit on what Steve had said concerning the guidelines on environmental quality, transportation and socioeconomics, they are not going to be evaluated before the technical site suitability decision. They will be evaluated in this type of process, but the technical basis reports for those guidelines will be based on the same database that is developed and used in the NEPA process and developing the draft EIS, and we will be coordinating the timing of our process of evaluation of those guidelines with the NEPA process to ensure that our work in no way prejudices or interferes with the valid and complete NEPA process.

And so we can't be as definite on scheduling and plans on those particular guidelines as we can on the technical ones, because we're holding back to hear from the NEPA people what is going to work best with them. But we are coordinating with them. Our findings will be made in coordination with that group.

And the distinction we have made between a technical suitability decision and an overall suitability decision is that we can't really make an overall suitability decision until all of the guidelines in 960 have been looked at, including these NEPA related ones. And so it's simply

that the overall decision can be made once we have completed the process for those in conjunction with the NEPA process.

Now, the peer review aspect of this, and this has been a subject of great interest. Our main goal in using peer review is to ensure the quality of our technical work. I think that is the key goal in using an independent technical peer review.

We're also interested in building scientific consensus and in helping to improve public trust and confidence. But the first goal is to ensure the quality of our technical work.

After concerns expressed by a number of our stakeholders at the meetings we had on the type of peer reviews that the National Academy has managed in the past, we have agreed to publish our draft work scope and take comments on the draft work scope. I will say that in drafting that work scope, we have paid a great deal of attention to the written comments we have already received on this subject, and I think we have managed to address all of them. I'm hoping we have. But certainly we will find out in our public comment period.

At the moment, we are assuming that the procurement will go through and that the NAS or BRWM, I guess, of the NAS will select the peer review panel, manage the peer review, and oversee the development of the peer review report. The

size of the panel and the duration of the review will be up to the NAS and will be based on the complexity of the technical basis report that they are reviewing. There is a time limit and a maximum number that they have agreed that it's reasonable to work within so that we can plan our schedule.

In selecting the peer review panel--I should add a little caveat. I am using the same viewgraphs basically that have been used at the other public meetings because I don't want to put out written material suggesting that decisions have been made until our comment period closes. However, some of these things have developed further along and I am going to be enlarging on them orally as to where we think we are in the developing of this process.

So what we are talking to the NAS about doing is setting minimum technical and experience professional requirements in areas of expertise that are necessary to review a certain technical basis report. They would publish these and request nominations from the public of individuals who qualify under these minimum qualifications.

In the selection of the slate of peer reviewers, we are asking that the Academy pay attention to minimizing the potential for bias, certainly to be concerned about individuals who are salaried by one or another of the chief players in this program, something of that sort; to ensure

that diverse scientific views are represented. Obviously from a management point of view, we have to be aware of the timely availability of these reviewers, and in direct response to concerns of our stakeholders, we are asking them to consider as much as possible geographic sensitivities, especially the unique concerns of the citizens of Nevada, and minority representations, and to be able afterwards to address the public on how they responded to these issues.

Now, certainly if it's not possible to find a woman of a certain expertise, then there won't be any women, but we would ask that they say we looked for a woman, we could not find a woman, no woman was nominated. We did try to address the concern. We were unable to. And that actually is something that they have been doing in at least the last couple of reviews that they have done anyway. We are simply making it explicit in the work scope and asking them to be open so that it is a transparent process to the public.

The management of this peer review must provide opportunities for public observation of interaction between the peer review panel and the authors. And, in fact, what they normally do, and will certainly be doing in this process, as I think many of us have seen in the 801 study, is soliciting technical presentations and written information from the public that the peer review panel should take into account. And there will be at least one meeting where the

public, and we certainly would hope that the public includes our oversight groups, our regulators, our stakeholders, would give technical presentations on issues that they feel are important and should be addressed in this peer review.

We're also requesting information from the public. It is a requirement of the Academies, and one that we certainly agree with, that any written information that is given to the panel by anybody, including the Department, has to be made available to the public.

We're asking that the reviews focus on evaluating validity of data and interpretation and adequacy given to technical uncertainties in describing the current state of understanding.

The report should address at least these technical issues. I don't think I need to read them through. You can all see what they are. But the intent is to make it focused on the quality of the technical work, of the science that has been done. And we are asking that the report include documentation and discussion of external technical issues that have been presented to the peer review panel that for one reason or another have not been included as one of their recommendations, again, in order to help make the scientific evaluation more transparent to the public.

And the draft work scope, which as soon as it gets through concurrence should be published for comment, I

believe, we've certainly put a lot of hours into trying, actually incorporates all of these concepts in it. And the people we're working with at the Academy are very comfortable with what we're saying at this point.

Now let's go on to the guideline compliance assessment. After we get the peer review report back from the National Academy, certainly if it comes back and says you really ought to do X, Y and Z test, it will reduce this uncertainty here and this uncertainty here, so that you have a much firmer grasp of this understanding. Then we need to re-evaluate our situation and our test program and consider the steps, there is a feedback group in the testing program, and gather more data.

If it's felt that we have a strong technical basis to go forward with the guideline compliance assessment, then the next step is for our team to put together this assessment. Now, this repeats a little bit what Steve said, but we have to ultimately make a higher-level finding for each qualifying and disqualifying condition. That finding requires an assessment that the qualifiers are present or that the disqualifiers are not present, and that the conclusion is not likely to change even if we continued to collect more data.

Our compliance assessment will be written based on the technical basis report that we produced, and the external

review of that technical basis report.

The compliance assessment will be the DOE staff analysis of that technical data and other data such as design information, that type of thing, that is relevant to a particular guideline condition. We'll present our compliance arguments. It will contain recommendations to the director for a guideline finding, because a higher-level finding can, after all, be either positive or negative, and it will comprise a part of the basis that the director will use to make the decision on the higher level finding.

Once we've produced that draft, we'll publish a Federal Register notice and, of course, as always do our regular mailing to let our stakeholders who have requested information know that the guideline compliance assessment, the technical basis document and the peer review document are available for public review and comment.

We will hold, during the comment period, public workshops to discuss the compliance arguments and the concerns of the public. At the end of the comment period, the compliance assessment may be revised based on those comments. In any case, an external review summary will be developed that documents all of the comments received and our responses to them, and that record will be a part of the formal decision package so that all comments will be available to the director to consider when he makes his

decision.

Now, the DOE decisions. The first ones will be the series of higher-level findings. The director will have to accept or reject the case for higher-level findings based primarily on the record that we're developing in this process; the final technical basis report, the peer review report, guideline compliance assessment, external review summary of all of the comments that we have received in our public comment period, any response we have to these comments, and other information as appropriate. And those words "other information as appropriate" come from the Act relating to the body of information that the Secretary uses for her decision, and we felt that it was appropriate to include this for the director as well.

Notice of the director's decision and a rationale for that decision will be published once the decision is made.

We've said several times that a favorable higher-level finding requires a judgment that no new information is likely to change the conclusion. However, it is conceivable that new information could be developed that requires a re-assessment of a higher-level finding. If this should happen, this information should be brought to the attention of the director as soon as possible so that the director can take, and the program can take, appropriate steps.

Technical site suitability decision is based on the evaluation of site conditions and design concepts. And that involves a higher-level finding on all the guidelines that are addressed in the site characterization plan, and that is a decision that is made by the director of OCRWM. That is a program decision.

The overall suitability decision is also a program decision. The director then at this point will have made the additional findings on the NEPA related guidelines, so that findings at the time that we say an overall suitability decision has been made by the director, what we're saying is all of the guidelines in 960 have now had higher-level findings made.

Now, if at any time the site is found to be unsuitable in this process, we are required by the Act to submit an alternative plan to Congress within six months of an unsuitability decision.

The final agency action, the Secretarial decision, is the site recommendation to the President of the United States. And that recommendation is going to be based on the overall suitability finding that our director has made based on all of the documentation and the records that we've produced in this process, the final EIS which our NEPA people will have produced, input from the NRC and stakeholders as required in the Act, and other relevant information, as

required in the Act.

Those are the three major DOE decision points, and that's my formal presentation. I'll be glad to answer questions.

DR. ALLEN: Thank you, Jane. Questions from the Board?

DR. LANGMUIR: Jane, I want to bring you back to the peer review process, and what comes to mind there is, as I understand it, you're going to ask the Academy groups to review individual topic areas separately and report on them. It also I think in the document you presented us suggests that the Academy put this together, an Academy report.

Is the Academy then being asked to integrate all of this? I'm concerned that individual groups will not be able to evaluate by themselves the significance of what they're doing with regard to the whole suitability issue without seeing the other reports, because everything is tied together, of course, and as a system, it's how do these things fit together that determines suitability.

I'm asking you several things, but is the Academy being asked to integrate it all when the individual reports have come in to them?

DR. SUMMERSON: We are not asking them to bring together at a later time all of the separate peer review panels and produce another report integrating, a separate action of that sort. But the final peer review that is scheduled will

actually have an interim and a final that would look at the total system performance and involves integration of all of the aspects, because our system guideline involve the performance of the whole site. And so that is where we see this overall integration taking place.

DR. LANGMUIR: But the Academy will not be doing any of the integrating themselves in what they provide to you? This will only be done--

DR. SUMMERSON: Their review of our total system performance assessments and other evaluations of the whole system and performance of the whole site, they will review that as a unit. And so I would fully expect they will be commenting then on how well we've integrated all of these factors and if we're evaluating them and analyzing them appropriately.

DR. ALLEN: Incidentally, Chris Whipple may be present. He's the chairman of the Board of Radioactive Waste Management. He might have some comments.

DR. SUMMERSON: I haven't spoken to Chris. I have been dealing with Carl Anderson and Ina Alterman. But they have been very actively involved in writing up and drafting this work scope and have been very helpful in how we have phrased the type of technical issues.

DR. ALLEN: Having been myself involved in many NRC projects as well as report reviews, how does the time

schedule work out? Do you expect all this to be done within two or three years?

DR. SUMMERSON: I have been assured that--my own staff, I have a little more trouble with Carl and Ina--I have been assured that they have a track record for running on this scale reviews and getting them turned around and in on time, they feel that a four to six month time period, as long as they have a long lead time, knowing what the subjects are, so that for instance they could start impanelling now peer reviewers for several years down the road, that they can give us the four to six month turn around, depending on the complexity.

DR. ALLEN: Well, I hope so. But I just point out that one of the criteria for setting up the panels is that they include diverse viewpoints. But nevertheless--

DR. SUMMERSON: You have put your finger on my biggest headache--well, my biggest headache right now is just getting it through procurement so we can even get started for the 95. We're trying to walk the line between meeting the schedule pressure, but being sure it is done in a valid, technically valid and transparent for the public way. Everybody involved is working towards that goal.

DR. CORDING: Ed Cording here, just to follow up on that. When do you see the first reports, the bulk of the reports being given to the NRC? At what point, in terms of

time, two years from now?

DR. ALLEN: The NRC being the National Research Council.

DR. CORDING: I'm sorry, yes, National Research Council.

DR. SUMMERSON: Actually, the NRC and the NRC will be getting it at the same time.

DR. CORDING: I meant the Academy.

DR. SUMMERSON: Right now, we are looking at getting the first technical basis report to them the 1st of February. And it will be released to the public at the same time, and of course the other NRC would get it then as well.

DR. BROCOUM: I just want to amplify one thing you said about the schedule. We started thinking about how to do peer reviews a while ago. I talked to Myron Uman, who was then the staff--and he told me that they were able--the National Academy was able to run two dozen more or less simultaneous reviews and complete them on schedule for the NIST, National Institute of Science and Technology, I guess is what the acronym is today, and so they are confident they can do this, given the conditions, that we meet the conditions in terms of lead times and everything.

DR. CORDING: But the more contentious the issue, the more likely they are to have minority reports, the sort of thing that delays the whole review process, is all I'm pointing out.

DR. BROCOUM: I mean, you know, I think that's a valid

technical issue.

DR. BREWER: Garry Brewer. The whole point of being contentious here is something that you can't ignore. The Committee on Nuclear and Alternative Energy, the CONAES Report, which was probably in terms of scope and lack of clarity and conflict about the same size as this, was 30 months late. And, I mean, you can't just presume that because some staffer in the National Research Council tells you that they're going to meet the schedule, that it's going to work, because it isn't going to work.

DR. SUMMERSON: I think we're all aware of the potential dislocations and that sort, but I don't think that's a good reason to not do the best possible technical peer review of the work. We just, as I say, all have to do our best to make it work and have contingency plans.

DR. BREWER: Well, there's another part to this. I have a couple of kind of followups that are related to this. One of your slides said that you're trying to eliminate bias or minimize the bias. But the whole NRC process is one that seeks balance, and that means diverse and often quite disparate points of view. They seek balance in their boards, panels and committees, and one of the consequences of seeking balance, as Clarence rightly pointed out, and all of us have been on these boards and committees in one form or another, is that you run the risk, and in this case it's almost a

certainty, that you're going to get minority and dissenting views.

DR. SUMMERSON: Absolutely. We realize that. We didn't put in there that we want diverse scientific views represented. What we were referring to in bias was the concern that a number of people have expressed that a DOE contractor, someone who is salaried in regards to this program--

DR. BREWER: That's a conflict of interest as opposed to a bias.

DR. SUMMERSON: Okay, then we should change our words.

DR. BREWER: Yes, you certainly should.

Now, there's another part of this. You know, a peer review is fundamentally one form of expert judgment about matters that are hard to figure out, I'd say on a good day.

In 1992, there was an expert judgment workshop that we very much encouraged DOE to do, and that's another form of expert judgment and there's been no sort of discussion in the morning's presentation, in spite of our invitation for you to do so, on how you propose to use other forms of expertise, particularly since the scope of the activity, by definition, by what you're doing in the PA, is going to be greatly reduced. You're not going to be able to provide as much information in terms of data. You're going to have to rely

much more on experts and their judgment, and we haven't heard a thing about that and I'd just like to put that in the record. At some point, we should probably follow up.

DR. SUMMERSON: Well, if I haven't taken all of his time, Steve has the rest of the presentation. He's addressing the other uses of expert judgment.

DR. BREWER: Yeah. One of the issues here, and I will stop using everyone's time, if you reduce the scope of activity once you are able in terms of the simple logic of it to present to the National Academy of Sciences, the NRC, will be less. And so they will be looking at less and making judgments according to their process, which is a very elaborate one, about less information. It's very much like the Sherlock Holmes story of the dog that didn't bark. You know, there's less barking going on here, and what you give them is a very reduced scope of possible information, just the logic of it. How do you account for that?

DR. SUMMERSON: I'm not sure I can account for that, but I mean, yes, what you're saying is correct, and if they don't think that the less that we present them supports the matters of interpretation, they'll tell us so.

DR. BREWER: Let me be more specific. Will there be some sense of the scope of activity in terms of what was going on in the SCP and up until this program approach, and the reductions that have occurred in terms of what you then

present to the National Academy of Sciences? Because they can pass judgment on what they're handed and say yes, this is okay, but are you going to give them the opportunity to comment on what's not there?

DR. SUMMERSON: They have expressed that they do not want to be asked if we asked the right questions or defined the correct test program.

DR. BREWER: So someone's got to do that.

DR. SUMMERSON: That is what happens during the guideline compliance assessment, and that is open to all stakeholders and the public to tell us if it's not enough.

DR. BREWER: Okay, thank you very much.

DR. ALLEN: Dr. Dreyfus, did you have a comment on this?

DR. DREYFUS: I think it happened.

DR. ALLEN: Okay, other questions from the Board? Staff? Bill Barnard?

DR. BARNARD: Bill Barnard; Board Staff.

Jane, both you and Steve are earth scientists. I was just wondering if there are any technical areas related to site suitability that you think are going to be tougher to deal with than others.

DR. SUMMERSON: Well, of course, I mean hydrology, let's be honest.

DR. BARNARD: Is that the only one?

DR. SUMMERSON: I wouldn't say it's the only one, but I

think it's heads and shoulders above the others.

DR. ALLEN: Other questions from the Board? Staff? From the audience?

MR. MC QUIRE: Robin McQuire, Consultant.

Jane, do you have a list of the technical basis reports that you anticipate will be submitted to the NRC and the dates scheduled for them?

DR. SUMMERSON: I don't have it on me. It's in the draft work scope, which hopefully will be going out any day now. And I think the Waterfall diagram--

DR. BROCOUM: The Waterfall diagram was presented several times to the Board, and I believe during the--also that we gave out this morning.

DR. SUMMERSON: Now, it's still draft. We're still working it with the site data collection people in terms of when data is coming in, and some changes will certainly continue to be made through the years.

DR. ALLEN: Other questions?

MS. TREICHEL: Judy Treichel, Nevada Nuclear Waste Task Force.

We were told at least once, and possibly more, at meetings that were held here in Nevada that there was a big connection between the peer review process with the NAS and public trust and confidence, that that was really one of the ways that you were headed toward trying to build that. And

we were told that we would be able to see--that the public would be able to see the scope and terms of the contract before it was finalized. Will that happen?

DR. SUMMERSON: Yes. As soon as I can pry that loose from concurrence at headquarters, it's going in the Federal Register and it will be sent to everyone who has been attending these meetings and expressing interest, and we will be asking for comments before it's finalized.

MS. TREICHEL: Okay.

DR. SUMMERSON: Although I did use your written comments when I met with the procurement people to help draft it. So I hope I've been addressing the concerns. But absolutely, it's a matter of getting it through concurrence.

MS. TREICHEL: Well, that was what we suggested, that we wanted to see how it all came out. Okay.

DR. SUMMERSON: Absolutely.

MS. TREICHEL: Thank you.

MR. BLANCHARD: Max Blanchard.

Jane, I'd like to ask just one question, and that is it seems like some of the processes that have been used in the past in the program have had difficulty getting out of a loop in the cycle and it looks to me like one of the difficult parts of this approach subjects the cycle to a closed system to where you can't get out of the loop with respect to receiving comments through the peer review process

where in each guideline, the situation could develop where there's a minority opinion. The minority opinions that would be published along with that report would be advocating yet additional information and analysis and more site characterization, and it wouldn't be surprising that something like that would develop in a process like this.

Have you given thoughts about how you would be dealing with that, which would then cause you to go into another five year cycle of site characterization?

DR. SUMMERSON: The work scope requests that any suggestions for additional testing or gathering of additional data be explicit about exactly what uncertainty those tests would be expected to address, so that the DOE managers have a valid basis for their decision on whether to accept or reject that recommendation. Ultimately, it is a DOE management decision of the level of risk they want to take and the argument they want to take on showing compliance.

MR. BLANCHARD: Okay. So are you saying that in your report to the National Academy of Science review groups that there will be a section in there addressing uncertainty which will allow everyone to decide whether or not the uncertainty is supported by technical analysis?

DR. SUMMERSON: Max, I'm not sure I want to say in every report, because I haven't been involved in drafting the outlines for every report. But I would think that

uncertainty, technical people, is going to have to be addressed in every one of the technical bases, yes.

MR. BLANCHARD: Yeah. Well, the uncertainty analysis would go a long ways--

DR. SUMMERSON: You know, other than the one of is it located in a national park or something like that. But, yes, they have been specifically requested, as I said, that any recommendation for additional testing that is made needs to be tied to a specific issue and an uncertainty as to how that uncertainty will be reduced or what question it will answer, not just a gee, it would really be nice if we knew something about whether the moon is green cheese or not. We need to know exactly, the DOE managers who make the decisions need to know exactly what would be accomplished by additional testing. And then it's their decision.

DR. ALLEN: Carl Johnson, did you have a question?

MR. JOHNSON: Carl Johnson with the State of Nevada.

Jane, I was very disappointed in your response to Garry Brewer's question relative to the request of the NAS/NRC for any comments they might have as a result of their review relative to changes in scope of a particular study, report or whatever.

It sounded to me like from your response in that, you're not going to request the Academy to do that. Then it's going to fall onto the rest of us as stakeholders to

provide that information to some I think unknown or unidentified organization at this point, because it appears like the NAS process will essentially be a closed process for outside comments or consideration of reports, documents or whatever that have not been provided specifically by the Department. I don't know where we as members of the stakeholders doing our technical evaluation of the site, where we fit into that system.

DR. SUMMERSON: If I implied in my answer to Dr. Brewer that the NAS process would be closed to technical considerations by the stakeholders, I did not mean to do that. I meant--what I was trying to say was we are not going to present them with a technical basis report and the SCP and say tell us if we, you know, did everything we should have done from this vast menu.

But the peer review process--before the peer review starts, the public will be, well, first of all, to nominate peer reviewers, but also to submit any technical information that they feel would be relevant on technical issues, to raise technical issues that they feel we have not addressed or raised, and in the opening, at least one and however many are deemed necessary, meetings with the public, that peer review panel will be soliciting presentations on technical issues that it is felt have not been covered by the DOE in our technical basis report. And you will have had that

report for not a great period of time, but certainly a month anyway, that would, you know, help you to make those presentations.

So I don't want to second guess and tell the panel I think our stakeholders are going to be concerned about X, Y and Z, so could you look at this. What I am asking the NAS to do is to manage a process that allows you to tell them what your concerns are rather than for me to try to speak for you.

DR. ALLEN: Garry Brewer?

DR. BREWER: Brewer of the Board.

There are just a couple things that you have to really understand about the NAS process. First of all, the people are volunteers. The second thing is they will be heavily academics, which is why they don't take instruction. I mean, your fantasy about specifying what the report will tell you is just that, a fantasy. I mean, you have to be realistic about it this. Having managed four or five of these things over the years, it's all you can do to keep them in the same room at some point.

DR. SUMMERSON: Dr. Brewer, as the daughter of two academics, I do understand what you are saying to me. What we're doing is what the advice that the NAS has given us, that the work scope says what we need and want. Yes, they can add anything they want to.

DR. BREWER: And will.

DR. SUMMERSON: And will.

DR. BREWER: And delete a whole bunch that you want them to do. That's just a promise.

DR. SUMMERSON: I understand.

DR. BREWER: That's not a question. It was a comment. It's sort of let's be realistic about this process.

DR. SUMMERSON: I understand that what we are doing is setting goals to try to meet. But the fact that it is likely that we will fall short of the ideal, I do not think is a good reason not to try.

DR. BREWER: Thank you.

DR. ALLEN: Other questions or comments? Bill Barnard?

DR. BARNARD: Bill Barnard, Board Staff.

Jane, how are you going to deal with thermal loading and site suitability determinations?

DR. SUMMERSON: I'm not. I'm going to let Jean Younker do it.

DR. BARNARD: I'll save that question for later, then.

MR. ERICKSSON: Leif Ericksson. I'd like to speak in this position as an ex-NRC staffer.

I headed up one of those panels and we actually had three sub-panels, and it is possible to get some kind of consensus. I share the concerns about the time schedule involved, and I also share the concern about the bias aspects

that have been coming through. It will be extremely difficult to get a panel together that doesn't include a lot of biases that need to be dealt with.

My concern about the time, I think the more time concerns involved with the NRC process is the internal review. And it's easier to get the panels to get the report together than it is to get it through the internal review. But I think that the schedule cannot drive your ambition to seek a good scientific basis for your program. So I'm very much in support of what you're doing.

DR. SUMMERSON: Thank you. I have been assured by Dr. Dreyfus in this whole process, that while the schedule is important, if we come back with a valid well documented and detailed reason why it's slipping, he will accept that. And I think it's that the independent technical peer review from the National Academy, you know, I can't control them. So we either are looking for an independent peer review or we're not.

DR. ALLEN: Dr. Cantlon?

DR. CANTLON: Yes, I'd like to get you to sketch a little bit the iterative process between the site suitability determination and the recommendation of the site to the President. There's a two year process in there. Now, part of it obviously is related to the EIS incorporation. But is there anything that you foresee happening in the technical

side of the picture, particularly with incorporation of new data?

DR. SUMMERSON: Well, certainly any new data that continues to be collected will be considered. Licensing activities will continue to be going on, and we're very much working closely together on that. So, you know, as I said, we do recognize the possibility that new data might arise that requires reopening something, and it could be data that we find. We're not closing the door on that.

DR. ALLEN: Steve Brocoum?

DR. BROCOUM: We've had discussions within the project as to when the data cutoff would be. You know, some people say three years, some people say two years, some say one year. I think if any significant data shows up, certainly that changes a finding we made in the past or changes your concept of how the site is operating, it will not be ignored. It can't be ignored. So whether DOE finds that data or some other party collects that data, it will not be ignored. We have numerous cases of nuclear power plants when new data comes up at the last minute, and of course is not ignored.

And also we have a formal program that we are required to implement during site characterization. That's performance confirmation. So prior to going--presumably making the site recommendation report, and certainly prior to submitting the license application, we will have a

performance confirmation program in place.

DR. ALLEN: You mean if suddenly the water table goes up 600 feet, it's taken into account?

DR. BROCOUM: That's correct.

DR. ALLEN: Don Langmuir?

DR. LANGMUIR: Yeah, Langmuir; Board.

This brings up a related question. I would assume that you'll have things begin, such as thermal loading, which will not be anywhere near completed when decisions are made in '98, or even in 2001. Your budget shows a substantial shrinkage in funding of site suitability evaluations as you pass '98. Is there flexibility and will there be flexibility in the program to keep these activities going, longer term tests that start now or start in two or three years, and will the money be available to work those programs and keep them going beyond '98 or beyond 2001 perhaps, if you have to? Thermal loading being an obvious example.

DR. SUMMERSON: The budget money that is identified for site suitability evaluation relates to funding the implementation of this process. When that drops off, that does not directly relate to Susan Jones's site research dropping off. That's a different budget item. So the site program--

DR. BROCOUM: Let me make a comment on this.

DR. SUMMERSON: It's a separate budget.

DR. BROCOUM: Yeah, we have, even putting the five year plan together where we don't have the numbers in this, we do have it in the internal version, we've allocated all of it, siting to licensing to NEPA and to management and compliance. Those are the four categories. We show high budgets for siting in the early years, which then drops off after '98. We show lower budgets for licensing, which then rise after '98. In fact, to some degree, that is an arbitrary assignment of numbers because a lot of the technical information serves both needs. So what we're doing is we're emphasizing suitability early so we're showing that budget under suitability. The same activities, when they continue to go on, they'll be shown under licensing in the later years.

DR. CHU: This is Woody Chu.

Jane, I'd like to follow up on the question just before last on technical site suitability. In your viewgraph on environmental quality, transportation and socioeconomic just before you went into peer review, the last bullet seems to be an implied equation, that is, the difference between technical site suitability and overall suitability is merely incorporation of the last three factors of environmental, transportation and socioeconomics.

DR. SUMMERSON: That's correct.

DR. CHU: Okay. That's kind of satisfyingly crisp.

DR. SUMMERSON: We have divided the DOE decisions into three, and as Steve said earlier, this is anything other than the site recommendation report, which is statutory in the Act. It's an arbitrary definition on our part. The other two, the technical site suitability is defined as higher-level findings on those guidelines covered in the SCP. The overall suitability decision is defined as higher-level findings on the remaining guidelines, i.e. those related to NEPA.

Now, the timing of that overall suitability decision in relationship to the Secretary's recommendation of the site to the President could be months, years, days, five minutes, you know, once that's there, depending on where the EIS is and the other things that go into that recommendation. But that's just the arbitrary definitions that we have made to help make the process more transparent to our oversight and the public as to what we expect to accomplish.

DR. ALLEN: Jane, I think we've had you on the hot seat long enough. We appreciate your patience.

Let's take a break for 20 minutes. We'll reconvene at 10:20.

(Whereupon, a recess was taken.)

DR. ALLEN: May we reconvene, please?

We're going to start off with a short statement by Garry Brewer.

DR. BREWER: This is Brewer of the Board.

Two things that I wanted to clarify for the record. The first is to publicly apologize for the sharpness of my comments directed toward Jane Summerson. It was not directed to her personally, but just what was being said. And for that, I apologize.

The second thing, and I think this is really important, the Nuclear Waste Technical Review Board is not against peer review. In fact, we have encouraged peer review and other kinds of airing and sunshine and ventilation from day one, and comments about this particular form of peer review are not be misconstrued at all. Wherever you can get help, get it.

DR. ALLEN: Thank you, Garry. I misread the agenda slightly this morning. It turns out we have not finished with the DOE presentation, and Steve Brocoum has about five or ten more minutes of material to add, and we'll very much restrict the questioning on that to get on with the rest of the program.

DR. BROCOUM: I want to make a comment here. We're talking a lot about, you know, in these reviews with the National Academy and others, the implication is we're trying to reach a consensus. We're really not trying to reach a consensus. In my own personal view, I don't think we're going to necessarily reach a consensus on this program. What

we're trying to do is show people we're doing a credible and a good job.

It is our job as DOE managers to take all points of views and make decisions. Decisions can be that we have enough information to make a high-level finding, for example, or we don't have information, we ought to get more data, and that may impact the schedule. So that's our responsibility. We're willing to take that on. But we're trying to get all the help we can.

And so at least it came across to me that in some of the discussion about the National Academy, we're trying to reach a consensus. We're not trying to reach a consensus, and I personally gave up--you know, I don't think in a program of this type, you will reach a consensus. What we're trying to do is get understanding.

Before I go to the expert judgment, I want to make one other comment because of some comments again that Dr. Brewer made about the less information. I had a question this morning about the ESF. I wanted to make that point again. I think I made it the last time I was in front of the Board. We are having more information from ESF than was ever contemplated in the SCP. For the audience that may not have been here last time, in the SCP, we had two shafts 12 feet in diameter, 300 feet apart, going down the Topopah Spring, and no more than two miles of drifting.

So I think whatever final configuration we come up with, we will have more underground information than we ever envisioned in the SCP base case.

Now, I'm going to talk a little bit about expert judgment, and I'm really talking about expert judgment from the project perspective, how we think we'll be using expert judgment.

The Board has in their December, in their Tenth Report, gave us some comments about expert judgment concerning numerous critical issues that cannot be resolved by data alone. And, you know, when you're dealing with the geologic system and predicting for thousands of years, you obviously require substantial input of expert judgment. And I think we all know that it's used extensively day by day by scientists, managers and everyone else without even necessarily realizing they're doing that.

The Board focused on the use of explicit and formally solicited expert judgment by the DOE in various studies, particularly in the PA area, and the Board has expressed concerns what that methodology might be, that we need to incorporate expertise outside of DOE, and that to have a successful licensing process, that we need to have some agreement between the DOE and the NRC on the kind of process we will use.

The NRC, of course, has views on expert judgment

also. It has been used extensively in analyzing safety issues, and examples are the seismic hazard on the east coast where studies done by Livermore and EPRI were used. The Atomic Safety and Licensing Board uses experts in the context of expert testimony during the hearing process.

The NRC has a NUREG on peer review, 1297, where they say because of several unique conditions inherent to the geologic repository system, expert judgment will need to be utilized in assessing the adequacy of work. Peer reviews are a mechanism by which these judgments can be made. They relate peer reviews to assessing expert judgment.

There is also another NUREG from the NRC. The CR means that it's a contractor report, so it's NUREG/CR-5411, which means that it does not necessarily reflect the NRC position, but reflects the contractor's position.

But in that, it says expert judgment is likely to play an important role in identifying and screening events, scenarios, developing and selecting models that characterize the geology and hydrology of the repository system, assessing model parameters, collecting data, and making strategic decisions about the repository. Most of this refers to the technical aspects of the program, with the possible exception of the last phrase.

It goes on to say that we could enhance responsibility and accountability because you have a well

documented, systematic process.

From our perspective, expert judgment--you know, for most routine areas, it's implicit you hire experts, you pay them because of their expertise, and you expect them to use their expertise in their fields. But you can have explicit use of expert judgment and can do it in an informal or a formal structured way, and you may have formal elicitation.

We believe that technical peer review constitutes one means of obtaining expert judgment, as stated in NUREG, as the NRC stated in NUREG 1297.

In evaluating site suitability, we'll be doing, and as Jane went through, three basic processes. One is we will have a technical process where we evaluate uncertainties, where we look at alternative conceptual models, where we need to decide whether additional testing will help us understand and reduce significant uncertainties, the technical area. That was basically the first box on Jane's diagram.

Then we'll have a regulatory area where we do the regulatory assessment. That's what this is trying to explain. And finally, the DOE managers have to make, in my case, have to make a recommendation to the director, and the director has to make a decision regarding findings. Three major steps.

We see clearly in the first step that formal

elicitations of technical experts, both internal and external to the program, on controversial topics which have large uncertainties, that prior to development of technical basis documentation would be useful. And examples are volcanism where we're planning to do elicitation this year, and I think we're planning to use outside experts on that panel; seismic hazard analysis where we're planning to also do a formal elicitation, and the fact that we needed to describe that process was one of the comments that the NRC gave us in refusing to review a technical report--a topical report on seismic hazard. And finally, in the ground-water travel time area, some sort of an expert elicitation is being planned there.

So in some areas where there's large uncertainties or are very controversial such as these, we will use formal processes of expert elicitation. All the areas where we're going to produce these technical reports, we will do the peer review, as Jane described, through the National Academy, assuming that contract is put in place.

For the guideline assessment, that's the regulatory and policy part, the second, I guess, box on your chart, we are not planning to use formal structured expert judgment in those, but we are planning to publish along with the decision, a rationale. And that was one of the major comments that came from one of the workshops that was led by

Jane.

Also I think, listening to Jane's presentation, we will have lots of interaction with the interested parties and the public as we develop these, including documents for comments.

We think expert judgment is inherent in complex analyses, and we think that formal elicitation would be useful in dealing with technical uncertainties that are significant in establishing the technical bases that we're going to use for preparing our assessments.

So in the technical aspects of the program, such as volcanism and seismology and ground-water travel time, we see a clear use of formal elicitation.

So basically, in conclusion, we will focus on technical issues and provide issues for consideration in developing our assessments. These results are not decisions. We view expert judgment evaluation, however they're done, as decision aiding, and we feel that managers, like Dr. Dreyfus, need to be free to consider other information that may be relevant to an appropriate manager reaching that decision.

Also, and the reason this here, managers need to be able to understand and explain the basis, for those that were around in the '90 to '92 time frame, we had some very complex ESF alternative studies, the Calico Hills risk/benefits, the ITE, Integrated Test Evaluation, that became very complex and

the only people that can clearly explain in front of the Board were the decision analysts. So since DOE is responsible for the program, the kind of process we had has to be one that DOE can take ownership of and DOE can take responsibility for.

So that's really all I have to say about expert judgment. We don't have an overall policy as a program. There were recommendations that came out of the workshop in 1992 which included things like training, having guidelines, several others, five or six recommendations. There was a letter from HCNW to the Commission in July of '91 that had some insight into expert judgment. There was an NEA workshop in October of '92 that I attended from the Department in Paris.

And we are, now that we're reorganized, expressing in the program how in the programmatic sense we may, if we want to come out with any formal guidance, we ought to have guidance on the issue of expert judgment, but not necessarily specific procedures. So that's all I can really tell you at the time. My viewgraphs really reflect how the projects, i.e. Yucca Mountain project, is intended to use expert judgment.

DR. ALLEN: I'd like to move on just as fast as we can. Are there any burning questions from the Board? Do you have a burning question?

DR. BREWER: Yeah, I have a burning question. I'm confused. On the one hand, I think I heard this morning in the comments from Dan Dreyfus you're going to do as much as you can do by '98, and then the decision is going to be made.

But then in your comments previous, the comments here, Jane's comments, there is the assurance that if things don't work out, you'll continue doing the work, putting information together. If the NAS comes back and says you need five more studies to get this thing in shape that we can sign off on, you'll do the five more studies.

Now, are we going to decide in '98 or not? That's the question. I don't get it.

DR. BROCOUM: Dan is in the room. I don't see him. He's not here. Okay. I know he's around somewhere. I'm giving you my own--I can't speak for the rest of them--my own personal opinion is that we will, if the information is there to make a high-level finding and the peer review more or less says that and we go to the Board, like your Board, and there aren't major problems, then we'll make that finding. If that information is not there and we can't make the finding, then we will not.

Dan is now walking down the aisle. Do you want to repeat the question?

But we have a schedule. We're working hard to a schedule. I think--you know, when you have a very short

period of time to do something, you really focus and you decide what's really important. And so part of the schedule we had is to get the collective community in our program, which is very large and very diverse, I guess 2,000 people, to focus on things that are really important, and that's what we're trying to do.

DR. ALLEN: This is an important enough question that I think, Dan, you perhaps ought to comment on it, or you might want to repeat it.

DR. DREYFUS: Well, I didn't hear the question as it was stated. I just got an interpretation.

DR. BREWER: I thought you were in the room or I would not have asked it that way.

DR. DREYFUS: I intended to be in the room.

DR. BREWER: Basically, it's my confusion in listening to your crisp presentation, you are doing a lot of very interesting things in terms of the management of this project, to get priorities set, to get things focused, to get it to work, and that's fine. And I infer from that that there will be a decision in 1998.

Then we hear other presentations from Steve twice and from Jane Summerson that, well, if it doesn't seem to be working out, if the NAS doesn't approve, we certainly won't do anything, we will pay attention to the additional studies that are needed, and so on. So it's confusing. Are we going

to make a decision or not?

DR. DREYFUS: Well, I guess this requires a philosophical response, I'm afraid, and it's not going to be quite as crisp.

When I came into the program, it was very clear to me there was a whole lot going on that had no convergence, no probable convergence in our time. If it hadn't been clear to me, it would have been brought forcibly to my attention by a whole lot of people who are in a position to stop this program tomorrow.

My view of the situation is that if that perception, if that kind of a picture persists, that a whole lot of very interesting work is going on, but nobody understands how it will fit together, and if anybody steps up and says gee, I think you ought to do "X", we add it to the agenda. We don't necessarily do it. We don't have enough money to do it. But sometime between now and decision time, we'll do anything anybody brings to the table, which I think is the picture that the world has of this program.

Then I am advised and I believe, and I've been in Washington long enough that I know when to believe people and when not, that this program will never get to '98 as we know it. Somebody will decide there's another way to do something.

Now, the question then rises can this program be

made to do something, and with the criteria that people understand what's going on and have some idea of when it's going to end and what the steps are, that society is willing to pay for it, and it's a cash flow problem, not so much a total cost problem, the faster you do it, the cheaper it is. But there is a cash flow exercised here, and I think, and my experience in Congress last year is that the profile that we had before Congress last year pretty much is it. I don't think we shot low. So I think that that gives us a dimension of what can be expected over the next few years.

And then there is clearly a social tolerance time. And if you don't think so, you haven't been in the same rooms I have, and we have court cases, people do not want to wait forever to find out if this can be done.

So now you say, well, what can I do? And clearly, you'll start with an arbitrary set of deadlines, not entirely arbitrary, the best judgment of the management of the program, which is where we started, people who have been with this program collectively many, many years, and I said what can you do. Let's go and look at what has to be done, and that gets you back to the documents, what has to be done. And what can be done, what has to be done, and can we in fact give a credible document to the Nuclear Regulatory Commission, which is the end point for this game, and can we do it in how much time.

I did not give them a schedule. I gave them an idea about how much resources I thought we're likely to be able to get. At that time, that was a guess. At this point, I have a fair amount of confidence that that's about it, because I've had a Congressional budget cycle. I told you a year ago I had to do that budget cycle now, not later after we did reorganizations or whatever, and that's why, because I needed that information. I've got it.

Now, nobody in their right mind would suggest that if the Nuclear Regulatory Commission tomorrow were to say what we see in these documents--and the documents are not yet done, you've got drafts in front of you of some of them--what we see in these documents will not get you a docketable application, that we'd say well, fine, we're going to file it anyway. That would be ridiculous.

On the other hand, I am not willing at this point to suggest that, gee, it sounds like it's going to be hard to do, so let's change it. The way you manage it is you set some rational guidelines, some rational schedules, and you manage to the schedules, you change the schedules when you know why you changed them. And at this point, I don't know a reason to change our schedule.

And what Jane said today is pretty much what I have told everyone in the program. That if you come to me and you tell me this can't be done because we found "X" and now we

have got to do stuff that we didn't have in this plan, that I will go and tell the Congress and the world and the Secretary that it takes more time and it takes more money, and they'll do what they need to do. But I want to be able to tell them it takes more time and it takes more money because this happened, not just we threw the work over into the next fiscal year because we didn't quite get it done, or we didn't quite have enough money to do it, or whatever.

So that's the difference. We're going to manage to a schedule, and we're here seeking input. And if anybody in a position to give us input tells us it isn't good enough, we'll see what's good enough. We'll price it out and we'll go back and report that that's what's good enough.

So I have no problem saying what we thought it was good enough has proven not to work, but I want it proven not to work, not just another suggestion that perhaps in another ten years and another few billion, we could do a better job.

DR. ALLEN: Thank you. I think that does clarify to some degree the point. May we move on?

DR. BROCOUM: I just want to make one comment. A lot of people say they weren't able to get a copy of that five year plan, that they ran out. So we're trying to print another hundred and we're trying to have them here after lunch.

DR. ALLEN: Thank you, Steve.

We should now move on to Malcolm Knapp of the NRC,

that is, the Nuclear Regulatory Commission.

DR. KNAPP: I'm Mal Knapp. I'm with the Nuclear Regulatory Commission, where I'm in charge of the Division of Waste Management. In the next 15 or 20 minutes, I hope to give you some of our views on DOE site suitability plans. I hope to address the concerns that the Board has raised. I've changed the order a little bit.

I want to talk a little about the interface we anticipate having with DOE, some of our concerns as a regulator, and a couple of comments we have on the implementation of 950, perhaps as friends of the court.

I'd like to note that we are still learning about what's going on. It seems as though I'll come to meetings like the one today and DOE will make a couple of presentations and I'll make one, and I know about 10 per cent more after the DOE presentations than I did before I wrote my talk. So the program is changing. We are still learning. So things that I have to say are preliminary, and if I come before you again in a month or two, I would expect I'll say something a bit different.

I also note that much of what I have to say today I think has already been ventilated at least in part by questions by Board members and others. I think you'll find we share a number of the concerns that you have.

Before I get to the concerns, though, I would like

to make sort of a general remark on now the program approach and site suitability work, and that is in general, I'm encouraged by it. I've been back involved in the high level program for about six months, and a couple of the concerns that I had early on in my first look were that DOE did not appear to be well focused, nor did they appear to be well coordinated. And I see the benefit of this program in part as bringing focus, coordination and integration to this program, and I applaud that. And I want to make sure before I begin to pick away at some of the smaller pieces, that you understand that overall, I am pleased by the way things are headed. I hope that DOE doesn't get caught with the devil and the details. But the initial scheme seems to me to be a good direction to go.

Speaking about the DOE/NRC interface, one of the first points to be made is that we regard the implementation of 960 as a DOE responsibility. They are going to be making their decisions on site suitability. We become active, of course, in the licensing process. And for that reason, our focus on their site suitability work will be as they develop their prelicensing information in support of their application. Therefore, we will be looking at it with respect to 10 CFR 60.

With that in mind, and thinking about the interface, I have some concerns about how they're going to

issue their pre-licensing products, and some of those were resolved a bit this morning by some of Dr. Summerson's remarks. But again, we're bringing this into focus, and one of the strong actions NRC will be taking over the next months is that at every step in this process, it's my intent to interact a lot with DOE. We're going to be reviewing the five year plan carefully, we will be reviewing their technical implementation plan, now due I believe in November, carefully and we're going to be commenting on areas where we believe we have concerns or where we think they may be moving in a direction that will not lead to a sound license application.

To give a little background for a couple of comments I'm going to make later, this is the I hope current version of the site suitability decision, waterfall diagram. We put this one together because it's a little simpler than the DOE version.

The only point really to be made here is that among the higher-level findings, one which will be coming in now in less than a year, I believe it's coming at the end of fiscal '95, not calendar '95, will be their high-level finding on surface processes. We see the high-level findings as the focal point of the DOE site suitability program, and so our interaction and our comments are largely focused on those.

The next viewgraph you've already seen. The

interaction that Dr. Brocoum mentioned, the recognition that 960 and 60 are not inconsistent. We have no difficulty with that. We see the data collection analysis steps coming together with these steps, synthesis, technical report, external review, and then coming into the suitability analysis and the regulatory analysis.

One of the things I would note, as I think Steve Frishman would remind me if I did not, is that the agreements with the NRC here will be resolution, not closure. The sorts of agreements we anticipate we would reach would be DOE has taken as much data and done as many analyses as we think are necessary at this point. We would not expect that we would reach closure on issues. That must wait of course until the licensing process.

Now, here I'm still interpreting a bit what DOE is doing. And please correct me if I misinterpret. The viewgraph that Dr. Summerson spoke to at some length I think is a blow-up of these two bullets, and that is their suitability evaluation process. And I will not take up your time with reiterating what she has said about development of the basis, the review, involvement with the National Academy, public comments and what have you, although I would note one thing. This is the viewgraph I received from them on--I think took away on a presentation on the 28th of September. You notice the word observation. I believe your current

viewgraph says participation, and that's commendable.

DR. SUMMERSON: And instead of address public concerns, it says, I believe, address external technical--I'm sorry, there's another change there. Instead of addressing public concerns on that technical basis, it's addressing the technical issues raised by the external--these are just words to try to clarify understanding.

DR. KNAPP: Right. But that leads to a couple of points. As I said, not only are we still learning about the program, the program and the plans are changing as we learn, so that is one of the reasons our comments are preliminary.

But another thing that I've noted, which I commend, is I think here, DOE was responsive to a strong desire for public participation as opposed to observation. And watching this process develop as we go out to these meetings, I am getting at least a feeling that DOE is attempting to listen and attempting to be responsive. I commend that and encourage it to continue.

But going back--now that I've said something good, I have to turn this around. I'm concerned about this process because I see much of this process as being isolated in these areas on this viewgraph, which leads me to the concern that if it works out this way, by the time that DOE brings us a regulatory analysis, they will have gone through one, perhaps two public comment periods, a peer review by the National

Academy of Science, or however that finally works out, and bluntly put, I'm concerned we might be faced with a fait accompli.

For that reason, it is my intent that we will be heavily involved in the public participation here, and in public comment here. Now, in the best of all possible worlds, it would be very nice if DOE could put a package together and then we could review it as regulators. I don't think we can afford to wait. I don't think it would really be responsible for us to wait.

If we think that DOE is headed in a direction, regardless of its merits for site suitability, which does not lead in our view to the completion of a successful license application, I think we need to tell DOE as early as possible. I think we'd have good reason to be faulted if we are not.

So exactly how we will interact still remains I think to be worked on as we learn more about DOE's process, and as we review it. But one message I'd like you to have is that it's my intent to review these things early and intensely, and if my understanding I think that the surface processes report will be out in February is correct, then we're going to be getting into that in February. We will not be waiting until it finally gets into the last steps.

I mention a couple of concerns that I have as a

regulator, and these concerns are again somewhat modified by what I've heard this morning. As I think most of you are aware, DOE is focusing on qualifying and disqualifying conditions and may or may not be setting favorable and potentially adverse conditions aside.

Again, with respect to DOE's responsiveness, I was pleased to hear that you will reconsider using favorable and potentially adverse conditions.

The reason I'm concerned about that is that I see these as having a significant role in the license application. These things appear in 10 CFR 60 and will need to be considered, and I think that it is very much in DOE's interest to ensure that in developing the site suitability decision, they do not neglect or back burner the favorable and potentially adverse conditions to the point that they will have been left out of the picture and not fully considered when they bring in the license application later on.

I have no disagreement with the focus on qualifying and disqualifying. My only concern is that the others not be neglected to the point where you look around one day and find out you do not have the technical basis that you hoped you have to suppose these.

And similarly, recognizing at least in my view what DOE is doing here is a management decision to try to make in

1998, I think Dr. Dreyfus has said this morning does it make sense to continue. Well, in my experience, the quality and completeness of the information that you need to make a management decision are not necessarily anywhere near as severe as the quality that you need of information to support your case in an adjudicatory process.

So a concern I have here is that DOE is careful, and I think this is something the Board already mentioned, in fact be sufficiently complete, have sufficient quality assurance work done with it, that if they wish to use this data later on, or these analyses to support the license application, they will not find that, in fact, they have to go back and repeat them because the quality of work simply cannot be demonstrated to be good enough to support an adjudicatory hearing.

A few comments on the implementation of 960 itself. Again, I'll be interested in how these are flushed out by what DOE does in the development of the program.

We're a bit concerned that the higher level findings may have difficulty in actually meeting the expectations of the public or the Board or others. With the amount of data currently available, it's not obvious to me that the higher level finding, as described this morning, this is good, for example, the qualifying condition is present, we don't foresee anything coming at us in the future

that is going to cause it to be absent, it's not obvious to me, based on what I now know, that they can reach a higher level finding on some of these qualifying conditions with the information currently at hand. And in some cases, for example, surface processes, I believe they will be dealing with the information currently at hand simply to be able to get it to a point where they can finish this by the end of fiscal '95.

That leads me to the next concern, that tight schedules may limit the data and the analyses that they can perform. This was--a comment again, to change this a little bit, results from a conversation that I had with Lake Barrett about two weeks ago. He called me and he had just finished a meeting, I believe, with some DOE people out here to exhort them to make progress on the tunnel boring machine, and he wanted to make sure that the NRC got the message that he had in mind when he gave them that exhortation.

He said he gave them three priorities. The first priority was safety. The second priority was procedure, to include quality assurance. The third priority was schedule. He wanted to use a schedule to keep things moving, to force action, but his first priority was safety and his second was quality assurance to do the job right, to do it properly.

Again, I found that encouraging and I would encourage DOE to continue in that process so that the tight schedules

do not wind up becoming limiting. Again, I think I'm saying very little that was not already said in other ways.

I'm concerned that some of the bounding decisions that DOE wishes to reach may be very difficult to make. And that relates in part to a concern that some of the higher level findings may not be separable, to go back to the earlier schedule that finds findings in particular areas changing at different times with the waterfall diagram. And I'll return to it for just a moment.

It's not clear that these things in fact can be made separately. I'm not sure that it's possible to make some of these without consideration of other aspects of the repository, perhaps most of all the total system performance assessment. Now, I recognize there will be performance assessments performed about annually as DOE continues the suitability, but whether they will be extensive enough to support conclusions reached in high level findings is something that I'm concerned about, and that's something that we'll be looking at carefully as we look at the DOE products that are coming in.

To talk about one of those in just a little bit to illustrate my concern, let's again return to surface processes coming in in a year. I believe that DOE will be reaching conclusions, if my understanding of the draft of the five year plan is correct, on about five conditions

associated with three guidelines, qualifying, disqualifying and erosion, qualifying on surface characteristics, qualifying and disqualifying on hydrology, and I'd like now to expand on that a little bit and talk a little more about erosion in particular.

And here, I've taken the liberty of paraphrasing some words in 960 and combining them. The gist of the qualifying condition; erosional processes at the surface are unlikely to cause radionuclide releases greater than those allowed under EPA standards and NRC regulations. Again, this is a paraphrase, but if you look at the qualifying condition, you look at the reference to I think 960.4-1, that's where it comes in.

Well, this is going to be an interesting conclusion for DOE to reach. If they reach this in the fall of fiscal '95, that will be three months before, optimistically, EPA has completed its final version of the high level standards, and a year and three months before NRC has made any necessary changes it needs to make to 10 CFR 60. Now, that doesn't mean you can't do it.

But what I think it means to me is you're going to have to take your worst case scenario in terms of how rigorous EPA will be and how rigorous NRC will be, and then reach your higher level finding and the qualifying condition with enough conservatism and bounding assumptions so that no

matter how conservative we are reasonably likely to be, you in fact can find that qualifying condition to be present and unlikely that it will change in the future.

That may turn out to be a tall order. Perhaps not in this condition. I think surface processes are an appropriate one to start with. I think in the concept of separability, they're probably as likely as any of the HLFs to be separable. But it does speak to the fact that your bounding assumptions and your conservative assumptions may have to be pretty conservative, and I'm concerned that DOE is going to reach a closed set. That is, by the time you make a sufficiently conservative assumption, that with the slack you have to cut everywhere else in the program for that assumption to work, you may find that you can't meet that assumption at the site. I think that's going to require a lot of very careful attention and, again, another area where we plan to be watching closely.

On the other hand, the disqualifying condition looks like something that's pretty straightforward, frankly. I mean, that's separable. It's not like other things. Either you can or cannot get down at least 200 meters below the surface, and that's one where we would be more optimistic you could reach a finding on that condition.

That really concludes the views we have at this point. I'd like to summarize with a couple of comments.

We're still changing these things, our comments, as we look at the program. I think the program is frankly--I think to try to accomplish what DOE has set out to do in the time table that they have is going to be challenging to say the least, and I wish them every success.

We will work closely with them, and when we find inconsistencies or holes on a detailed basis, we're certainly going to share them with DOE and we're going to share them with you.

That concludes my remarks. I'd be happy to answer questions, if I can.

DR. ALLEN: Thank you. Questions from the Board? Don Langmuir.

DR. LANGMUIR: I'd like to get into some of the details, if I could. One of the major NRC regs applies to ground-water travel time, and the need for that to satisfy the 1000 year or greater arrival.

My understanding is NRC's definition of a disturbed zone is key or integral to that definition, and that we're looking at a definition of a disturbed zone which was written ten years or more ago. If that definition as I understand it is still applied, and it seems to be still applied by NRC, it makes the whole repository, the disturbed zone, under a high loading scenario, and may make the travel time zero in the worst case just because of the definition that NRC is

requiring DOE to use. I wonder how you feel about that, and if NRC is reconsidering defining the disturbed zone as a starting point for travel time.

DR. KNAPP: First, you're right; it was written, in fact I wrote it or had a major hand in it 15 years ago. Somebody once said one of the things that you should do in the federal government is to stay around long enough to realize the consequences of your actions.

I'm not going to take up an awful lot of time. If the Board wants, I can be eloquent on why we put it in there and what we had intended. But the fact is we were more naive about geologic disposal. We were looking in those days at a different set of sites, and the concept of--and we had different technical information, which I'm not sure over the intervening 10 or 15 years has been fully supported.

To answer your question briefly, I am taking a look at exactly how useful the disturbed concept is or whether or not it's properly applied. Now, I can't tell you what the Commission might decide, and I have not had my staff develop enough information that I'm ready to say anything one way or another.

I can tell you that your concern is valid, it's one that I share, and I think we need to ask are we in fact throwing out the baby with the bath water. Have we in fact created a disturbed zone which makes it impossible to have

any ground water distance at all. I think it needs to be asked. That was not our intent when we put it together in the regulation, obviously, and if it turns out we don't need that intent because of our increased understanding of technology, we'll revisit it. That's all I can tell you now.

DR. LANGMUIR: It leaves us with the peculiar problem that the disturbed zone, which perhaps is the best thing we've got at the mountain to isolate the waste, isn't considered as part of a beneficial aspect of the system. It isn't considered for its usefulness in isolating the waste if we start the timing from beyond it.

DR. KNAPP: Well, as a matter of fact, that was exactly the argument we thought would be made, which is why we wanted to start the timing beyond it. We were very skeptical of the technical merit of that argument. You know, it may have tremendous merit.

The problem that we had at the time was that we foresaw an argument should we start the ground water travel time at the edge of the repository, and should we be in a repository with what amounted to aquacludes above and below and beside it, which was certainly contemplated in those days. And I'm talking about a saturated repository. That the licensee would come in and say hey, the way this works, we can meet the ground water travel time in the first ten feet, and the rest of the site could be swiss cheese.

Well, that's fine except as we all know in this room, is this thing goes through the thermal cycle, exactly what would happen to an aquaclude is certainly beyond my ability personally to perceive, and so we wanted to forestall that argument. We wanted a measure of the quality of the site in which we could have some confidence that as time passed, would not have run the potential of being dramatically changed.

Now, I'm not saying it would be changed at that end; it's in our ability to predict it. So what we had in mind was to try to force the issue for ground water travel time to be something that could be measured. That's why we use pre-emplacement ground water travel time, something that we could look at with some confidence that as the site progressed through the millennia, we'd have something that we would have some confidence, based on measurement of existing information, would be unlikely to change.

As I said, that all was predicated on information we had at that time, based on those sites and those analyses that suggested that perhaps of the controlled area, 10 per cent might constitute the disturbed zone. So we're going to have to go back and take another look at that. As I say, that's a legitimate challenge to that particular part of the regulation.

DR. ALLEN: Any other questions from the Board? I think

we probably ought to move on. Thank you.

Our next presentation is by Steve Frishman of the Nevada Nuclear Project Office.

MR. FRISHMAN: As is often the case, I don't have any viewgraphs to bore you with.

Just as Mal has been doing, I've been trying to interpret this whole site suitability process from the very first time I've heard anything about it, and I don't know whether 10 per cent new knowledge every time is the right number, but there's certainly new and sometimes startling knowledge every time I hear anything about this developing site suitability process.

I think what I want to do today is put my comments sort of in context of some things that we heard today and things that I tried to listen to very carefully that are sort of new statements within the context of the description and discussion of this process. I think your questions earlier brought out some of the things that I was interested to hear.

I'll just touch on some various aspects of what I'm interpreting out of the proposed process, and some of the real concerns that I've got. Many of the regulatory concerns I think Mal did a good job of explaining, and we agree with a large number of the concerns the way they're stated.

Let's start out with the idea that as now I've heard stated first a couple weeks ago and now it's getting

more and more firm in the rhetoric, and that's the technical site suitability decision is a business decision. It's a decision, as I heard it described a few days ago, a decision whether to continue to investment towards the license application. And that in itself I think is an interesting approach, and when it's coupled with the second statement that was made a couple weeks ago, beyond the one about technical site suitability being a business decision, and that's that the decision to submit a license application is the safety decision.

Now, that brings me to kind of question why that difference is set out there, because in reality, being a technical site suitability determination in 1998 or whenever it is done prior to a suitability determination and a Secretary's recommendation, is in fact the support ultimately for the Secretary's recommendation. And the Secretary's recommendation certainly is not a business decision. The Secretary's recommendation must, under the Nuclear Waste Policy Act, be a safety decision.

So I'm a little bit confused about how the rationale is developing, and I'm beginning to see that it seems almost to be developing because it has to be used to bridge various portions of the puzzle that maybe we're not seeing very well. But that's one that I think needs to be held up front because technical site suitability at the,

well, nominally 1998, two years before a--or three years before a safety decision is made, what is going to be done within that period of time that will improve the quality of the safety decision.

Technical site suitability was stated to be done, unless something new turns up, and three years later after the rest of the guidelines have been applied--and I'll talk about that a little bit later--then you all of a sudden come to the ability to make a safety decision. What's happening in that period of time that takes you from a business decision to a quality safety decision? I don't get it. So that's something I think that needs to be considered in the whole scheme of this process.

Now, I heard another bridge statement today, and I've been trying to figure out what it means and I think I'm beginning to get it. And that's that Steve Brocoum said that 960 is more focused on the site, while 10 CFR Part 60 is more focused on performance.

Well, I want to show you sort of a stream of logic that shows that this really can't be, but I think I've finally figured out why this bridge had to be built, and I had not heard it before. I think it has to be built to defend the concept of separability of guideline decisions. It seems to be that's about the only way you can do it if you make the interpretation that that's the difference between

the two.

But let me show you how it doesn't work. For a technical site suitability determination, what you've got to do is make a determination that the site is not disqualified or you have to make a determination that the site meets the qualifying condition. You have to make both of those decisions.

Now, in order to demonstrate that the site meets the qualifying condition in all of the guidelines which are applied in technical site suitability, the qualifying condition is a performance condition. It's one that essentially says, just as Mal showed, says that under this guideline, the site will meet the release standards of both EPA and NRC regulation, and that's about it. That's about what the qualifying condition says. And that is a performance determination.

So how can you be in a situation where you're trying to separate the pieces out, have separability among the guidelines, and at the same time, try to insist that it's a site, really just a site factor, but you're really making a performance determination that requires understanding the full gamut of the site.

And it also requires another thing that was pointed out in the NRC's recent letter about the PPA; it also requires that you factor in the waste package in order to

make that performance determination, and nowhere in technical site suitability are we dealing with a waste package. We don't know what that waste package is, and according to DOE schedules, we won't know what that waste package is.

So we're to the point where I think in 1998, the technical site suitability decision is going to, almost of necessity, if it's going to be defensible at all, is going to have to say we don't think it's disqualified, but we can't demonstrate that it's qualified because we don't have enough to do a credible performance assessment because the program has not even been scheduled to give us enough to do that.

Now, I guess what I'm saying is you can't have it both ways. You can't say that the guidelines or that 960 is more for the site, when in fact you're trying to make it work for performance when you don't have the information and knowledge capability to make it work for performance.

Now, I guess you're well aware that we have had a gripe all along about the guidelines, and we got dismissed from the court in our lawsuit over the guidelines and the fact that we believed they were inadequate under the Act, and we got dismissed for what we believe, and I think even the surliest of lawyers would believe, was a really foolish decision. But anyway, I guess we're all going to pay the price for that decision anyway.

Now, in general, we think that the whole concept

the Department is using about the guidelines, or trying to use about the guidelines being a performance measure, even though just today we're thinking what we're hearing to defend something else, sort of illogically they're saying that it's less a performance measure.

Now, we still go back to 112(a) in the Act to try to find out what the guidelines ought to be to make a site suitability determination, and it's pretty hard to find that the act contemplated that it lead to a massive performance determination. The Act seems pretty clear that there are site characteristics that you should be concerned about, and you should be concerned about them way up front before you ever worry about overall system performance.

And just to remind you of the words and what I think is essentially their clarity, let me just read you about three lines of it without getting into all of the ten mile long sentence that's in 112(a). "Such guidelines shall specify detailed geologic considerations that shall be primary criteria for the selection of sites in various geologic media. Such guidelines shall specify factors that qualify or disqualify any site from development as a repository, including factors pertaining to the location of valuable natural resources, hydrology, geophysics, seismic activity," et cetera, et cetera.

I don't see a lot of performance in there. I see

the Congress saying be very, very careful about selecting a site in terms of collecting and understanding the information that is there and you can measure one way or another in order to determine whether you can understand that site, and then whether those factors themselves are acceptable as you go forward towards performance.

So I guess the approach that I'm seeing with the site suitability determination and the technical site suitability determination, I think first of all is really not linked to the thinking that was in 112(a) in the Act, and I think now having heard this latest concept that came up today, I think it's illogical and I think it's trying to have it both ways, and you can't have it both ways.

We have maintained all along that the site should be analyzed first based on the geologic and hydrologic work that you can do there to try to understand it, try to understand it in terms of maybe it needs to be the best understood piece of geology on earth, but try to understand it in the context that geologists and hydrologists try to understand sites, not in the context that nuclear engineers try to understand the repository site.

So I think we need to go back to some real basic thinking about this whole process, and especially since you're going to be in a situation where you just don't have the data to do anything other than some very high flying

performance assessments that aren't going to convince me, and I'm kind of doubtful that they're going to convince very many people.

Now, let me talk in the context of the technical basis report. I'm still trying to figure out what that technical basis report is or will be. I imagine some work is being done on trying to outline it, but it seems to me that if it's going to be used the way the peer review process and the box process is laid out, then the technical basis report really has got to be everything you think you know in a particular area of geology or hydrology.

And if you go back and look at DOE's schedules for the PPA, we look at 1997, we have a whole list of things that are called site investigations, 3-D geologic description, climate, post-closure tectonics, UZ, SZ geochemistry, UZ hydrologic description, saturated zone hydrologic description. You look at those, all of those are going to be, at best, bounded in 1997.

Now, if the technical basis report is tell me everything you know in each one of these areas, then how is a peer review group going to deal with bounded information in the sense of everything you think you know and everything you think you need to know at this point. How are they going to deal with bounded information? The UZ hydrologic model could be this, could be that, and now the only criteria you could

use for saying, well, that bounds it and it doesn't matter which it is, is if you know what you want to apply that to, if you know what you want to apply that technical basis to.

Now, if you're doing that, then what you're doing is you're sliding over into the next box, that next box being the one about guideline compliance assessment. Now, I don't think we want the NAS doing a technical peer review in the context of forecasting into that next box of guideline compliance assessment, because that's not what their expertise is.

What the hope is is that you will get an erudite technical review of everything you think you know about unsaturated zone hydrology, regardless of what it's going to be used for. Well, that doesn't work. It can't work, because you can't get the NAS peer reviewers, I think, to do an adequate review if they don't know what the material they're reviewing is going to be used as a basis for. And it makes a very difficult situation that they get into, and I heard one other thing from Jane today that makes it even more difficult, and that's that in their discussions over the contract, the NAS doesn't want to be put in a position where they have to make a judgment over whether the right tests were done.

So what are we going to get out of anybody's, including an NAS peer review of a technical basis report,

unless you blur that line between technical basis and guideline compliance, and I really believe we don't want the National Academy in guideline compliance because that is a management decision that DOE is solely responsible for, and I don't care how many scientists you stack on it, the management decision isn't going to be different from what the managers want it to be anyway.

There's no way in this situation that you can separate out a purely technical review and do it independent of what that material is going to be used for. So I think this whole process needs to be re-thought, or at least cast honestly. Say that you can't do it by these very firm lines between the types of analyses and reviews that are done, and figure out some process that maybe we all won't like it, but at least you're telling honestly what you're doing.

And you can't, I think, go through this thing without a firm understanding that ultimately what DOE management wants is to have some way to shore up a technical site suitability determination, and you can't fool the people when you say we have an independent scientific review of the information, when the reviewers didn't know why they were reviewing that information.

And, you know, unsaturated zone hydrology I think is a great example to look at. You get a peer review in there and just segregate it completely from the whole concept

of what the regulations and the guidelines say, and hand as much information as the Department wants to give to a peer review group and say okay, here's everything we know about unsaturated zone hydrology at that site, but remember it's just bounded still. Now, is this okay?

Do you really think a group of professionals, self-respecting scientists are going to say yeah, that's great, that's all you need to know? They can't tell you that because they're scientists and they know that they do not have truths; they have various possible models and versions of the truth. And what they really want is the truth, and you can't get there from here with this process.

So I think that's a problem that is inherent in this process and I think the whole process ought to be re-thought and have sort of honesty brought to the forefront and say what really is going on and say what is impossible to do.

One final point that I wanted to make is that it appears from the way both Jane and Steve were speaking that the peer review of the technical information is intended to be the place where those of us who are doing technical oversight are going to need to plug in everything we think we know, and that's going to be tough because we hadn't planned on it, and also because it puts us in a position where ultimately that NAS panel is going to be, if they review our work at all, they're going to be peer reviewing our oversight

work as well as everything DOE thinks it knows, and there are going to be some choices made there that are probably going to be irreversible for us as oversight, even if we disagree with those choices.

And I guess all I can remind you is that if we get put into that position, then it makes our effort, if the process continues to go forward, it makes our effort with a notice of disapproval an extremely important effort, because we're going to be out there trying to tell Congress then that our oversight work was rejected, not even by DOE, but rejected by a peer review panel, and our concerns never did get to the point of being able to deal with site suitability because we had sort of an internal process, and now we're going to try all of these issues and we're going to show you, the Congress, how unsafe this site is, regardless of all of the people who in separate little boxes said things that DOE management added up to say it's a safe site.

So it's going to change the whole nature of how we have to do our business if the NAS peer review becomes the point in the process where DOE essentially discharges whatever technical work we as oversight people may have been doing.

That's enough for now, I think.

DR. ALLEN: Thank you, Steve. You're right on schedule.

We have certain logistical restrictions in the

hotel here, so we've got to quit about on time.

Are there any important questions here from the Board itself?

Okay, thank you. What we're going to do is delay, because of these logistical restrictions, delay the talk by Steven Kraft until after lunch. So we'll adjourn now at the scheduled time, 11:30, and reconvene again at 12:45 as scheduled. Thank you.

(Whereupon, the luncheon recess was taken.)

AFTERNOON SESSION

DR. ALLEN: Okay, can we go ahead, please?

The first speaker on the afternoon's program is actually scheduled as the last speaker of the morning program, is Steve Kraft of the Nuclear Energy Institute.

MR. KRAFT: Well, good afternoon. Those of us involved in this program come to Las Vegas a lot. This is a tough room. I was watching some of my colleagues before me make their presentations, and I went out looking for a hard hat.

When last I had the pleasure of appearing before this Board, I was not an employee of the Nuclear Energy Institute, because there was no Nuclear Energy Institute. The Nuclear Energy Institute sprang into being on March 16th of this year, as a merger of the American Nuclear Energy Council, Nuclear Resources and Management Council, U.S. Council for Energy Awareness, and the Nuclear Division of the Edison Electric Institute, where I was employed, and Chris Henkel, who's here with me today.

In pursuing this program, following the DOE program and related matters for many, many, many, many years, we were engaged in a forced march, I might add, from Seventh Street to Eighteenth Street Northwest in Washington, D.C.

The Nuclear Energy Institute--I guess, a minute or two--is responsible for nuclear energy industry policy, providing a unified policy for the consideration of boards such as this, other government activities, providing information, et cetera. Our members are broader than the membership that I used to represent at EEI, and not only includes all the nuclear powerplant owners in the United States, it includes most of the supporting nuclear industry, plus utilities and suppliers worldwide.

I want to thank you for holding this very, very important and timely meeting at this date. I agree with both what Mal Knapp said, and what Steve Frishman said--it's rare that I agree with Steve, but I will agree with him on this one point: The PPA, which we now know as the PA, which began life as Scenario A, is a work in progress. Our views of that program, of that performance plan is itself a work in progress, and so, I was taking furious notes during the discussion as I learned more and more and more and more about this during the course of the discussion, and so I will be using my view graphs as a starting point, but will discuss some other matters as they now seem to be being presented.

A brief history lesson. We have been involved, from the industry standpoint, in this process since the beginning of time. It is my life. I like to kid my wife, I knew nuclear waste before I knew her. I certainly knew

nuclear waste before I knew my children. The only thing in my life that--the only thing, as we've learned, the only thing in history that has actually gone on longer than nuclear waste is baseball. I don't mean the game, I mean the film, "Baseball."

Okay, should I knock off the jokes? It's after lunch. Thank you, Mr. Chairman, for asking me to appear. I hate getting up in front of a crowd that's going, "Go on, get it over with. I want to go eat."

Anyone can write letters to DOE. A lot of people have. These were our set of comment letters. The only reason we list them here as demonstrating our bona fides in this process is they are, of course, the milestones by which you measure your involvement, but I think everyone knows, especially the DOE people, that we have been an active participant in developing this entire waste program, and, certainly, in the suitability process for years and years and years, and, in fact, a lot of the work that was engaged in in the recent several four or five years, particularly Jean Younker's work in early suitability assessments and what have you, I think, grew out of the critical comments that we made over time about the need to have that kind of analysis going on in the program.

I remember very well a situation going back to around 1985, where we were trying to get the Department of

Energy to understand the need to do performance assessment-type analysis, which you call now performance assessment, and we were suggesting that there must be some way a model could be developed to do this kind of assessment, and I won't name names, but individuals in the program at the time, some of whom are no longer in the program, said, "Well, we don't know how to do that. We're going to collect all of the data, and at the end of this huge process, we will then make a final determination of suitability, or whatever the law requires, and if you want us to do that, industry, you've got to go do that."

So, EEI got together with EPRI, and I think most of you know this history. In under a year, for under a million dollars, we wrote the first performance assessment model. Now, that's not to say it was the only, or the best, but it was the first, and the thing that I know, from talking to people in the program, is that a lot of folks in the program and in the contractor community in the program kind of learned from that process, maybe there are ways that this can be done.

I think it's interesting, and you should keep in mind that 960 is not just a technical process, it is a legal process, and we've been through the courts once, and, as Steve Frishman reminded us, the court said it is not a reviewable matter until the Agency acts, and that is an

important point that I will come back to.

Comments on the draft process. We, of course, filed a letter with Dr. Summerson, in fact, two letters in the recent history, and we said that we generally support the process. Jane, we're going to amend that. We have been sitting here, my colleagues and I, listening to the give and take of the discussion, and while I'm not saying we don't support the process, we just don't know anymore.

There has been a lot of very interesting discussion this morning, particularly in the peer review part of the process, that we're a little uncertain of now, and we want to go back and re-think our comments, and since this is not a legal proceeding, I would assume it is ongoing activity, that DOE's open to receiving future correspondence on that point.

Furthermore, as I will get into, the discussion, particularly in some additional points I want to raise beyond what we've already told DOE, we were contemplating filing a supplemental response anyway.

First point. Part 960 must be conformed to the current statutory framework. We have made this point over and over and over again. Steve referred to it in his presentation this morning. We appreciate the program's willingness to reconsider that matter. Just let me make the point again.

The guidelines were originally developed largely

for use in site comparisons, not exclusively so, but largely for that. The amendments in '87 said, "Go do Yucca Mountain exclusively. There is no need for comparisons anymore." I think everyone would agree. And there is, in fact, equally the need now for DOE to establish in some manner, preferably by rulemaking, clear and unambiguous guidelines as to what it is they're going to do.

They need to reflect the current statute, and they need to reflect their intent of what they're going--how they're going to proceed. If you do not do that, you're going to end up in--the decision, suitability decision is coming in the year--the overall suitability decision comes in the year 2000. If you go to the last page of Jane's presentation, is called, in parens, (The Final Agency Action). For those of you who are not lawyers, those are code words meaning reviewable by the court.

So, the point that we are making here is what do you want to have reviewable by the court? Do you want to have reviewable the decision and the application of the guideline, which certainly will be reviewed. Do you also want to have reviewed how DOE handled the guidelines?

Well, probably you will have to do that, but you will be in better shape, DOE, if you do something now to conform your guidelines to the statute, and I'm not talking about the substance of the guidelines, I'll deal with that in

a minute, I'm talking about the process, and before people say, "Well, you'll delay an already delayed process," since the court has already said this is non-reviewable, DOE is a competent agency interpreting their own regulations.

They can use a procedure in the Administrative Procedures Act that permits an immediately effective, interpretive rulemaking that says, "Here's the way it's going to go," not just something published on a blank piece of white paper that gets sent out for comment, but something that gets codified in your rules. We believe it will be much better, and, Steve, in your reconsideration of that issue, we ask that you take that into account.

But, what we think happens is you solved some of the problems everyone was talking about. If you've read Mal Knapp's letter to Jane, and he didn't really make a very, very strong point about it in this morning's presentation, but what the import of that letter says, from the NRC standpoint--this is not what we're saying, I'm merely paraphrasing, I believe, what NRC is saying--NRC is saying, "Look, DOE, 960 is your business, but if you were to ask us, we think you are misapplying your own regulations."

So, we kind of look at that as sort of supporting the notion, on our part, that says, "Well, conform your regulations to what you're going to do." There is even a school of thought that says you don't need 960 at all, but

that, somehow, there is no technical reason for DOE to have its own set of guidelines, and perhaps you can just rely on the NRC guidelines. We don't think that's doable under the current statute. The statute clearly calls for guidelines not just for comparison, but that brings me to the second procedural point that I want to make.

And that is, while this is certainly not required, while you're conforming your guidelines, conform them to Part 60. Get NRC and DOE on the same sheet of music, and not just like one of these negative bureaucratic non-statements, not inconsistent with, but the same notes on the same sheet of music. Ultimately, this is going to be the test.

Now, Dan Dreyfuss raised a very interesting point this morning, is that you don't want to wait until the year 2004, after doing all the work, before NRC says, "Sorry, not good." Well, we're not asking you to do that. What we're asking you to do is continue the process, but doing it to what it says in Part 60, not what it says in Part 960. There are enough differences, in our view, for that to be problematic in the long run.

But even if you don't--and I'm very heartened to see that DOE and NRC are--appear to be improving the working relationship, formalizing some additional steps that need to be formalized in terms of getting--Mal called it a resolution point on issues, not necessarily closure. We would argue for

closure. There are ways you can come to closure. NRC can learn rulemakings, if necessary, on closing issues, but even if they just get to this resolution point and DOE has more confidence that what they're doing is correct, I think that becomes important and, of course, the involvement of the regulator, as we've learned over the years in our work with NRC in a reactor role, is, in fact, a very useful thing to have.

So much for the procedural things that need to be done. Now comes the substance. As we began to think about making this presentation, and were contemplating what we told DOE in our letters to Jane, we began to realize that we didn't do anything--and this is where we will definitely file some supplemental comments--we didn't do anything to link together what we see linked together, that no one else seems to be seeing.

We believe that in conforming all these regulations to each other, that there needs to be a wholesale rewrite of the way the regulations call for the determinations of suitability, of licensing, even in the EPA standard, and this is drawn from our work in the EPA standard, is that you don't forget about subsystem performance.

You need to know about subsystem performance, obviously. You need to know how fast the ground water

travels and all that sort of stuff, but the test ought not be whether you meet some subsystem performance number if the ground water doesn't travel more than X, or the climate doesn't change more than Y, or you're not within so many yards of the National Park.

I want to know who's going to write a technical report on that. I want to know how much you're going to pay him, because I'm going to do it and become rich and retire. That's an easy one, I hope.

The point is, that if you go to something like a biosphere model, like EPRI has developed--the IMARC Code is an example--where you actually look at real people at a natural site--Yucca Mountain, population in the area in the far future, those sorts of things--you are going to come up with, probably, a more realistic and more defensible idea of how the site is going to perform, and come up with the decision criteria that makes sense, but it goes beyond that.

It not only does that, it also eliminates a lot of the fighting that I heard this morning between and among the different speakers, and questions from--were implied in questions from the Board, the question of uncertainties. The model can be run in such a way that you assess uncertainties early on. I mean, this is nothing new to DOE. I think that they've got plans to do this, but, you know, you don't have to spend, in talking about investment decisions, you don't

have to spend a lot of money analyzing something that the model shows doesn't affect the dose to the average individual in the target population, even if that particular parameter swings wildly over time. I mean, why bother?

You're doing it now because you've got a subsystem performance requirement that says you've got to prove you're within some kind of narrow band, but if you eliminate those requirements and just deal with the overall effect, which related to the conversation that will take place later this afternoon, taking into account both natural and man-made barriers, then you end up with a more realistic view of how a site will perform, and, it becomes a management tool, it becomes a decision tool, it's also a science tool.

We believe this relates very closely to the licensing process, EPA standard, the one that does not apply now is, in fact, total system performance criteria. We think it's going to remain that way. Of course, we don't know what that other NAS panel is going to come out at, but at least, in fact, that you ought to review Part 60.

You're going to revise Part 60 anyway. I mean, the Panel's going to come out with its report, then the EPA's going to do its thing, and the NRC's going to do its thing, DOE's got to--I remember the first meeting, the inaugural meeting of that panel, and I will now give you my view of my interpretation of what happened at that Panel meeting, and

that's why I want everyone to start working on doing this now, and not waiting.

The Panel said, "Okay, we're here to learn." EPA got up and said, "We have a standard. When you guys get your report done, we'll think about it." NRC got up and said, "We have a rule. When you get your report done, and after EPA thinks about it, then we'll let you know." DOE got up there and said, "We have a program. When you get your work done, and after EPA thinks about it, and NRC lets us know, then we'll start the program."

Well, let's get it all done now. I mean, the conversation this morning, Dr. Brewer, was there's a time issue here. Yes, there is. Let's get the job done.

In conclusion--well, my talk wasn't that long, and pretty self-evident--you need to conform Part 60 to statutory framework. We think you need to do some more work under peer review process. We're going to talk with them in another filing. You need to also reflect the changing nature of the site characterization plan in the performance program approach, and then the biosphere model and limitation.

But let me just make another point that is not in any of this, and is really not on point to this Panel. What I can't--representing the industry, primarily utilities, I can't help myself from what I'm going to say. The conversation this morning convinces me even more, you need to

separate what's going to happen in the disposal world from what needs to be done in the reactor world, and the only way you do that is with a centralized interim storage facility someplace, so you can get the fuel off of our sites, where it belongs, and you guys can play all the fun and games you want at Yucca Mountain, and we're not going to stand here and say, "Get it done, because here comes the fuel."

(Laughter.)

MR. KRAFT: Thank you.

DR. ALLEN: Thank you.

Questions from the Board?

(No audible response.)

DR. ALLEN: Questions from the staff?

(No audible response.)

DR. ALLEN: I think we better move on, then, and as I understand it, although Jean Younker is on the program, I think you're going to lead it off, Steve?

DR. BROCOUM: I'm just going to say a few words. Jean is going to make a presentation on a lot of the detail, the more detailed questions the Board has asked us about the kind of information needed, where our uncertainties are, how we're going to get our data in time, and what the schedule is for the next few years, and this is basically a snapshot in time of the stuff that Jean is going to present today.

We're still in the process, as I said, similar to

the caveats I gave this morning about the five-year plan. We're still in the process of, you know, of working out our budgets, working out our schedules, putting the whole thing together, so this is basically work in progress, and we're doing detailed out-year planning, so you'll hear a lot of stuff from Jean today. It can change in the details over the next few months. That's all I want to say.

Jean?

DR. YOUNKER: Good afternoon. I think I'm now hooked up here. I just told Steve Kraft that he's a hard act to follow, because at least he had a little kind of light humor in his discussion with us. I had the image of, "Here comes the fuel." You know, I could just imagine this caricature. It could be a really interesting little "Far Side"-type cartoon on that.

I'm going to use both screens a couple of times during the talk, so I'm just getting myself started so I remember to do that.

The Board proposed a number of topics, and a team of people worked long and hard to try to figure out how they could answer as many as possible in this representation in the time that's allotted. I'm not sure, I think we have about an hour, and I take it I should take the whole time? I assume the whole time is allotted.

DR. ALLEN: Except for what Steve already used.

DR. YOUNKER: Although we're starting late, so I'll try to watch the time.

The Board asked for some comments on what the waste isolation strategy, or I think some people refer to this as a safety concept, now looks like for Yucca Mountain, given all of the things that have been going on. What's the role of thermal loading in that strategy? What are some key technical issues associated with suitability and licensing? And, what significant features, events, and processes could impact suitability, and then, given all of the above, once you've explained that all to me, what are the priorities for analyses and information that flows out of that for the major program milestones.

And, as you might guess, trying to figure out how to pack this into an hour was quite a challenge, and so I think what I'll have to do as I move through this is to hit some high points in certain parts of the presentation, and, as you well know, some of the topics that I'm going to cover in three minutes are either--have been the topic of the whole meeting, or probably will be the topic of the whole meeting, so I think we'll just have to kind of economize on time.

I did ask a few specific people to be here to assist with questions in the areas where I'm certainly not the expert, which is almost everything in this whole presentation, so I will certainly call--hopefully, that will

be acceptable to you, Dr. Allen, to call upon a couple of people who would help with some of the things like schedules for ESF. I know those are topics that you may have more interest in than what I'm going to be able to deliver answers to.

What we put together, then, in terms of an outline is shown on this slide. We're going to tell you what the strategy looked like in the SCP. I know a lot of people keep saying, "We didn't know you had one," and we keep pointing to the SCP and saying, "It was there," you know, "It's in there," and, of course, it's hard to find it. People finally, in fact, internal to some of the organization that supports DOE, recently discovered it, and it was really--it was quite an awakening to see, "My God, it really was there." You know, we really weren't fibbing when we said it was there.

We'll tell you how we think that strategy has to be refined and at least some of the new thinking that needs to be put into perspective, take a look at the strategy and see whether it does need to be changed, and then we'll talk about the key elements or components or the mechanisms of that strategy, walk through every one of them--and this is why I said I'm going to have to kind of hit the high points of what do we know now, what do we see as the key uncertainties, and what's our best plans, or kind of the highlights of our plans

for reducing some of those uncertainties.

And then, given all of that, in the same way I think you tried to lay out in your agenda topics, we'll try to put the priorities, at least in the--I think we have a pretty good explanation and division of our priorities between now and technical site suitability. I think you'll see that most of what I say beyond technical site suitability really still offers our PPA, or PA now, thinking, and doesn't go into much more detail than what you've already heard before, so let me just say that the focus is on our thinking to 1998, with a little bit of additional thought applied beyond that time.

Okay. Now, just to convince you, I know this probably is going to bore some people who were there, in fact, in the time when we gave these briefings, but this little hub down here tells you when the slide was prepared, and we did do some public briefings right after the SCP was issued in January of 1988, and this top-level strategy slide, as well as the two that follow, are taken directly, without change, from those briefings.

The strategy places primary reliance on low flux, slow water movement, and long radionuclide transport times in the unsaturated zone, looking at the low probability, potentially disruptive processes that could have significant impacts. You're going to have to identify and characterize

those, and, finally, move on to pre-closure, the pre-closure component of the overall safety strategy. At that time, our main focus was seismic hazard and seismic design, but we said we'll do the appropriate work to characterize the hazard.

These were the objectives that were stated, and I did give you the reference, in case you want to check me out. Section 8.0, pages four through nine, you'll find these highlighted. These objectives are actually the titles of sections: Engineered barrier system objective, limit release; natural barrier system objective, provide long radionuclide travel times; and pre-closure disposal system objective, obviously, safety is a key, as was pointed out earlier this morning, and that construction doesn't compromise the ability of the facility to meet the other requirements, so you always have a concern, even at this point in time, when we're thinking about the need to think ahead to make sure you didn't do something that could potentially impact later performance.

Okay. This next one is the one that really sums it all up, and I won't go through every detail of it. I'll just point out a couple of items on it, and this--reminding you, once again--this is still from that same briefing, and what we showed in this one was that you could break the overall strategy into the engineered barrier, and the components of that engineered system at that time, in our conceptual

design, for pre-closure as well, and then for the natural barriers of the post-closure system, and the key thing I wanted to point out with this, I think as you read through these, you will find a few places where--and I'll point these out in the next chart--where we've learned something, which you would hope, after the number of years that have passed, that will put this in a slightly different perspective, but as the team that helped me put this presentation together challenged each other on this, we found that it was really quite robust, quite robust, and I think I'll be very interested to see whether the reaction from the audience is similar.

The main thing I want to emphasize here is that within the engineered barrier system, you see listed unsaturated rock/air gap, and one of the concepts which I think was strongly underlying the strategy of 1988, and I think still does today, is that the very setting that we've chosen to look at as a potential repository limits the water available to contact and corrode the canisters. So, even though that's not, in a sense, what we think of in some of our current thinking as an engineered barrier, that whole idea that the low flux setting then allows the engineered system to perform in what we think could be a very advantageous way was a highlight of this strategy as we put it together in pre-1988.

I think the rest of this, if you read the objectives of the components, they will fit right in with what I'm going to continue to say here.

Okay. What about the refinements between 1988 and 1994? Well, I think, very clearly, even early in that time period, or certainly a lot more recently, I think we have increased recognition of some fast flow paths in the site. I think you've heard presentations recently that suggest some pulses penetrate deep. We don't know what percentage of the total transport of water through, percolation flux through the system travels those fast flow paths, and that's clearly going to be a key topic that we're going to have to understand in order for the site to move forward.

The now explicit focus on the contribution that thermal loading could make to system performance is a refinement, I think. It's there in our discussions in the site characterization plan. It's really not a part of the top level strategy, but if you look over in the engineered barrier, the waste package sections of the SCP, we were beginning, at that time, and, certainly, the Livermore people who had contributed to that part of the site characterization plan had begun to think about the potential high value if you really could dry the rock out, use the heat as a part of your engineered system, dry the rock out, and have a predictive capability on how long that would stay dried out that you

could use as a part of your safety case or isolation concept.

So, it's there in the reading, but, now, of course, given a lot of discussions that you've already had with us, and I think we're going to have a meeting this fall, I believe, that will focus on that topic, with you.

Multipurpose canister as a potential waste form is certainly something new since the 1988 strategy was developed. Given that you have the multipurpose canister as a waste form, then you get--you look at your placement options, and of course, we have a reference case for a vertically-emplaced canister in the site characterization plan, and now the in-drift emplacement appears to be, you know, the reasonable mode, at least for the large MPC, and that also gives you some options for what you might do if you want to use enough packing material, pack backfill of sort, or air gap options.

And then, the whole dose-based standard, the remanding of Part 191, and the order for the EPA to go back and develop something that will be dose-based gives us a greater role for the saturated zone. I think many of us suspected that, and you'll find places in the site characterization plan where there are some caveats applied that, you know, with appropriate characterization, the reliance on the saturated zone that was not very high in the original strategy might be something that would give you at

least some additional conservatism.

And then, the consideration now, very recently, and the program approach that is now being implemented is the possibility of an extended, or at least the ability to extend the retrieval period if you decide that that's a prudent thing to do.

All right. One of the--I'm not going to hot topics, I'm not going to say that. One of the topics of this is, I know, is what the perspective is, given this waste isolation, kind of updated strategy from the site characterization plan, how does the approach to thermal management, thermal loading fit into that, and I think the best we can do for you right now is to give you this kind of an explanation, and that is that our plan is to maintain flexibility in the design to allow modifications that could eventually improve system performance.

That means you're going to take the approach, as you would in any good engineering design, identify your key environmental parameters and your design parameters, and then define the envelopes for those key parameters.

That means that when we get to technical site suitability, where will we be with this process? Well, we'll talk a little bit more about what our vision is of what the database will be supporting the technical site suitability evaluation, but from the standpoint of thermal loading, I

think we believe that there will have to be a reference thermal loading based on the current design concepts at that time, and then we'll have to look at sensitivity to the range that's under consideration.

As far as the licensing strategy goes, it continues in the same mode in that you will determine--and, in this case, now, we're really getting into the phase of establishing licensing conditions--the range of conditions over which the designs work. We'll use the performance confirmation, perhaps the extended performance confirmation period if that's chosen to be implemented to show we are within those conditions, and then modify the strategy, as needed, to improve performance as you go through that period. Clearly, you'll be going and negotiating with the regulator and determining if the new information suggests that you can make some changes that will make the system work even better.

Okay. So, in a nutshell, to kind of restate where I think we are--and I think if you look in the five-year plan, the Executive Summary, in fact, I took these words pretty much from that Executive Summary, so it should mirror what you read there, with a lot more words, of course.

The top-level waste isolation strategy. Establish bounds on water contacting the waste packages as the ultimate limit on your non-gaseous releases; develop a long-life waste package that will last at least a thousand years as your key

to your early repository safety arguments.

Then, establish the bounds on waste form dissolution and transport for your plus one thousand year safety arguments or safety case, and then, of course, with the dose-based data, we have to look at the dilution that you will be able to rely on in the aquifer to predict the actual doses.

Okay. Now, this is the part where I said we'll walk through each of the key mechanisms or components of this strategy, and, in many cases, there's a lot that you could say about this--perhaps not me, but other people could say a lot more than I could say, so I'm going to hit a few high points, just refresh your memory, in some cases, of things that you've already heard, talk about the key uncertainties, and then kind of highlight some of the plans for resolving those uncertainties.

So, to break this out into components now, and this is kind of just dissecting that previous strategy, the dry environment around engineered barriers provided by the unsaturated zone is kind of the first component that we'll go through; the robust engineered materials, our evidence for and our uncertainties about dissolution of waste matrix and the solubility of radionuclides, the slow release of them through the engineered barrier, and then the transport through the geosphere.

Okay. Now, at this point, I'll give you something to look at besides words. We've dreamed up a little cross-section for you to think about as I'm walking through these various parts of the strategy.

Just so you have the picture, basically, the low ambient flux is the first one we're going to talk about, the dry environment; then stepping into robust canister, and this one's clearly focused on spent fuel, but we know we have another waste form to deal with; the possible packing material. This is an option that's not--I don't think it's in the reference design thinking at this point, but it's certainly something that hasn't been ruled out, and then, of course, the geosphere.

So, on the dry environment, then, what are a few of the key things about our current understanding that we might not have been able to say in 1988 is kind of the way we looked at this as we prepared, because we didn't want to try to rehash, you know, the whole Chapter 3 of the site characterization plan talks about what we know about the unsaturated zone at Yucca Mountain, or at least a good share of it, so, kind of what have been some key things.

Well, I think one thing that you've heard about and that we think is really important is we're getting a better understanding due to some of Alan Flint's work on the spatial distribution of infiltration rates, and that, I think, starts

to give you an understanding, at least, of your upper bounds, what kind of upper bound you have on infiltration, given changes in climate, given changes in exposure of materials, so that's one that I think we all believe is one that's making some advances in our understanding.

Certainly, some of our unsaturated zone hydrologic modeling has been a basis for and used as part of our total system performance assessment, has helped us to get a better feeling for the importance of exactly how we cast the fracture matrix system. I think we all knew that. We always waved a flag and said, "That's going to be really important," but I think we have hard evidence now of just how important that is.

The old age of matrix groundwater, this one you'll see coming up within this presentation on both sides. It's something we're getting a handle on. It's also something we have some real uncertainties about, because we are getting some mixed signals in terms of the ages of groundwater, and that's what's leading to the point I made earlier about our recognition of the deep pulses.

All right. Moving on with the key uncertainties, some of these tend to kind of focus on the key uncertainties that we hope we'll get at in the near time frame. You'll see a mixture. As I was going through this today, I found that there were a few things I'd left out if I went to the longer

perspective, so don't think that I'm necessarily complete if I'm thinking about the longer time perspective out to 2001 or 2008, but we tried to at least get at some of the things that we know that are key for the technical site suitability.

Similarly, as we get underground, one of the key uncertainties is how much actual seepage, how much inflow will we see? That's going to be a really important piece of information to us in our understanding of that site.

Here is where the age of the water comes up, the young age of some of the deep unsaturated zone groundwaters that we've detected. Another, clearly, a key uncertainty will be the effect on whatever thermal load we finally choose as our reference case for suitability, and, in the future, beyond that, on how flux will be redistributed and how much additional flux you have to then take into account when you do your performance assessment modeling.

I'm sorry I cannot go through every point, but I know if I do, I just won't make it in the time we have, so if I skip one that's a favorite, please feel free to zing me.

Okay. Plans for reducing uncertainties. The continued infiltration monitoring is clearly one that will lead to further understanding in the spatial distribution infiltration. The observations in the ESF, we're doing a fair amount of just sample collection and analysis every time the TBM advances, and that kind of type of chemistry that

we'll be doing, as well as the radial borehole testing that will be going on in the early testing alcove should give us some additional insight very early into the hydrologic system that we really couldn't get any other way.

Looking at variation in matrix saturation, the ESF will be important; behavior of seeps, once again; and the one key area that we're really beginning to focus on is comparing what we see with what we've predicted we would see. That's going on in both the surface-based program, as well as now in the ESF, where using the 3-D geologic models, and looking at, in the case of the surface program, looking at previous borehole saturation profiles, for example. The scientists are now getting very aggressive about predicting, and then testing their understanding by seeing how well they do with those predictions when they can get to them either in another drillhole, or in the ESF, when we get that opportunity.

Some of the long duration thermohydrologic testing in the ESF. Now, this is going over past technical site suitability, because, clearly, we won't have that kind of information at the time the 1998 determination is scheduled.

The hydrogeologic modeling that we're doing and we will continue to do is going to help, I think, reduce uncertainty in terms of how to represent the various processes and the scales of those processes. Probably the most important here is the scaling, and then some lab testing

is going to help out, too, of course.

All right. Let's move to number two, the waste package materials, and those of you who know my background, know that this is not my area. I'm a geologist. I'm very comfortable talking about the geotechnical materials. The engineering part, I probably--I look over at the engineers on the Board and say I'm probably going to misuse some words here, so, you know, just be tolerant with me.

Basically, we've had a really important degradation mode study where the literature has been reviewed to attempt to figure out for the list of candidate materials that we have at this point, what kinds of failure modes or degradation modes have to be looked at, what should we be expected to deal with.

Now, we're moving toward designating the most appropriate materials for both inner and outer barriers. Here are some primary and secondary choices that are under consideration at this point in time, some crack growth studies or corrosion resistant materials underway, giving us some early indications; planned, and I think just barely underway, some thermogravimetric testing of corrosion allowance materials, and I'm not real familiar with this part of it, once again, so if we have questions, we'll just ask the people who are here who can really elaborate; and then some observations that we have kind of coming in from the

reacting mode on cladding life.

One of the key uncertainties clearly comes back to the near-field environment, what kind of near-field environmental range of conditions do we have to design that robust canister to occupy. What will corrosion rates look like under the kind of variable humidity and temperature that the canister will experience? Pitting corrosion is the biggest concern, and what kind of pitting corrosion will we experience with the kinds of corrosion-resistant materials that we're looking at, even to the extent of the zircaloy cladding, and another one that's become very important recently, I guess, with the WIPP experience and with our understanding of what the waters look like in terms of microbial content is the microbiologically-induced corrosion.

And, what will we do about that? Well, on this side, clearly, I think I've already said this, and you're going to start to see a theme here, we'll have to have a range of near-field environments that are within--that fit the information that is available at that time when we go into a technical site suitability evaluation, and at the time of the 2001 construction authorization application.

DR. CANTLON: That's 1998, not '88, isn't it?

DR. YOUNKER: Yes, I think you're right. Sorry for the slip there. I was probably slipping back in time, thinking I was really doing a site characterization plan.

Modeling and testing of pit corrosion processes will be carried out, and we have a little bit of information, I guess, that might be applicable, coming in from analogs where you can look at some iron materials and copper materials that have been in the environment for a long time. The actual applicability to our conditions, I think, is a question to both people who are looking at this, but it still gives us a handle on how materials last in the different environments, and, then, clearly, we're going to have to look at the microbiologically-induced corrosion.

All right. Now, we're at the waste form and the early mobilization step, and we have some spent fuel oxidation and uranium oxide and spent fuel dissolution experiments for a range of possible environments; solubility experiments for a range of possible near-field environments; and some data on glass dissolution and alteration, and this is the area where I think, from talking to the experts in this area, we probably have a ways to go in terms of really getting a broader and more convincing database.

One of the key uncertainties, oxidization state of the spent fuel that would be coming into the system. This whole question of how much of the cladding would be breached, and how much will still be a non-degraded form, such that it will add at least conservatism, even if it's never taken into account as a part of the engineered barrier system, per se,

quantitatively, we certainly suspect that the more we know about it, the better off we are in terms of using that as a conservative, you know, another element of your multiple barrier concept.

Waste form dissolution rates in the presence of limited water, you'll see a theme here all the way through. I think the uncertainty that keeps coming through as you poll the people who are looking at this is, what does that limited water environment that could be very good, what does it do to us in terms of our ability to fully measure the rates at which things will happen, like diffusion, or like dissolution. Obviously, it makes it very hard. It's not new to you, but I'm pointing it out again just to remind where there, because it could be a very good environment, this also makes it a very difficult place to characterize and get the information you need to then do your predictive modeling.

This whole question of waste form colloids, I think, was addressed at one of your previous meetings, as I recall. The question of their existence now is pretty clear, but how stable are they, what will happen to them, you know, over a very short distance from the time they come off the waste form, we really don't have much information yet on that.

And then, of course, some solubilities for neptunium and technetium for the near-field environment, we

have some already, and I think some of the initial ones are going to be helpful, especially under less humid conditions, less water.

Okay. What sort of plans for reducing? Establish conservative but realistic assumptions for cladding performance. I think that's an indication that my sense of talking with people is we're probably not heading for enough focused work in this area to take full credit for the cladding, but we probably are going to be able to get enough of a handle on it to at least use it as a conservative part of our argument.

Waste form dissolution testing; clearly, underway, using the low saturation drip test approach, which I think, once again, illustrates how hard it is to make the kind of measurements you need to make.

As far as waste form dissolution, look for conservative but realistic values. Our total system performance assessment, I think when you heard that presentation, you know that, in this area, we have some concern about whether we were really very realistic in the way we got rid of our waste form.

Colloid investigation strategy, you've heard that presented before, to really focus on the key radionuclides and determine whether colloids play a role in their transport, and then the solubility experiments that we

already mentioned.

Okay. Now, we're up to the engineered barrier system, which is some part of either an air gap, maybe some packing material, and then, presumably, the material down here, assuming that we have the possibility for anything that ever does get out to move down through this material, so, basically, the slow release, current understanding, kind of a theoretical basis for thinking that we probably won't see a lot of inflows into a large opening in an unsaturated material, but you do have the counter argument of, well, yeah, but we do see some fracture flow in some of the tunnels at Rainier Mesa. You've heard that information presented, so, clearly, this one has some uncertainty in it that comes up on the next slide.

Considerations of advective flow through capillary barriers, you've heard discussions about the potential in the unsaturated zone for using capillary barriers as an air gap, per se, as a fundamental part of your system; and then, measurements of diffusion rates in partially saturated media area leading to, I think, some sense that the diffusion rates will be extremely slow. There are uncertainties, of course.

One of the uncertainties that's key is the per cent of waste package surface degraded to expose the waste; as far as the diffusive release goes, potential for continuous liquid film to support diffusive release. If you don't have

that, then you're probably going to have very slow potential for release; and then, of course, our overall strategy and layout for our schematic up here, what does that really look like.

Okay. What are we going to do? We're going to use a range of designs for the 1998 technical site suitability evaluation. We're going to certainly look at seeing how much inflow we have in the ESF, laboratory measurements of diffusion rates. We are looking, will look at whether some kind of packing material like we've schematically shown over here could be used.

You've heard, in the total system performance assessment presentations, that you sure have to be careful about that from the potential of lowering your, or causing your package to overheat, basically, just because if you put something around, maybe if it's just down here, it won't be such a problem, but when you backfill, you know in our modeling results, we caused our packages to get a little warmer than what you would like; and then, sensitivity analysis of a range of drift-scale thermohydrologic models.

Okay. Moving up to the geosphere, what do we understand about it? Well, this one now throws us back to the initial view graph. We talked about spatial distribution of infiltration rates. Clearly, that kind of gives us an upper bound on what's going to happen in the geosphere from

the standpoint of the amount of flux coming through the system, so both of these two you've already heard about. The same thing with understanding the overall flow through the system.

There is some very interesting information put together for the ACNW meeting coming up here, I guess it's next week, that kind of puts all of our data together on groundwater and paleo-groundwater dating, and I think John Stuckless, from USGS, will be making that presentation. It tells a very--I think, begins to be a coherent story about what the flow processes look like, travel times, as well as how high the water table may have ever been in the previous climatic--under previous climatic conditions, and so, I think we're getting some real understanding of that part of the system, it looks to me.

Once again, the laboratory measurements of matrix imbibition and matrix diffusion. You've heard about our measurements of retardation, and then one last one here that becomes important, because we are talking about now being able to adequately characterize the saturated zone, is hydraulic gradients in the saturated zone, and, specifically, you all know the question of the steep gradient, and whether that really has any potential for causing a problem for us, whether it's just a part of the overall system that is just a feature that has a clear explanation. It's going to be

important to us in, I think, the overall credibility of our understanding.

Okay, uncertainties. Once again, thermal loads on percolation flux. How much refluxing, or how much additional flux do we have to take into account, based on the thermal load that we choose.

Young dates for some of the deep unsaturated zone groundwater. This question comes down how much of the total flow through the system could be traveling along those fast paths, and we talked about that in the groundwater travel time discussions that we've had with you all and with the NRC.

Conceptual model of fracture-matrix coupling in partially saturated media; clearly, you all know this is a key, exactly when the fractures will carry fluids given partial saturation.

Effect of long-term transient infiltration rates due to climatic change; response of the system to climatic changes, how much the water table position could change is obviously a key uncertainty, and, as I mentioned, I think that is one that, through some of the work that has been pulled together, I see in this ACNW presentation some real beginning of a really good understanding of the system.

The dispersion caused by heterogeneity in the end, the geosphere that we have to model, and then, once again,

the steep gradient.

Okay. What are we going to do about the uncertainty? Obviously, do as much as we can to understand where the seeps are coming from and how old they are. We have the tracer experiment set up to go. I think at least in '95, certainly by '96 we'll get some good results from that. Sensitivity analysis, once again, of the range of flow and transport models that fit the current information base.

This is one I know you have interest in, the Calico Hills question of how we characterize it, what experiments we do, if we do in situ experiments, whether we do a drilling program is one that we're going to take a very hard look at this year in a systems study. I look at it as kind of a, in a sense, an update of the Calico Hills risk benefit thinking, at least, not the whole report, necessarily, but we need to take a look to see if the answers that we got in that are valid, how they fit into the new way that we're looking at the program.

We do have some boreholes planned to investigate the steep gradient, and then, one thing I didn't put on here, and I added when I was going through this. I think if you look at the broad set of tools we're trying to use to get a handle on future climates, I think it's worthy of mention.

There's really a wide set of things you can do. Some of them are kind of esoteric, from a geologic viewpoint,

but I think we really are closing in, I think, on some packages of tools from the standpoint of the marsh deposits, and looking at the kinds of organisms that inhabit them, you know, looking at modern environments. There's a lot of things we can do there at least to get some better confidence in our bounds on the climate.

To sum this all up, then, in terms of where the key uncertainties seem to be related to the waste isolation strategy safety concept that we've presented to you, it looks to us like there's probably a set, a list like this--and, you know, if you drop down a level, of course, the list expands, but to try to roll it up into something that we could talk about here, it's no surprise to you that we think the percolation flux distribution through repository horizon is one of our key uncertainties. That certainly comes out of our performance assessment modeling, and it comes out of any hydrologic modeling that you would ever see anyone do.

Saturation in and around emplacement drifts, the material degradation and dissolution rate of spent fuel in this low saturation environment, diffusion rates in the low liquid saturation environment; once again, that whole question of how do you get a handle on the rates when you have--your expectations are there will be very little fluid there. Fracture matrix interactions in flow and transport, exactly how we characterize that, and then our dilution

expected in the saturated zone.

There's a few other important things that didn't make it into the strategy discussion in the way that we put it together, so I want to make sure that you knew that we know they're important. We don't really think they're as important as the key uncertainties that we highlighted, but in the pre-closure part of the overall safety of the system, clearly, there's some concerns about how much usable host rock, and how good is--how constructable is that host rock.

We have a major effort going on in our seismic hazards and design basis work with the topic going forth in our interactions with the Nuclear Regulatory Commission on that, and some specific characterization driven from that, much of it already done, but some yet to do.

And then, given the consideration of the extended retrievability period, what kinds of potential rock stability problems do we bring on if we try do that, and that's something that we're just very, very recently getting some handle on, and in that, I might add that I think people do have some concerns about that. We do have to really take a good look at this.

And then you asked about the alternate regulatory criteria, and its impact, and we've already told you everything that we have to say about that in terms of DOE's feedback to the Academy Panel, and so, about the only thing

to remind you here, I guess, is just that, clearly, the time frame is going to be a key part of the answer, and then it leads us back to a need to really get a handle on the dilution that's reasonably expected in the saturated zone.

Okay. Now, given all that, where does it leave us in terms of priorities, and how does that data flow to the key milestones? So, now we're at the shift-over point here to say, what does our program look like.

Okay. If you kind of take a overview look with me for a moment at the testing priorities, and I really, in this part of the talk, I really didn't get a chance to look at the design and I didn't bring in much in the performance side of the program. I really focused in on the site testing priorities, because that seemed to be kind of the thing--the concerns that we saw in your letter kind of focused on how much information about the actual site will you really be able to get your hands on in the time frame before '98, and then again before 2001.

For the surface-based program, I think the strategy that we've used is to use the immediate next year or so to analyze and interpret the recently acquired data, as well as any existing data that had not been looked at adequately. I think that makes a lot of sense, in light of, you know, needing to kind of establish where are we, what is our understand right now?

Use existing holes for pneumatic testing. You know that we've had concerns about whether we need to make sure we're in there learning as much as we possibly can about existing conditions as the large excavation is created to determine if there's anything, you know, what additional information we can learn from that in the site as it's already been drilled and excavated. I think some people have questions about how much value this will have, but we clearly are going to try to do our best to test that question.

We have some other new strategically-placed new boreholes that I'll mention in a later slide before '97 that we'll have available to help us kind of expand our understanding, and I think before the technical site suitability evaluation.

One thing that I think is key is there's been an attempt to really expand the geophysics program in the near term to get a better overall kind of three-dimensional understanding that can be used as a part of that predictive modeling that I talked about before where, with some reflection, lines only run this year across the site, both north/south and east/west. We should then be able to use that to get a little bit better sense of whether, for example, there's any major structures that are buried that we can't see to the west side of the Ghost Dance Fault.

I know that's been a concern because, you know, if

you are not definitely going to be able to excavate over there prior to '98, it sure would be nice to have some good geophysics to look at, at least to give yourself a sense for whether there are any significant structures there.

The post-'97 program, just to kind of expand this out, then shifts over, for the surface program, at least, to really focus on support to ACD and Title 1, and I think to kind of fill in the three-dimensional geologic modeling stratigraphic modeling for the site.

Shift to the ESF for the minute. The pre-1998 tests really focused on geology and hydrology, understanding in those, what, seven testing alcoves that I'll talk about in the next slide. 1997 to 2000, the program then develops the engineering parameters to get you ready for the construction authorization, and post-2000, as we've told you in our discussions of the program approach, we then focus on getting --completed the long duration coupled testing, and getting performance monitoring well underway so that we can feed that information back into the system and try to do some optimization.

Boy, it scares me when I look at one of these where I have all these yellow stickies on it. It probably means that I thought I was going to forget to say a bunch of important stuff, so I better read and see what these are, see if they're important.

All right. What I tried to do here, we had enough information for site suitability to really give you a little bit more detail, I thought, and so we tried to break it out and give you a table that I hope will give you a vision of where we will be in terms of additional information and understanding at the time we go into this key milestone, technical site suitability.

And so, in trying to tabulate that--and I know I've left some things out, and I want to apologize to the people in the audience, because I may have left things out that are equally important to what I have put up here, but let me just say that from the surface-based and laboratory side, it's clear that we will get some information from the C-well tracer complex when they get that rolling. It looks very likely that we'll have the money to drill several of the anomalies in Crater Flat to get a little bit more data on the--to fill in the rate curve for Bruce Crowe's volcanism studies.

The geologic drilling program--and this is, by all means, not set in concrete, but it looks like the plans for this year, at least, we know we'll drill one water table borehole into the area of the steep gradient. That will allow us--that, alone, with a reflection survey that will go up Yucca Wash and cut right across the steep gradient should start to give us an idea of what more we need to do. At

least, we'll do those, take a look at our understanding, see what we come up with, and then there's a possibility in the actual plans, there are four or five more that could be done, given funding, and given the need to do them.

Systematic boreholes, which are part of that systematic drilling program that we laid out in the site characterization plan to kind of systematically establish the stratigraphy and structure, there's a couple of those in the plans, pre-1997, and on the unsaturated boreholes, I think it's about four. Now, these are merged with, as much as we can, the drillholes that are put along the gradient for the south ramp, and so there's some consolidation, as I think you've heard some of our people talk about already, so we're trying to, as much as possible, economize on the total number of drillholes that we are going to invest in.

I mentioned the seismic reflection; very important, I think, from the standpoint of the near-surface structure, shallow, intermediate, lines across the block, probably three east/west and two north/south, and then the one I mentioned in Yucca Wash, and then, also, the long, deep seismic reflection line that runs up across Crater Flat should do a lot to kind of help us gain some confidence in the overall tectonic models, structural models for the area.

The trenches for tectonics and tectonic modeling and seismic hazards, pretty much completed in FY95, and, of

course, in the whole period of time that we're talking about, any new boreholes will do rock properties measurements, so even though we don't get a lot of new in situ thermomechanical data, we will still be getting that from any of the boreholes that are drilled.

Shift to the ESF for a minute. At each of the testing alcoves now, there are seven planned prior to--and maybe I should just go ahead and put that diagram up and point at the ones we're talking about. A little bit later in your package, there's a schematic that shows--numbers these testing alcoves that I'm talking about.

Radial boreholes and hydrochemistry tests in each of these seven testing alcoves, the idea here was to get as much information as we possibly could. This has now expanded. The radial borehole study plan was expanded to include the fault permeability testing, so that in each of these alcoves, we will get information about the chemistry and hydrologic properties to the extent that we can, and they are strategically placed in that they're now, instead of being just spaced along the ramp, they're spaced at where we expect the contact zones to be, so one would be at contact with the non-welded unit, one would be at the top of the Topopah Spring welded, so the placement of these is key to maximizing the amount of information we can get prior to 1997.

Obviously, you know we're going to observe seeps in perched water, if we see any, through the baltic siting. It's somewhat frightening, depending on how much we see it, where it is, and how it behaves. That's going to be a very important part of the ESF facility.

The faults that we'll encounter prior to 1997, we will see the Bow Ridge, clearly, very early. The Drillhole Wash structure we encounter right here. The Sundance, in fact, I think on one diagram that's in your backup, it shows this testing Alcove 6 has been moved back so that it's probably going to be at about the point where the speculation is that the Sundance will cross, come across, so that we get a chance to actually look at the Sundance structure in that testing alcove, presuming that we find it there, and then, of course, the Ghost Dance.

Key to our characterization pre-'98 is getting two testing alcoves over to the Ghost Dance Fault vicinity, such that we can get a better understanding of how that behaves as a potential preferential flow path.

Any time we turn the TBM on, these last three areas of information will go forward in that we'll map--we'll do consolidated sampling and do our geochemistry, mineralogy, petrology on those samples, rock water interactions testing will be going on, as well as the measurement of thermal/mechanical properties, and construction monitoring.

So, there's a lot of information. The main thing in going through this in the detail that I have is to give you the impression that it looks like we will get a fairly extensive body of information into the program prior to the 1997-98 time frame.

Now, moving on past technical site suitability to the 2000/2001, from here on, now, most of what is on these slides is material that you've already seen, in that it's the way we've really talked about prioritizing the program when we presented what was then the PPA to you; set up and do confirmatory hydrogeologic tests in the ESF, looking at the potential for some diffusion tests, get some interim results. We will have started some of the long-duration coupled testing, hopefully, in '96-'97, so we should be able to take a look in 2000 to see where we are and what kinds of information can be extracted.

We'll certainly attempt to bound the thermohydrologic response and we'll have to in order to make the case that we have to make in the construction authorization application; same thing with fracture matrix coupling.

One point I was going to make on this one that I will add, because I think it's of interest, one thing that's under consideration is that once we get over to this point, one important focus might be to put in an alcove over here--

or maybe it's in this alcove, I don't recall--but to start doing some plate-loading tests that would help us to get a little bit better handle on the stability over an extended retrievability period, and so there's some thought, you know, as to what specific testing, but we just aren't far enough along to really give you any more detail on that time period.

Okay. Now, I think from here on, there were in the backup I gave you--

DR. REITER: We don't have the backup.

DR. YOUNKER: Oh, did I skip one? Oh, you're right, I did. Sorry.

And then, going past 2001 to 2008, the priorities here basically confirming your previous information. This is your known, your performance confirmation period for your design, confirm your repository design, hydrogeologic tests in repository drifts, of course, continuing on with any of these long duration tests, but you're really only going to start feeling--beginning to get a sense of the repeatability of your results when you get out into time frames out into the mid-2005 to 2007.

Long-term confirmatory tests, and, hopefully, we'll be gaining increased confidence in the way we're modeling the fracture matrix coupling.

Okay. The rest of this is provided to you because I know you had real interest in the schedule, as it stands,

for ESF excavation, and this one is key to the schematic that I've shown here, and attempts to give you an understanding. Alcove 2 is the Bow Ridge Fault contact. The Alcove 3 is the Paintbrush non-welded contact. Alcove 4, the welded, and then 5, of course, the Drillhole Wash structure, and 6 and 7 are the two Ghost Dance accesses.

DR. REITER: Jean, we don't have that backup in this handout given out today.

DR. YOUNKER: Sorry. It was supposed to be there. I apologize. I'll make sure you have it. It hasn't changed much.

The other thing that's in there is simply a schematic. Is it in any of the materials the audience has?

(Negative response.)

DR. YOUNKER: There's also a schematic that will be available--we'll get copies over here--of the surface-based program that kind of shows the location, not very well, I guess--it didn't come out on the view graph, at least--of some of the drillholes that I was talking about. Let's see, one of the ones, SD-12 is being completed right now, and one that will be important is this SD-7. There's one UZ-7 that will go into the right--to help understand the Ghost Dance Fault.

So, I think there's, I mean, if you look at the program from the surface-based and the ESF's standpoint, roll

it together, and try to get a picture of where we'll be in '97-'98, you know, granted, there may not be a lot of time, but I know your concern is whether we can digest it. You know, we're certainly going to get a chance to look at a lot of underground rock. We're going to get a chance to do a lot more sampling in drillholes, but I know, you know, the question of how you take all this information and digest it is clearly one that's on our mind.

I'm open to questions, and, as I said, I have people here who can help me, I hope.

DR. ALLEN: Okay. Thank you, Jean.

Are there questions from the Board?

DR. CORDING: Ed Cording.

It really does look like you're on the verge of access to a lot of really good quality information, and I think that there's--that the schedule is extremely tight, and the ability to achieve information by a certain date, or to analyze it, I think, is a real question, and it would seem to me that it's not a matter of whether one can get this information. It's just a matter of--it may be a little bit more time than what you have, you know, you're trying to meet a certain date, 1998, for example.

There'll be a lot of information coming in, and whether or not one makes a decision in 1998 or not on site suitability, there will certainly be a lot of more

information useful for site suitability, or whatever you want to describe it as, site suitability and licensing, and it's going to be important to integrate that into the overall picture. Isn't that, I mean, into the--it needs to be continued to be integrated, even immediately following, say, a 1998 decision.

One other thing that concerns me, and I didn't ask a question properly to you yet, but one of the things that does concern me is the ability to achieve the schedules. The schedule that's shown here is actually not a very high rate of advance-type of schedule, and--but even in the last month, a month or so ago, we were--the north ramp extension was being described as part of this pre-1998 schedule, and I think there was a discussion about stopping right after the Item 7 there, after the second Ghost Dance Fault crossing, and then not continuing out before 1998, so I was wondering if the reasoning for dropping the north ramp extension at this point, at least in this presentation here, what is the basis for that?

DR. YOUNKER: Well, I think the plan right now, or my understanding of it--and I will turn to someone else who can give a better answer in a minute--I believe the idea is that the north ramp extension is still in the five-year plan, but probably deferred until after '97-'98, and I think part of the problem is just attempting to squeeze the work that we'd

like to get done into the time that we have, and trying to prioritize. I believe that the--it was the smaller TBM, I guess, that was going to be purchased to do that, and I think that is not in the budget pre-'98 right now, so I think the idea is that when we do that, if we do the north ramp extension, we probably will go to drill and blast.

DR. BROCOUM: Let me make a comment, Jean.

Right now, the north ramp extension is like '98'99 time frame in the five-year plan, and it's only there because of budget constraints, although you don't have the budget numbers in the five-year plan that we handed out today.

We are considering, though, the possibility of purchasing, rather than purchasing a TBM, purchasing a drift, and if it's deemed important, you know, based on all these conversations we're having, that it's more important to do the north ramp extension and continue on beyond Alcove 7, that will be something that will be considered.

As we tried to explain, this is all work in progress, and we haven't locked into the far out things yet. These are the various things we are considering, so--but just to get the five-year plan done had that schedule put in it because of budget constraints.

DR. CANTLON: Jean, could you give us some kind of a feeling for what the process has been or will be of providing the kind of feedback from TSPA back into this process of

prioritizing and planning? I presume that what you've laid out here is a first cut, and that, iteratively, it's going to mature and, essentially, Steve just described one of the possible changes.

To what extent is the TSPA process going to be involved in that changing of these priorities, and I presume the next iteration is '95. Is that going to be moved along and available early enough to feed into your priority setting?

DR. YOUNKER: We certainly hope so. I mean, we have established it such that now, whatever performance, whether-- we have some that we call mini performance assessments. They're not an exercise from the top to the bottom of the pyramid, but they're really a look at one part of the system from a performance assessment modeling perspective, and I think our hope is, every one of those, if there's something to be gleaned that can be fed back in either to the site program, you know, in terms of priorities, to the design program, or to the overall priorities that need to be set programmatically, you know, it's our goal to always have that chapter at the end of the report.

Now, how well we do and how easy it is to connect and result in something that makes a fundamental change in the program is, of course, it's a very difficult question, but it's top on our list of why we're doing these interim

performance assessments.

DR. CANTLON: Well, to press you just a little bit in more detail on that, one of the things that the Board has essentially looked at over the years in working with DOE is the problem that you have of communicating between your various divisions, and is there some kind of management mechanism to bring that really into play in a timely way? Is that a priority?

DR. YOUNKER: It absolutely is a priority, and I guess the only--I tried to think of the ways to communicate. What you have now, I think, is a situation where the people in the site program who have the most direct interfaces, the performance assessment development, meaning they are people that are really working with the process modeling, and who tend to be, you know, toward the modeling end of site, are now identified and talking on a regular basis with the performance assessment team, so that you don't have--I think that the kind of separation that you were aware of in the past, I think, has--we've gone a long ways from that point, partly because, I think, we were looking at a lot of new people in the program--I'm giving a reason now for why there was broader separation--a lot of new people. I think we hadn't identified the people who needed to talk to each other.

Through the TSPAs that have now been done, I think

there's been an awful lot of good interaction, and I see it continuing with my people and performance assessment every day, so I have a lot of confidence it's happening. Whether we've formalized a management mechanism, I guess my gut feeling is the way you make it happen is you get the right technical people talking to each other and sharing information on a regular basis, and getting excited about their work and wanting to talk about it with the people who are going to use some of their work.

DR. CANTLON: Right, and who's responsible for making that happen?

DR. YOUNKER: I think we all are, all the managers in the program.

DR. CANTLON: When everybody's responsible, nobody's responsible.

DR. YOUNKER: No, I mean I manage performance assessment for the M&O, for example, under the Steve, and I'm responsible.

DR. BROCOUM: Performance assessment is in our group under suitability and licensing. We have an opening, by the way, that is posted right now for a team leader, performance assessment, and I'll just say that it's open through October 18th, in case anybody's interested.

DR. YOUNKER: Should anyone be interested.

DR. BROCOUM: What my guidance is to the performance

assessment people is not--don't be--they were doing these biannual, every other year performance assessment is showing us how great the site is, in part, and my guidance was, that wasn't the goal. The goal was to have feedback back to the site characterization program, so Jean, for example, mentioned these mini TSPAs. We're looking for ways to have feedback timely so they can feed to the plan for the following year, and that's one of the issues on performance assessment, so we're trying very hard to make that happen.

Another thing we're doing is last, I guess it was last spring or last February, we had that one-week technical program review. I think it was more or less like a scientific meeting. We are planning a technical program review January 30th through February 4th, I think the dates are, where we're going to focus on the needs in the data--these data--technical data packages for suitability, and what those needs are, and how the principal investigators are feeding into those needs, and that will help bring all the people together about those data packages, as opposed to just a scientific meeting when you have a whole bunch of people telling you what great work they're doing.

So, we're trying to use these kinds of methods to bring the right people together.

DR. ALLEN: We're getting farther and farther behind, but Don Langmuir had a question.

DR. LANGMUIR: I've forgotten which one it was, Jean, but something that came up that's very specific in here, a question, was your--under the summary of key uncertainties on slow transport through the geosphere, you titillated me with young dates for some deep unsaturated zone groundwater, and I have a kind of a preliminary answer to that from a conversation in the hallway, in which I learned that some of the Chlorine-36 dating is now suggesting ages as young as a few--10,000, maybe 20,000 years are coming out of this, some rather young dates for water down to the middle of the unsaturated zone.

DR. YOUNKER: Right; yes. Yeah, that's the information, I think at least some of it is that I've seen in the draft presentation that John Stuckless will be giving, and I think he's beginning to see a fairly coherent pattern when he's taken all the information and put it together, so it's going to give us an additional understanding, I think, of the total groundwater, unsaturated and saturated zone hydrologic systems.

DR. LANGMUIR: Is it beginning to make you more nervous about travel times through the unsat zone? They're getting shorter and shorter all the time.

DR. YOUNKER: I don't--I think I'm nervous if I don't understand them, let me put it that way. I think the more understanding we have, the better off we are.

DR. ALLEN: I think all of us have questions as to why certain things are or are not included on your list, but we could sit here all afternoon and go at this, and I think we'd better get on with it, but, Dennis, do you have a quick question of a general nature?

DR. PRICE: I can do this real quick, and that is: What is the question you're interested in answering regarding the steep gradient? Is it potential pathways to the repository?

DR. YOUNKER: No. The steep gradient, I think the whole question there is just, I think our UZ hydrology peer review, as well as the ESSE peer review both said to us, if you don't have a good credible explanation of it, or at least some understanding of it, your overall understanding of the hydrologic system will be questioned, so it's really just a good, you know, a good enough explanation that we can make it a part of the overall hydrologic system in our presentations.

Because, right now, we kind of tend to not quite know how to explain it. We have a couple of different options. Hypotheses have been presented, and I think we probably are not too concerned. Most of us are not too concerned about its performance implications, but it causes you to feel a little weak in your understanding of the hydrologic system.

DR. ALLEN: Unfortunately, I know there are further questions. I think we've just got to move on to be fair to

the speakers, and also, during the session this afternoon, there'll be some occasion on this, so, Pat, will you permit me?

The next speaker is J. Van Miegroet from Belgium, who will talk about the concept or role of engineered natural barriers in that program.

DR. VAN MIEGROET: I am going to provide you a refreshing intermezzo, if you please, from the meeting. Somebody from your staff was a little bit fearing that people in the audience may not even know where Belgium is, and just asked me to put into some perspective the situation in the country where I am coming from.

So, this is Belgium. Belgium is located in western Europe, about the center of the triangle between Paris, London, and Bonn, so we are really centrally-located, and Belgium is a very small country, 30,000 square kilometers, heavily populated, 10 million inhabitants, best known for its capital, Brussels, which is also the capital of the European Union.

So, the nuclear facilities are only civilian facilities in Belgium. We don't have a military nuclear program. We have been living under the umbrella provided by the United States. These nuclear facilities belong most to the nuclear fuel cycle; namely, seven powerplants, with a total power of 5,500 megawatt electrical, four in the

northern part of the country--you can see that here, which is what is called Doel, three in the southern part of the country, which is called Tihange.

There are also two fuel fabrication facilities at Mol-Dessel, one for uranium fuel, one for plutonium, which means, under the present condition, for MOX fuel. There was even, sometime ago, a pilot reprocessing plant which was called EUROCHEMIC, also located in Mol-Dessel; located, also located in Mol-Dessel.

The nuclear wastes arising from those facilities are of the three classical types, of course; short-lived, low activity, 150,000 cubic meters for the period up to 2050, including decommissioning waste; Type B, long-lived low and medium activity, 25,000 cubic meters, same period; and then Type C, heat-emitting long-lived high activity, 5,000 cubic meters. So, there is, indeed, no comparison with your nuclear waste program.

Before starting my presentation on the underground disposal, I think I better indicate what the project timing is, because this project timing brings with it a lot of differences with this schedule business that your program is heavily connected with.

As you can see, the first time we plan to install the heat-emitting waste in the underground facility is 2050, in the year 2050. The reason for that is that the geologic

medium we are planning to use is not fit to receive heavily heat-emitting waste, so we have to let it cool down for at least 50 years somewhere in the surface, and we are actually serious about it in the sense that we have been building a special facility at Mol-Dessel to store during those 50-plus years the so-called canisters, vitrified canisters coming back from the reprocessing installation in France.

So, this building is being built, and will be brought into operation sometime during next year, and the waste will just be left there for further cool down, so that explains the fairly long-range planning that I have been showing.

Now, how do we go with this geological disposal? First of all, we did select, a fairly long time ago, 15 years ago, should I say, we did select the geological medium into which we plan to install those high-level waste heat-emitting wastes. It was based on the following rationale:

The European Catalogue of geological formations having suitable characteristics for the disposal of solidified HLW and/or long-lived radioactive waste identified in Belgium five formations that could be suitable for such an undertaking; three hardened rocks, and two plastic rocks. The two plastic rocks were Ypresian and Boom clays. Ypresian and Boom are the name, actually, are the name of cities in Belgium where these two clay layers are actually coming to

the surface.

The next step of the rationale was to select one of those five potential rocks. There came along a circumstance or condition; namely, that the Boom clay was present in the underground of the Mol Research Center at adequate depth, with a number of attractive features unequaled by the other media. Those attractive features were, essentially, low permeability, homogeneity, self-healing properties, and low migration velocities for most nuclides.

Going one step further, performance, preliminary performance analyses were carried out in 1986 to '88 under the name of the PAGIS action, with realistic datas on a number of major scenarios, and these come from the medium potentialities. They also quantified the critical importance of several clay properties, mostly the effective thickness of the layer, the diffusion coefficient, and the retardation factor for dose limitation, which is, of course, the ultimate goal of the whole exercise.

These performance analyses also identified--and this is extremely important--that the very efficient confinement provided by the clay layer masks the contributions of the engineered barriers in the systems performance evaluation.

Starting from there, we went out to start defining the most important facility conceptual design features. The

PAGIS findings indicated that it--or recommended to maximize the thickness of the clay barrier available for nuclide retardation. It is keep the mined repository as flat as possible, and, two, minimize the amount and severity of the perturbations imposed to the natural barrier while constructing and operating the repository.

These two major principles have led to a number of design criteria. One, the waste will be disposed of in horizontal galleries. Two, the disposal gallery diameter will be kept at a minimum. Three, the heat-emitting waste, vitrified canister and spent fuel, will only be disposed of several decades after fuel unloading from the reactor, when residual heat generation will be down to a small percentage of its initial value.

Four, minimizing the volume of oxydable materials associated with the waste will restrict gas production and pressure buildup to levels acceptable for the clay layer. Five, the backfill that is needed to bring the gallery to their more or less initial condition, will primarily aim at reducing the disruptions to the clay layer by minimizing the residual void percentage inside the galleries, developing a high degree of chemical compatibility with the geological environment, providing counter-pressure to the gallery wall, thus significantly postponing lining collapse and preventing water vaporization in the backfill.

Moreover, and this is going on at the moment, additional efforts are being made to develop tunneling techniques that would limit the disposal gallery diameter to little more than the waste canister diameter, reducing even more the geomechanical and hydraulic disruption of the clay layer.

So, this is essentially the clay layer as it stands, or lies at Mol in the underground laboratory that has been built there. The distance between the above-ground and the mid-plane of the clay layer is about 230 meters above the clay and under the clay, which is about 90 meter thick, you get a sandy aquifer on both sides.

The repository itself should artistically look like this; heat-emitting waste being separated from the rest of the wastes that need to be disposed of, also, in the geological medium, and then the gallery for heat generating waste would look like this, with the heat generating waste in the middle of the gallery, inside a so-called protecting shroud, which is a thin, but thin means 2 centimeters, about, a thin pipe, which would host the canister and which would also be made to host the fuels in assembly for the case where fuels of assembly, unreprocessed fuels in assembly would have to be disposed of.

So, you can see that to install that thing in the medium, in the clay layer, we have to excavate a fairly large

gallery, 2 meter by 2 meter gallery, that is then supported by a concrete wall, and then we have to backfill the distance, the underlapsed space between the center shroud and this concrete wall.

So, the idea that I have been mentioning a few minutes ago, additional efforts are being made to develop tunneling techniques that would limit the disposal gallery diameter to little more than the waste canister diameter, refers to this, where we would actually excavate, tunnel a gallery which would be only a few centimeters higher in diameter than the needed diameter of the central tube, which would even more reduce the perturbation to the geological medium.

Beyond the criteria that has been developed to satisfy the essential findings of the PAGIS evaluation or performance analysis; namely, keep the mine repository as flat as possible, and minimize the amount and severity of the perturbations.

Several other important criteria have also been developed. Distributing the global repository into at least two areas sheltering, respectively, the heat-producing and the non-heat-producing waste; completing the gallery network, including installation of the central shroud and backfill, before initiating the waste installation phase, thus, totally separating the active and non-active operational phases;

maximizing the thermal conductivity of the backfill; and providing the disposed waste with some degree of retrievability.

The R&D programs have been developed to meet those requirements and to make and to provide to the program the needed information. This R&D program is focusing on, one, the long-term safety demonstration; and, two, the technical feasibility demonstration. We feel that the two aspects must proceed hand-in-hand, because you cannot concentrate yourself forever on demonstrating the safety of the system without getting a sufficiently clear idea of what the system will look like even in some of its technical, and even technological details. So, the two aspects are being pushed simultaneously.

The first of them is this long-term safety demonstration. One, quantification of the clay material properties relevant to the nuclides migration process; small-scale permeability, diffusion, retention, and so on. Detail mapping, using seismic techniques and confirmation boreholes of the local geology in search of the inhomogeneities that might affect the global permeability of the clay. I'm not talking here of the small-scale permeability, but of the global permeability at the scale of the global layer.

Corrosion experiments, investigation, mapping, and modeling of the regional hydrogeology, assessment of gas

production, pressure buildup, and pressure release mechanisms, development and demonstration of backfill additives for trapping hard-to-catch nuclides, identification and development of FEPs and scenarios for performance analysis, development and calibration of the mathematical models used for deterministic and stochastic performance analyses, and, finally, exploration of natural analogues potentialities in a clay environment.

All this is going on. There are contracts, some of them back several years ago to really explore and generate the data that are needed for the further performance analysis, and then from the second aspect, technical feasibility demonstration.

As I say in the paper that you have in front of you, the actual repository is not to be constructed before several decades. It is, thus, likely to take advantage of presently unheard of technological developments. However, demonstrating the technical feasibility with today techniques of several key aspects of its construction and operation, particularly those dealing with unusual equipment or unusual uses of existing equipment, is a necessary step when attempting to build now a realistic and convincing safety case.

Most important those key aspects is selection, fabrication, testing, installation procedure, mathematical

modeling, and so on, of the pre-compacted bentonite-based material that will backfill the annular region; design, construction and testing of a prototype machine that will transport, handle, and emplace the waste canisters and spent fuel subassemblies at their final disposal location; design, construction, and testing of a special micro-tunneling machine that would essentially limit the tunnel excavation to the diameter of the waste-hosting shroud.

So, this is our program of research and development. There are, of course, some concerns which are remaining about some program that we feel we have identified and for which, at the moment, we still don't have any solution of any demonstrated, at least, solution.

The first of them is the inadequate retention performance of the clay barrier for some nuclides; most notably, Iodine-129; large scale permeability of the clay layer. The seismic experiments that I have been mentioning have not been providing, up to now, the answer that we were looking for.

Backfilling and obturation, with the needed effectiveness of the shafts and main galleries in the post-operational phase; buildup and release of gas pressure inside the geological medium; and potentially harmful consequences for the repository of the next major glaciation period.

We fully realize that the depths of the boom clay

in the northern part of Belgium is on the low side, when taking into account the potential problems; erosion, for example, deepening of valleys that may derive, and others that may derive from the glaciation period that is predicted for the next 50,000 or 60,000 years.

That's it. That's about the way the Belgian program is being conducted, is being developed, is being conducted, and the time schedule into which the whole picture is fitting, so I am open to any questions that you may have.

DR. ALLEN: Thank you.

Are there questions from the Board?

DR. CANTLON: Cantlon; Board.

I understand that you have now expanded your program to include disposal of spent fuel, as opposed to vitrified reprocessing waste, and how do you visualize the container? Here you have void space, and so on. Are you planning a filler?

DR. VAN MIEGROET: At the moment, but these things are rather preliminary. We plan to install each individual assembly as it is, without any other reprocessing or pre-reprocessing of any kind into a cylindrical box, filling the void inside the cylindrical box with sand, essentially, and then that will be--that would be the package that then comes forward and we would dispose in the repository.

DR. LANGMUIR: You don't have the kind of regulatory

guidelines assigned to the Belgian program that we have here, obviously. Is the concept of site suitability even something you think about? Is that a concept that you've had to deal with in your program, at least among yourselves?

DR. VAN MIEGROET: The concept of what?

DR. LANGMUIR: Is the site suitable or not? Is that an issue that you've raised?

DR. VAN MIEGROET: Not really. We are, indeed, extremely lucky not to have the type of regulation that you are submitted to. However, and I did not mention that when I was indicating the planning of the whole thing, however, besides building the facility or installing the heat-emitting waste in the year 2050, we have some intermediate deadlines, which means that every ten years, our government is requesting us to supply to them, every ten years, a state of the development of the repository, or of the works that would ultimately lead to the repository.

We have been doing that for the first time in 1987, and we will, thus, do it again in three years from now, two, three years from now, and on these occasions, we have to submit a report, and we did so in '87. We have to submit a report that is being scrutinized by a so-called scientific commission that is being gathered for that purpose by the government authorities, and, thus, inside that body, there are quite a lot of discussion about quite a lot of aspects of

the design we are presenting, including, of course, the site suitability aspect of the thing.

We have been given, in '87, a green light to proceed along the line of the Boom clay layer with a small restriction; namely, that we should not completely forget to investigate, or do at a very much minor level, investigate the other clay layer that I have been mentioning in my paper; namely, the Ypresian layer, which is--which has some characteristics less favorable than the Boom clay layer, the Boom clay, but which has the interesting characteristic, to the contrary, to be deeper in the ground in some places of Belgium.

So, we are doing that, and we plan to present the results of that preliminary investigation aspect in the next report, which is in '97.

DR. BARNARD: Bill Barnard; Board staff.

You mentioned for disposing of the heat-emitting waste, that you're going to be waiting several decades to allow for the fuel to cool off. How long is several decades?

DR. VAN MIEGROET: Several decades means, well, I say that more or less, when you see the planning, the time schedule, you can see that we anticipate to start in storing the so-called heat-emitting waste in the year 2050, which means that for the first canisters that we have available, it will be about six decades at that time.

DR. REITER: Leon Reiter; Board staff.

Mr. Van Miegroet, one of the primary reasons we invited you to make a presentation is because Belgium has such a large reliance on natural barriers, and we can follow in the round table on this.

I wonder if you could tell us, to what extent is this reliance on natural barriers dictated by the fact that you're in clay, and to what extent is this a general philosophical approach in Belgium? For instance, you said you also looked at some hard rocks, some shale, but you've decided to go with the clay instead of the shale.

Was part of that due to the fact that you could build--have a stronger natural barrier in clay?

DR. VAN MIEGROET: I don't think I would say so. The selection between the plastic clay and the non-plastic material, shale, was made at a very early stage, and it was, as I said, rather circumstantial, because one of the two plastic clay layers was actually located--happened to be located under the nuclear research center at Mol.

It turns out that the findings that have been made since then have been, well, confirming the hopes that the people who made that selection, or elected to proceed, so have been confirming the potentialities of that layer, and, thus, having made that selection, and coming to the conclusion that because of the self-healing proprieties, or,

essentially, because of the migration properties, the retention properties, the clay was so good, to the extent that I see it in this PAGIS report, it does not need to be completed, should I say, by other barriers, artificial barriers, except that it needs to be protected.

In other words, the artificial barriers all do play, in our concept, very little role in the total protection of the people, of the population, they are extremely important for, in, as I said, minimizing the perturbation of the main, of the natural barrier, actually.

DR. ALLEN: Thank you very much. I think we simply must move on, but it was very good of you, Dr. Van Miegroet, to visit with us. Thank you.

The final speaker before the round table is Edward Patera of Los Alamos, who will be talking about crystalline rock repositories and the role of engineered barriers, particularly, there; I gather, particularly the Swedish experience.

DR. PATERA: Thank you very much. My name is Ned Patera, and I'm presently with Los Alamos National Laboratory, but I was asked to come and present to you the crystalline rock repository concepts and the role of natural and engineered barriers based on my experience at the OECD's Nuclear Energy Agency, where I was for the last two and a half years. So, we'll get going here.

These are the countries that are considering crystalline rock as a host repository medium for disposal of high-level radioactive waste. Canada, Finland, and Sweden are the ones that are looking just solely at crystalline rock. France, Japan, Spain, and Switzerland are also considering other geologic media, such as clay or salt, and perhaps I should talk in terms of argillaceous material instead of the clay, because we've just heard of the distinction between some of the plastic clays and some of the hard clays.

Now, some of the advantages and the disadvantage of using crystalline rock for a host medium for disposal, one, the hydrology is usually pretty favorable, with the low porosity and low hydraulic conductivity. The chemistry, normally, at repository-type depths is reducing conditions; that is, that the oxidation potentials are very, very low, which help out in the solubility, and also the corrosion resistance of any canister. There's also the sorptive potential of the mineralogy, both the primary mineralogy of the rock itself, and also within the fracture walls.

This should be geomechanical, not geochemical, but crystalline rock, as we all know, is quite solid and is easily mined, and also, since these are not sedimentary units or laid down in, such as the Yucca Mountain, we're not limited to a two-dimensional repository design. It can be

three-dimensional, and this picture illustrates--this is from the NAGRA concept--what a repository layout could look like in a crystalline environment.

You can see--it doesn't really show up too well, but they have used a multi-tiered level of galleries within the system. Now, one of the--also, one of the disadvantages is this occurrence of large-scale fractures that can act as conditions for radionuclide migration. In all the concepts that I know of, what they do is the layout of the galleries themselves are in the solid blocks of rock, and they stay away from any of these large-scale fracture features.

The last advantage that I'd like to mention about crystalline rock is one about human actions, and I mean future human actions, or the human intrusion problem, and, usually, you can find areas of crystalline rock that basically are rather boring, geologically and economically, so that you can reduce the potential for any sort of resource potential that future societies may be going after.

Now, at this point, I'd like to focus in on the Swedish program, and just tell you a little bit about it, and what they're doing, and, also, as you've all heard, I'm sure, that they are using a copper canister as their primary barrier for containment and isolation of their waste, but we'll talk a little bit more about this later.

First, the law. And this, in Sweden, as in other

countries, the law says that whoever operates nuclear powerplants is--has the responsibility of disposing of the wastes in a safe manner, and this is fundamentally different from the United States and it, I think, makes a big difference in terms of the way the Swedish system has been organized.

There are four nuclear power utilities within Sweden. They formed a consortium, first of all, to supply their nuclear fuel to their powerplants. When the law, the stipulation law in 1977 came out in Sweden, that directed them to begin looking at radioactive waste disposal, the utilities passed this consortium that provided the nuclear fuel to the reactors, with the project of looking at how to dispose of spent nuclear fuel within Sweden.

This was the KBS project. That project was completed in 1983, with a report called KBS-III. This came up with the reference Swedish system for the disposal of high-level waste and spent nuclear fuel, and so I wanted to show you a little bit about the SKB system.

What we have here is just pictures of what the whole system looks like within Sweden, up to the geologic disposal. First, they had the transportation system. There's a specially-designed ship which transports the fuel to the reactors by sea, and then it takes all the waste back by sea to their respective places. The low and intermediate

level waste goes to the SFR, which sit there, and this is a mined geologic repository in crystalline rock underneath the Baltic, but at a very shallow depth. It's 50 meters below the sea.

The spent nuclear fuel arrives at the CLAB facility up in the upper right-hand corner, and this is then stored there, and this--it's wet pool storage, and this has been in operation since 1985. This is the facility that Steve Kraft was talking about that provides them with a time buffer, and the capacity of this facility right now can handle half of the nuclear fuel that they expect to have. They have plans to expand it so it can hold all of the spent nuclear fuel within Sweden.

This is where the fuel will remain until it is finally disposed of, and it will be at this place where it will sit and cool for decades; in this case, about 40 to 50 years. Again, this is the Swedish system; where the waste comes from, where it goes to, and then in the final disposal concept, into crystalline rock.

This outlines what SKB isolation strategy is. The multiple barriers concept is basically imbedded in the slide. The stable host environment's provided by the crystalline rock. By stable, I mean tectonically stable, and also stable from any other types of perturbations that naturally occur.

They use a stable barrier material, such as

naturally-occurring clays and copper for the engineered barrier system. They want stable, ambient conditions. This is basically that they want cool conditions within their repository. This is why they let the spent fuel cool at the CLAB facility. I think their reference design temperature is a maximum of 80 degrees C, and, also, they want stable chemical conditions within the repository system, and, again, they are using the multiple barrier system to protect against any unforeseen events, material defects, or design defects.

These are the basic components of the disposal system, starting with the spent fuel. This is then emplaced in a canister, and this is the heart of the disposal concept to contain and isolate all the radionuclides. Originally, the KBS-III project had a thick-walled copper canister. They now are looking at a composite canister, with an inner liner of steel that provides strength, and then the copper outer can, which provides a corrosion barrier.

This is then embedded in highly-compacted bentonite clay, and this bentonite clay is there to protect the copper canister, and also, to limit the egress of any radionuclides later on. All this is placed in crystalline bedrock at approximately 500 meters depth.

Their safety assessment, they look at a variety of scenarios to assess what might happen outside the expected conditions, and this is just sort of a partial picture of

some of the things that they are looking at; changes in the climate, either warmer conditions, or Ice Age conditions. They realize that they are going to have a recurrence of the Ice Age, and what are the effects on the groundwater, and, thus, any changes in those geologic conditions, how would it affect the life of the canister, and any migration of radionuclides.

Also, under other unforeseen events, I think we would look at the human intrusion aspects. I know that they have done analyses with that, looking at those kinds of scenarios.

What I'd like to do is just describe for you what was in the KBS-III Report with regards to what the principal functions of each of these barriers are; in other words, what were the roles of the natural barrier, what's the role of some of the engineered barriers.

The final repository system as a whole has two principal functions. One is a containment period, and it just specifies for a long time, and this is what they consider the first phase. After the first phase, the system is then to provide for dilution of radionuclides by slow release and dispersal through the geosphere.

The canister itself has one principal function; contain the spent fuel for a long period of time, and when we consider what a long period of time is, the SKB right now is

saying that they can pretty much assure the integrity of a copper canister for over one million years, and this, then, prevents any release of radionuclides into the groundwater.

This should say the buffer barrier system, and this is the highly-compacted bentonite clay, and its principal functions are to provide a mechanical and chemical zone of protection around the canister. Once the Swedes had picked the copper as their choice, then their program became very focused. It all became focused on protecting the canister, and this is the primary function of this buffer. It's also to limit the inward transport of any corrosive substances to the canister, and then, finally, in the event of a canister failure, this buffer is to provide for the slow migration of radionuclides that would be leached.

And then, finally, the geologic barrier, the essential properties that they are looking for within a geologic site are the low hydraulic conductivity to limit the total flux of water past the repository system. They're looking for sorptive properties of the fracture surfaces, so that retardation will occur in any migration of any leached radionuclides in the event of a canister breach; and, also, they're looking for the diffusion of dissolved radionuclides into the microfissures within the rock. This is commonly called the matrix diffusion, for a lot of those that know about that.

So, those are the principal functions that they see for not only the engineered system, but also the natural system. Now, I would like to turn attention to the copper canister a little bit, and discuss a little bit what makes this so great. Why can they guarantee, or assure us of a million years' worth of containment?

This is basically rooted in the--I'll start with this Eh/pH diagram, and you'll notice that in the system of copper and water, under certain groundwater conditions, copper metal is a stable solid phase right here. Now, the expected repository conditions, and the one that they used in their latest performance assessment, which was SKB-I, they used a generic research site that they have been looking at, and there the expected conditions, or, actually the measured conditions is an Eh of about 7, and an Eh of between -200 millivolts and -300 millivolts, so that puts you right in this field here.

Now, as I said, this is where copper is thermodynamically stable and would sit there as happy as can be forever. However, the fly in the ointment is that the groundwater is not pure water, and so we need to look at a more complex Eh/pH diagram which shows the system of copper, carbon as carbonate in the groundwater, sulfur and sulfide and water, and in this case, we can see that the repository conditions, the stable, solid phases would be copper sulfide.

So, the question becomes, do we have sulfide in the groundwater, and, if so, how much corrosion would we expect from that amount of sulfur? Now, these Eh/pH diagrams are drawn based on a slice of concentration. In other words, if we reduce the amount of sulfur within this system--and I'm talking sulfide, not sulfate at this point--then the stability field of copper would begin to grow until you remove all the sulfur and you're back to this more pure system where copper metal is stable.

So, again, by using these fundamentals principles that are in elementary textbooks, the Swedes have been able to focus their whole program, not only geologic program, but their laboratory testing, on these fundamental issues; basically, protect the copper canister, and look for a site where the sulfur content is quite low.

Normally, in groundwaters you don't find very much sulfide. You do find sulfate, and a lot of debate has gone on about can you reduce the sulfate to sulfide, and then have copper corrosion. So, this is how they target their laboratory work.

In the site characterization field, what they do is they have developed techniques for measuring in situ Eh. This is very important to them. They need to find places where they can count on the reducing environment, and so they have developed special probes for that.

Now, the methods to prove the corrosion resistance for copper, for the copper canister, as I mentioned, laboratory corrosion tests, but these can only be conducted for maybe up to a few years. The extrapolation, then, of any of that information out to a million years would be propagation of the uncertainty within the experiments, would be almost meaningless.

So, what the SKB did is they embarked upon a program of looking at other ways of getting a handle on the corrosion rates of copper, and they've done several things. One is to measure the corrosion from modern applications of copper, and here they've looked at copper electrodes that have been implanted in the ground. These are basically in oxidizing conditions, but they've looked at this anyway, and determined corrosion rates for these. The span of time is on the order of maybe 100 years for this. Again, given the uncertainties in the measurements, and not knowing exactly the initial conditions, the propagation of uncertainties will be pretty tremendous out in a million years.

So, they go on and they look at the corrosion of historic and prehistoric copper-based artifacts, and these can give you information on the order of 100 to, say, 5,000 years. There are copper artifacts, and, also, bronze artifacts that have been around for a long time, and they can actually get a very--not a very, but a fairly good estimate

of the general corrosion rates based on the markings that have been initiated on these artifacts.

And then, lastly, is a study of naturally-occurring native copper ore deposits, and these are known worldwide, and they have been known to be in equilibrium with host rock settings for literally millions of years, and it's through this kind of coordinated study, on looking at the corrosion of copper, that they have been able to take credit for about a million years' worth of containment, with a high degree of confidence in their canister.

I just wanted to show you, this is one of the examples of a natural analog that SKB has looked at. This is a copper cannon that has been imbedded in the sea floor since the 17th century, so this is one of these historic artifacts that I was mentioning, and this is a very good demonstration for the public. They can put their hands on it. They can see this. They understand it, and it helps build confidence within the public.

So, the conclusions about copper as a chemistry material is that the long-lived and robust engineered barriers, especially copper, provide a high degree of confidence that radionuclides can be contained within a geologic disposal system, and this high degree of confidence can be shared by not only scientists, but engineers, politicians, and the public at large.

I have a second part of the talk that I was asked to give at this point, and this is basically a quick summary of what some of the other national programs are doing within the OECD. I can go through it very quickly, in the order of saving some time. As a matter of fact, there is Belgium, but we've already heard from our colleague here, and he gave us a very nice presentation on that, so we'll move on quickly.

Canada. Canada is going to dispose of CANDU spent fuel. They're looking at a crystalline rock environment. Their canister materials are titanium alloy as their primary one, with copper as a backup. The buffer material is a bentonite and sand mixture, and, right now, the AECL has finished their research and development phase on the concept of geologic disposal in crystalline bedrock, and they have written an EIS which is now out for review. There's been a special panel formed within Canada to look at this and review it, and make recommendations within the next few years as to what the next step in Canada will be with regards to waste management.

Finland. Finland has cooperated tremendously with Sweden, and their concept is basically identical to the SKB project that I showed you earlier, and, again, it's all the same. Right now, TVO, which is the utility that is charged with responsibility of disposing of the waste has selected five sites to characterize, and this process was a voluntary

process. They had gone out and looked for communities that were willing to take on the responsibility of having them characterize sites, and it's worked out very well. They intend to select one site for detailed site characterization sometime in the year about 2000.

France. The waste form is high-level waste in borosilicate glass, which they developed. The geologic media that they're looking at right now is, again, I'll say argillaceous rock, and also crystalline, The canister is a stainless steel canister that houses the vitrified waste, with a carbon steel overpack. I don't know if they have--are figuring on a buffer or not. Right now, the French law has mandated three areas of research for waste management:

One is the geologic disposal concept. The law says that ANDRA, which is the agency responsible, should site two underground research laboratories to do research in. If this is to be--if any of these sites are to be turned into repository sites, the National Assembly of France will have to pass a new law that actually says this. In France, it's only research and development.

The other two areas of research are transmutation and partitioning of radionuclides, and the third one is simply long-term storage of the waste material.

As I said, four sites have been selected, three in the argillaceous media and one in the crystalline

environment, and, again, this was done on a voluntary siting basis.

Germany. The waste form is vitrified high-level waste, and now there's a possibility that there will be direct disposal of spent fuel within the German concept. Right now, the geologic medium is the Salt Dome at Gorleben. It utilizes thick wall cast iron canister, and because it's salt, there is no buffer material. Right now, there is a lot of discussion about what will be done in Germany with regards to the whole nuclear power program, and also, waste management. There is a possibility that the Gorleben site will be abandoned as a political tradeoff for some other parts of the nuclear program, and Germany has just recently begun cooperating on research programs within the OECD on both crystalline and argillaceous formations.

Italy. There is no program for disposal of high-level radioactive waste in Italy. Right now, the spent fuel is sitting at reactor sites.

Japan will also reprocess their waste and have vitrified high-level waste. They're considering many different rock types right now. They are in a research phase. They are investigating a thick wall steel overpack, very similar to the one that's being utilized by NAGRA in Switzerland, and also, consistent with the NAGRA approach, they're looking at highly-compacted bentonite as a buffer

material. Right now, there's been a steering committee that has been formed that is to look at the whole waste management disposal project and come up with policies, and also responsibilities of different organizations, and I don't know when they're actually going to come to any decisions.

Korea. There is no program for disposable high-level nuclear waste. They will have away from reactor--and this is supposed to be interim storage, not interior storage, although I suppose it'll be inside. They're going to go with a wet-type storage facility, and this is to be constructed by 1997.

DR. CANTLON: This is South Korea?

DR. PATERA: This is South Korea, yes. You can read in the paper about North Korea.

Okay. The Netherlands. The Netherlands have just recently abandoned their research into the disposal of vitrified high-level waste in rock salt, and will now proceed with long-term storage.

Spain also has a high-level, vitrified high-level waste form. They are considering several media; salt, argillaceous rock, and also crystalline rock. Their reference canister and buffer system is a carbon steel overpack and a bentonite clay, but this has only been developed at a crystalline site, and the others haven't--they don't have other designs for the other media yet. They have

a siting process going on right now. Basically, it's to look at favorable attributes of these different geologic areas, and this is to be completed by the end of the year.

Sweden, I'll just go right to the status. They have a volunteer siting process underway. They want to enter what they call their demonstration phase, which is to build an encapsulation facility for spent fuel in the canisters, and this would be constructed near the CLAB facility in Oskarshamm that I showed, and then they would begin the construction of a repository on a limited basis, and a limited amount of spent fuel would be emplaced for a demonstration phase.

Switzerland. Reprocessing of their waste also provides them with a vitrified waste form. They're looking at both crystalline and clay formations. They're using a very thick steel overpack, and highly-compacted bentonite to form their long-lived waste package. They're currently assessing both the crystalline and clay formations; however, NAGRA's main emphasis right now is on the development of their low and intermediate level waste repository.

United Kingdom. Disposal program for high-level waste has been deferred while Nirex concentrates on the development of a low and intermediate level waste repository at the Sellafield site.

And, for completeness, here's the United States, so

that's all I have, and I would be happy to answer any questions, either now, or after the--

DR. ALLEN: Thank you very much.

Any questions? Don Langmuir?

DR. LANGMUIR: Obviously, the Swedes are trying to maximize the role of the waste package in the EBS in isolating the nuclear materials. Just for curiosity, and I think my numbers may need some help from you, the costs of the most expensive planned containment that's out there, apparently, the copper canister in Sweden, I look at our program, and if the numbers are approximately right, I figure it's going to cost us $70,000 a ton to put our waste in the repository.

If you factor in the cost of the Swedish canister, what's it costing per ton for the Swedish program to put their waste in a repository?

DR. PATERA: I don't know the actual cost, but I know that what part of the law stated, that the whole Swedish geologic disposal system has to be indigenous, and, therefore, they have to have the capabilities and the materials within Sweden to do all of this, and their reference canister from KBS-III, which, as you know, is a very thick-walled canister, and also backfilled, or filled with copper. They looked at that, and the amount of copper that they'd need, which was for about, I think it's 8500

metric ton fuel, amounted to less than 3 per cent of the Swedish copper production, annual production.

DR. LANGMUIR: But the cost per ton, you don't have any idea what that is?

DR. PATERA: No, I don't. I remember, when I was in the crystalline program, I did a very quick calculation based on our own crystalline program, using the Swedish concept, using 70,000 metric tons, and, as I remember, I came up with a cost of about $600 million for the waste packages, and that included fabrication testing, and all that. It was based on a carbon steel. I just substituted the cost of materials for copper into iron, so I don't think it's out of the realm of possibility within the United States to use copper at all, especially considering, you know, if you look at it in perspective to the amounts of money we're spending in other areas of--

DR. ALLEN: Particularly if we put it in Arizona.

(Laughter.)

DR. ALLEN: Other questions from the Board?

(No audible response.)

DR. ALLEN: Well, thank you very much, and let me thank all the speakers up to this time.

We will now have a recess for fifteen minutes, until 3:35. Garry Brewer, do you have anything you want to say at this time, or--

DR. BREWER: I'll wait.

DR. ALLEN: We'll reconvene in 15 minutes.

(Whereupon, a brief recess was taken.)

ROUNDTABLE DISCUSSION

DR. BREWER: This is the final part of the program and, as Clarence Allen said much earlier, strong opinions have been expressed over the relationship between engineered and natural barriers; in particular, the extent to which engineered barriers can be used to offset deficiencies in the natural ones. Jean Younker gave us some idea of the functions of these different barriers in the DOE's Yucca Mountain waste isolation strategy in her presentation this afternoon. We've also heard a summary, a very good summary, of the way it's done in other countries with the experience of using the natural barriers almost entirely to engineered. The Board itself has made some limited comments in this area. We've continually urged the DOE to devote more effort to the development of robust waste packages, and we view the threat of earthquake ground motion as distinct from fault displacement as being for design and construction in terms of it's problematic than one of site suitability.

Okay. The topic for this roundtable this afternoon is engineered and natural barriers; the role they can play, the role they should play, how they fit within the assessment of site suitability, and ultimately the thing that we're all

here for, what's the tradeoff when you're talking about building a safe repository. We have numerous questions that, in principle, we could get to and probably will cover some segment of them in the course of the discussion here.

To remind a few of you who have not seen or participated in the roundtable format that the Board has adopted here within the last year, basically we try to get the discussion started by cuing on individuals who have made presentations earlier in the day. The idea is often to get summary comments, to clarify, or to elicit differences of viewpoint and opinion. We will do that. I'm prepared to invite representatives from the DOE, the NRC, and the State of Nevada to make initial presentations of about five minutes apiece and in that order. After that, basically what happens--and, it's a wonderful thing to watch--people start asking each other questions and one thing leads to another, rather like parts of the day today. We get away from the flip charts and the canned presentations. We have serious discussion among serious people about a real hard problem. And, I think the Board has been really satisfied with the roundtable format, even though it comes typically, as it does today, at the end of a long day with a lot of material. It has been a positive thing in our view.

I would like to begin the session--oh, and by the way, I'm the ringmaster. So, I will point to people and try

to keep the conversation going. I've got a few questions that I've thought of and a few that our staff has thought of. We, typically, never get to that point because of the kinds of conversations that get started. But, I'm ready in case things sort of flag. We're scheduled to go until about 5:30. That was the original agenda. We're getting a little bit of a late start. Clarence Allen says that his summary comments will be terse; will be thank you, goodbye, I think something on that order, right, Clarence? Okay. We will always leave time at the end of the session for public comment for anyone who wants to do that and I'm prepared for 15 or 20 minutes at the end; so, we'll work back. And, about an hour and a half for the roundtable in round numbers.

Okay. I'd like to start quick self-introductions, and we can start over here; just your name, rank, and serial number, and basically kind of who you represent, please.

MR. CLARKE: Okay. I'm Bill Clarke, the technical-- officer for Livermore National Laboratory.

DR. BREWER: Thanks, Bill.

DR. STEINDLER: Martin Steindler, currently chairman of the Advisory Committee on Nuclear Waste to the NRC.

DR. BREWER: Thank you.

MR. BINGHAM: I'm Felton Bingham from Sandia National Labs, formerly connected with the Yucca Mountain Project, but no more.

DR. KNAPP: Malcolm Knapp, Nuclear Regulatory Commission, director of the waste management division.

DR. BREWER: Thank you, Malcolm.

DR. CANEPA: Julie Canepa, Los Alamos National Laboratory, technical project officer.

DR. BREWER: Thank you, Julie.

DR. ROSEBOOM: Gene Roseboom. I'm now retired from the USGS three weeks ago and in an Emeritus status.

MR. MAGAVERN: Bill Magavern, the director of Public Citizens Critical Mass Energy Project in Washington.

DR. BREWER: Thanks, Bill.

DR. WHIPPLE: Chris Whipple, chairman of the National Research Council's Board on Radioactive Waste Management.

MR. FRISHMAN: Steve Frishman, the Nevada Agency for Nuclear Projects.

MR. CURTISS: Jim Curtiss with the Washington, D.C. law firm of Winston and Strawn.

DR. MIEGROET: J. Van Miegroet, Belgium.

DR. BROCOUM: Steve Brocoum, assistant manager to Licensing, Yucca Mountain Project.

DR. PATERA: Ned Patera with Los Alamos National Laboratory.

DR. YOUNKER: Jean Younker with TRW, the M&O, and Regulatory Licensing Manager.

MR. KRAFT: Steven Kraft, Nuclear Energy Institute.

DR. COTTON: Tom Cotton with JK Research Associates and I'm on the senior staff of the M&O.

DR. BREWER: Okay. We know who the players are.

I'd like to start by inviting Steve Brocoum to spend about five minutes; a short summary of DOE's views on engineered and natural barriers.

I am reminded here that when you take a moment to be sure that you speak into the microphone because everything here is being recorded, it just takes an extra second. And, identify yourselves; that's another thing that's often a problem because poor Scott Ford, our long-suffering keeper of the minutes, doesn't know who you are and he's sitting there. So, identify yourself and speak into the microphone.

DR. BROCOUM: Some of these, I will put on the table. Earlier, you had me associated with TRW. I am not getting three paychecks.

What insight can we get from the regulation? I assume Mal Knapp is going to tell us the requirements of the regulation. I just wanted to make a couple of comments here that we get out of part 60 that I may not have said. In 60.102, during the first several hundred years when radiation and thermal levels are high and certainties are large, special emphasis is placed upon the ability to contain the waste with an engineered barrier system; several hundred years. Following the containment period, special emphasis is

placed on the characteristics of a geologic repository. The engineered barrier system works to control the release. The geologic setting works to control release to the accessible environment; out of 60. Later on, the design of any engineered barrier shall contribute to the containment and isolation of radionuclides. Also, later on, engineered barriers shall be designed to assist the geologic setting in meeting the performance objectives for the period following permanent closure. That's some of the insights.

The NRC staff when they were wrestling on public comments to the proposed rule in their NUREG 0804 had a lot of discussion on uncertainties with the engineered barrier system, uncertainties with the natural barrier system, and they pointed out that having multiple barriers, defense-in-depth, will help compensate if there's unanticipated events or processes that you haven't either characterized or understood. They had a quote there, a summary quote: "Hence, confidence in the geologic record compensates for the uncertainty in the survivability of engineering; while confidence and containment for initial period compensates for uncertainty in geochemical retardation."

A couple of comments. In our view and in our new proposed approach, confidence in the system performance is gained by early reliance on the safety of the engineered components. High confidence in site performance during

operation is based on demonstrations of retrieval, criticality control, and the robust long-life waste canister. As we said, we may not have as much information as we planned to have at the end of site--originally, with the site characterization plan. So, we will continue the performance confirmation to reduce uncertainty as we collect more information even beyond the license application. That will help us increase understanding about performance of a system on the basis of a performance confirmation results, help us maybe to reduce the uncertainties. We hope to maintain the flexibility to improve performance of the overall repository and the confirmation by perhaps changing the thermal loading or making other changes before we close it. The natural barriers, in addition to the engineered barriers, provide the defense-in-depth by, shifting focus in the long time period to geologic processes, low-flux, slow releases, long travel times, potential retardation along flow paths.

We've tried to capture this concept in a diagram, as always. During the operational phase, we will depend on retrievability, criticality control, robust canisters. We have to understand these very well. That's why we are going to have a Title 2 design for the canister. After the operational phase and beyond the containment phase, we have to depend on gradual releases, subsystem requirements, and the natural barriers. So, the defense-in-depth concept is

kind of putting this all together, a little more reliability of this in the earlier time frames, reliability on the whole thing, and increasing reliability on this in the longer out-time periods, whatever those time periods may end up being; now, 10,000 years.

That's basically my five minutes.

DR. BREWER: Okay. Thank you, Steve. There's five minutes on engineered and natural barriers from DOE.

We'd like to turn next to Malcolm Knapp to get a view from the NRC and then we're going to follow that with five minutes of Steve Frishman from Nevada.

DR. KNAPP: First, I'd like to thank Steve Brocoum for enabling me to cut my talk to three minutes.

One or two philosophical thoughts that go back to the initial development of 10 CFR 60. As Steve has said, our interest in multiple barriers at that time was to increase our confidence that the repository would remain robust in the face of unforeseen events. That if the geologic system failed for reasons we didn't understand, we would have reliance on the engineered system and vice-versa. I note that those thoughts occurred before our experience with Hubble, Voyager, and Challenger. I'm sorry to say that we foresaw that sort of problem. I wish they had not happened. I also note that we had a philosophy that engineered barriers were not to be used to compensate for an otherwise

unacceptable site.

Very briefly, the nature of the barriers--perhaps most of interest today, a 300,000 year waste package, 1,000 year groundwater travel time--what we had in mind was that these barriers would serve during some of the initial years, say, approximately, 1,000, over which we would have a substantial reduction in the toxicity of the waste and, as we saw it at the time, a substantial reduction in the thermal pulse as a result of emplacement of the waste.

In particular, with respect to the groundwater travel time, we had in mind a simple, we thought at the time, measure of the performance of the geologic setting, one which was a measure, not a prediction. It was our expectation that by measuring such things as permeability, porosity, head, age dating, that we would be able to get an estimate of groundwater travel time now rather than have to predict performance far into the future based on the result of accelerated tests.

A couple of other items concerning Part 60, it does recognize the need for flexibility. The rule does give the commissioners an opportunity to select some other, for example, groundwater travel time, given the right basis. This flexibility was included, in part, because we knew then that we would be smarter today than we were and, frankly, I expect we will be smarter in 2001 than we are today. It was

also included, in part, as a recognition that if we had a groundwater travel time of, say, slightly less than 1,000 years, yet otherwise we were entirely satisfied with the performance of the repository, we did not want an opportunity to overturn the process on what could amount to a technicality.

That's something of the history of how we came up with the barriers. Today, I think we feel as we did then. Certainly, with respect to the numbers in the barriers and conceivably the barriers themselves, my interest is in insuring that we do have some sort of protection from both the engineered system and the geologic setting. If there are other more workable ideas which would accomplish the same goal, I'm certainly prepared to consider them and, if they seem to make more sense than what we have, I'm prepared to suggest that the commissioners themselves consider them. Candidly, since I've been with the program, I've heard concerns about some of the barriers raised, but I have not seen viable alternatives across my desk. That doesn't mean they're not out there; I just haven't seen them yet.

DR. BREWER: Thank you very much.

Steve Frishman from Nevada?

MR. FRISHMAN: I think there's value in remembering the reasoning as related by Mal.

We have an expectation that was created by the

Nuclear Waste Policy Act and also a long history behind that expectation that led to the concept of essentially the adoption of geologic disposal as the national policy. And, that expectation shows up in the Waste Policy Act in the statement that I read this morning from 112(a) referring to geology being primary and the factors that qualify and disqualify a site. In the guidelines, themselves, there's a reiteration of that. Engineered barriers shall be designed to compliment natural barriers which provide the primary means for waste isolation. There was acknowledgement at the time of the writing of the guidelines that the Waste Policy Act was serious.

In the NRC's concurrence proceeding on the guidelines, the idea of not compensating for adverse characteristics of a site with engineered barriers became something of an issue and it wasn't until, I think, a second or third meeting that that issue really came to a head. The states, I think, unanimously insisted that that issue had to be dealt with. I think it was primarily Commissioner Asselstine who managed to get the language finally into the concurrence understanding. And, at the time, you can try to--well, you can try to discount it in the guidelines because it's spoken to in reference to when you're making comparisons among sites. But, that was only, I think, misfortune and ignorance on our part that in 1987 the whole

world would change on us. I don't think that there's anything special about whether you compare sites based on engineering barriers or whether you talk about engineered barriers at a single site.

The promise in the Waste Policy Act really goes at least back to the great gathering in 1957 looking at geologic disposal and whether geologic disposal is even reasonable to think about. At that time, I don't--I haven't recently searched the proceedings, but I don't recall a lot of discussion in what I have read of all of that about engineered barriers. The question was can we gain confidence in geology? And, the answer was maybe. I'm not sure that we progressed very much beyond that when the '82 Act was written. We may be better and we may be worse now, but the debate that's going on is making me wonder about the years past when I believe geologic disposal was possible. And, the reason I'm wondering about it is because I see it coming up as an issue not because of geologic disposal as being the policy in this country, but because we have a site that causes some particular problems and having to deal with it and it looks to me like sort of another way out.

Now, in the long-term, the engineered barrier really doesn't mean anything, anyway. When we're looking very long-term, if we're trying to really isolate these wastes over the very long-term from the environment, because

for the period of time of some of the way out bad actors, there's no way, at all, that you can rely on an engineered barrier; things like neptunium.

So, now, in the short-term we're looking at it and I can understand the reasons for a very short-term trying to assure the safety; you know, even at a time when you may find it necessary to go back and do something with that waste that you emplace. But, we have to remember 10,000 years is artificial. We also have to remember that 1,000 years is essentially arbitrary. It's as good a number as any, probably. But, we also should not be in the position of looking at these arbitrary numbers of years and doing what the Department has asked the NRC to do and the NRC has agreed to do now, which is to give credit for a container beyond 1,000 years. And, that again, I see as a function of the site and problems with trying to have the confidence that you understand the geology and the site and I, for one, being a geologist, am not going to be interested in trading confidence for or lack of confidence for our knowledge of a particularly complicated site, trading that for some engineer telling me I can fix it and you'd better believe me.

DR. BREWER: Okay. Thank you, Steve.

In my role as ringmaster--this is moderator--I think I'd like to start the discussion and try to really follow directly on Steve's points. I'm going to ask both

Marty and Chris Whipple from their positions of having actually commented, thought about, written, taken public positions on this issue to really address Steve's observations or comments.

Chris, do you want to start?

DR. WHIPPLE: Okay. Let me go off on two digressions and I'll come back to Steve's comments as kind of a closeout.

First, I'm sorry to talk to everybody from the back of my head. I hope the glare isn't too bad.

DR. BREWER: You get used to it.

DR. WHIPPLE: I'm used to it.

All right. Second, also a brief comment. I apologize I wasn't able to be here this morning when the role of the National Academy and the site suitability work was discussed. I'm not too sorry I wasn't here, but nonetheless a quick comment there just to tell you what I think we're going to be doing is doing technical reviews of documents. We will not be assessing the site suitability. That is somewhere else that whole collection of reviews the Academy will have done will have to be knitted together. And, under those terms, I think what we propose to do is doable.

All right. Back to the question of engineered barriers and I really want to attack this from my own angle because I'm an engineer and I think engineers have a perspective on this that's different from the regulatory one

and that's what I want to start with. My view is that engineered barriers can do four things for you. First is they can delay the time to which the waste package starts leaking and that's a time that you get to add to the travel time to the environment. The second thing they can do is if they're cleverly constructed, they can reduce the release rate from the waste packages once they start leaking. A third thing they can do is they can prolong the time in which retrieval is comparatively easy and I emphasize "comparatively" and make retrieval safer if future societies decide that that's something they want to do. And, I frankly think that's a reasonably likely prospect for a repository that someday somebody will say let's go get that stuff and it wouldn't be all bad if we made that something safer. The fourth thing it can do for you comes out of my own experience in working with chemical hazards and contamination. The track record of the last half century has been that we're going back and fixing a lot of things that were done to the state-of-the-art of their time. The possibility that we may want to remediate a repository some time in the next few thousand years is not something that we should be so arrogant to dismiss. The longer we can keep the waste tightly contained in manageable packages, so that the people who are possibly a lot better at such things than we are 1,000 years from now can get in and patch up our work, I think again

that's a responsible thing to take on and I think that's a real clear role for engineered barrier.

Back quickly to the first thing I mentioned about the time considerations, you can think of that in time constants. In round numbers, a Yucca Mountain repository would have a gas pathway on the order of 100 years, give or take 95 maybe. It would have a groundwater pathway on the order of maybe 100 times that, maybe 10,000 years, give or take. You can compare that to the potential life of package designs and to the lifetime of the isotopes you need to contain. When I do that, it occurs to me that the short life stuff, the 30 year fission products, the americium, are not problems under any circumstances. They just can't move fast enough to become a problem. Carbon-14 is a fascinating case. It occupies much of my days which I think is why the NAS has asked to go look at the waste standard. But, on the order of a 5,000 year half-life and the short travel time, I think it's technically feasible to contain Carbon-14 until it goes away and I think there's not been a whole lot of serious debate on that particular problem. And then, as you look at the groundwater side, you then move out into a bunch of 2x10 to the somethings, 25,000 years for plutonium, 200,000 for technetium, 2 million for neptunium, 20 million for iodine-129. And, even the most ardent engineer gets discouraged when presented with those kind of numbers, but there is a

point to try to look at those benefits. As I say, I think the points I made about retrievability and the capacity to remediate are things to not be lost.

Now, finally, to return to the last question and that's the issue of engineered barriers and its role in site suitability evaluation, I think this is a substantially ideal demonstration of the mischief that happens when you apply criteria developed for site selection to the question of engineering design. And, we're talking about engineered barriers as a design problem and, there, the notion that you can't fix a bad site by good engineering, it just falls on its head. I mean, it would be irresponsible to do engineering that wasn't as clever as you could make it. Quite separate from whatever logic that rule had in the days of trying to winnow down and throw out the lousy sites and end up with the good sites, I think that the time has passed for that idea and that I think the depressing aspect of how the engineering design is being used here came in this afternoon's session in which Jean's presentation defined long-term canisters as 1,000 years and Ned described it as a million years. I think we're got our sights set in the mud, and we need to think more ambitiously and cleverly about what we can do.

DR. BREWER: Thank you very much.

Marty, you in the past have had views and I'm sure

you do still. Marty Steindler?

DR. STEINDLER: I think I'm constrained to give you a legal statement that says that the Advisory Committee on Nuclear Waste has not formally taken up this issue. Therefore, what you hear is largely my own speculation.

DR. BREWER: That's what I asked.

DR. STEINDLER: Having said all that, I guess I'm free to speculate at random.

DR. BREWER: That's what you're asked to do, yes, sir.

DR. STEINDLER: Let me focus entirely on the issue of tradeoffs and simply give you a number of statements and see whether they make any sense.

First off, it's my contention that the focus of a licensing process is the protection of the health and safety of the public. All other things are substantially trivial. From there, I move to Part 960 and I look at 960 and it's basically silent on the engineered barrier system with a couple of very minor exceptions that really have nothing to do with the statement, "may you or may you not exercise tradeoff?"

I move from there to some commentary on Part 60 and I look at 60 and it also, of course, doesn't say anything about tradeoffs. On the other hand, it also doesn't say anything about performance allocation and allows whoever is going to be making decisions to pick their own performance

allocation between the engineered barrier system and the geology. There are a whole bunch of places where that kind of thing applies which we can dig out of the regulations. But, most important, I think, there are a sufficient number of places in the regulations--one assumes they were carefully worded by Mal and company some years ago--which clearly indicate that the two factors, geology and the engineered barrier system, are to work in concert in some fashion or another that certainly allows you to look at the question of who does what or which particular facet of protection is exercised by those.

Let me go back then to the general notion of the regulation and I trust it's going to come out this way, although we've had experience in which it is not; that is, presumably, the new regulation should be based on some kind of risk standard. The EPA approach is to set generally applicable standards on the basis of risk and one assumes then if that nice, but at the moment not palatable to everybody, notion is followed, then the NRC's bottom line is somehow to identify what has to be done in order to get to a particular level of risk. Well, if Part 60 does not forbid exchanging some aspect of the engineered barrier performance for some aspect of the relatively unsatisfactory function of the geology and if we continue to address the issue in terms of the regulations at the 10,000 year mark rather than to

begin to extrapolate this to infinity, then it seems reasonable that there is some certain flexibility in that general performance apportionment in that 10,000 year time frame that's allowed. So, what is required? The Part 60 requirements are the three subsystem criteria. The 1,000 year groundwater travel time which at some other forum I will tell you, I think, is a now long outdated and powerfully unjustifiable subsystem criterion. The one part in the 10^5 which is probably useful and can easily be met by engineering, and I'll get to Steve's distrust of engineers in a second. And then, of course, the substantially complete containment for 300 or 1,000 years; at least the short-life folks have gone away by that time. And, there's this minor problem of the 50 year retrievability which is being artificially escalated to 100 years under the somewhat mistaken notion that you can get solid, additional geology data in that small 50 year period.

So, you know, as far as the geology is concerned, Part 60 calls for some kind of an appropriate combination together with the engineered barrier system. All of that, you know, drives me to the conclusion that, within reason, I see no particular technical justification for the rigorous adherence to the requirements of defense-in-depth to the point where we're currently doing it. If the bottom line--and, I think that's the key, the key caveat--is adherence to

some kind of a process that involves quantification of uncertainties, the thing that concerns me about the current PPA approach is whether or not they will be able to quantify uncertainties sufficiently in their current model development based on bounding assumptions and that an evaluatable product is going to come out.

My final comment is about Steve's concern that he isn't going to believe the engineers. I think if he lives long enough and I don't think any of us will--all of us in this roundtable probably will not--we are certainly going to have to be at least mildly convinced by some engineering estimates whether we're geologists or engineers.

DR. BREWER: Thank you, Marty. Thank you very much.

I think I would like to ask an engineer what he thinks. I'm thinking about Bill Clarke.

MR. CLARKE: Can I use one viewgraph?

DR. BREWER: One viewgraph, all right.

MR. CLARKE: And then, I'll sit down with it.

DR. BREWER: And then, you sit down with it, right.

While he's getting ready with his viewgraph, the whole business of safety and so on, I want to come to Jim Curtiss and get your views next.

MR. CLARKE: One of my concerns throughout this program in the five years that I've been around is I don't think that most of us have sat back and looked in any detail of the

tortuous path that that water has got to go through to get into that fuel and back out into the environment again. If you take a look at the natural system, the uncertainty of the engineered system originates there and that's in the water contact mode. It's going to be extremely--to us in our modeling or whatever we do as to how much and what the quality of that water is and how it gets to the waste packages. If it gets in in the reflux mode and forms a continuous film, then we have all kinds of problems and things associated with microbiological corrosion, et cetera, et cetera. If it's a water drip, that's a different situation because now we've got probabilities of how many waste packages are under that particular drip and on and on, and is that drip enough to eventually fill a 5 foot by 18 foot long container because that's the only way I can think of to get through all those barriers and ooze that stuff back out onto the ground again. The other way, of course, would be some incredible event. And, incredible in my mind is that it may, in fact, flood a drift. Now, we have an immersion problem and all of the corrosion phenomena that we're concerned about comes into play.

But, look at what we've got to do. We've got to get the natural system water mobilized. We've got to get it through some kind of a drift spacing if that's what we use or a packing if that's what we eventually get to. We've got to

get it through multi-layer waste containers. We've got to now, even though we may not take credit for it because it's not the right material, we've got to get it through an MPC wall. Fuel cladding--and, we can spend a whole day talking about that--but it's going to have to get through that. It's not all going to be filled. There's going to be just a small percentage. And, now, it's got to interact with the radionuclides or the fuel and that has now got to travel back out through that hole again.

Now, in a nuclear reactor, you have a driver. You have 1,000 or greater PSI pressure driving that back out through those cracks. Even when that happens, it's generally a very slow weeping process before guillotine fracture and I don't know of any that's really happened that way. So, we don't have that here and we're going to have a very difficult time getting that back out. And, even to mirror what Steve has said, it's the process in that and when you slow things down. I--slow things down for a very, very long period of time that certainly is going to help the Carbon-14 issue because there's a temperature effect. The temperature will decay. It's certainly going to help many other aspects of the controlled release. Everything there, by the way, is an additive of release rates for each one of those components. And so, my opinion, obviously being an engineer, is to say once we get out to B, we've got problems. Let's keep it in A

as long as we possibly can, and I think that we can do that.

DR. BREWER: Thank you, Bill.

I'm going to take this out of order. I'm reminded that it's probably time for the public to speak and I wanted Bill Magavern to really follow up directly after that if you care to.

MR. MAGAVERN: Yeah. I think that you have to consider that citizens have seen that the promises that have been made by and on behalf of the nuclear industry have been largely unfulfilled starting with too cheap to meter and going through waste dumps that leaked and partial core meltdown at Three Mile Island which we've been told couldn't happen because of defense-in-depth. And so, I think that people are going to look with a lot of skepticism at the promises of containment. I think that the promise of the Nuclear Waste Policy Act in 1982 was to find the best possible site, not to find a site that had a lot of problems and make up for it with engineering. The theme of today is site suitability and it seems to me that once you deem a site suitable, of course, you want to use whatever engineering you can to make it as safe as possible. But, first, you have to decide whether the site is suitable and I don't think that reliance on engineering can make up for deficiencies in the site.

DR. BREWER: Okay. Thank you very much.

Now, Jim Curtiss was for a time a commissioner of

the NRC and had to deal with this sort of routinely. Jim, I'd like to hear your view?

MR. CURTISS: Let me just preface my remarks by saying I can't take responsibility for Part 60 when it was originally promulgated. I didn't go back that far. But, let me key off of Marty Steindler's remarks and touch just briefly on what Bill Magavern has said because I largely share the views that Marty has expressed.

It's clear that, as a legal matter, the statute and the regulations permit reliance on both the geologic medium and engineered barriers. I happen to view the regulations in 10 CFR Part 60 as a little bit more restrictive in terms of the tradeoffs that Marty spoke about and he described, and in fact, I think unless one resorts to the exemption procedure that Mal Knapp referred to which I think is going to be a difficult thing to do in the midst of a licensing proceeding, it's difficult to depart from what's in the subsystem performance criteria. But, the larger question, it seems to me, as we get down to this question of evaluating the relative relationship of a repository, the geologic medium, and the engineered barriers, is the tradeoff question and in the abstract I find that a very difficult question to evaluate absent some sense of what the overall performance measure--what Marty called the risk issue--clearly articulated is. My own personal view is that I don't think

we have that in 10 CFR Part 60 in the subsystem performance criteria. Beyond the qualitatively robust system that Mal Knapp referred to, one is hard put, I think, to define what the safety objective is of 10 CFR Part 60's subsystem performance criteria.

Secondly, it's in my view not the case today that those subsystem performance criteria are related in any direct way--what I've referred to previously as the nexus between the subsystem performance criteria and the EPA standards--and absent that overall sense of the performance objective of the repository, what the man and woman in the street are going to expect when we get to actually building this facility. It's very difficult in my view to draw the tradeoffs question or to address the tradeoffs question unless you've done that.

Now, let me pick up on a remark that Steve Kraft made earlier. In my view, the way to address that in the process that we're going about today as a result of the National Academy review and the ultimate promulgation of the EPA standards and the NRC regulations is to address clearly in the EPA standards what that safety objective will be and I assume that will happen. And then, perhaps more difficultly and Mal referred to this, define the relationship between the standard and the agency's implementing regulations that, in turn, will permit us to say what that objective is. And,

once we've done that, in my view, you'll be able to cast the tradeoff question in a more clear light.

DR. BREWER: Very good.

I wanted to turn next to Tom Cotton to really follow up on the question of tradeoffs and, after that, I wanted to go to Felton Bingham for--take the discussion to TSPA. I think that's kind of the logic of it here.

DR. COTTON: Okay. I'll just make a couple of observations on the tradeoff question. First is I'm not--it's pretty clear what tradeoffs between engineering and site fixtures mean when you're comparing sites. I can say, well, look, I could go with this site with this engineering and get this kind of performance. I could pick another site that maybe has less attractive features, but allows me to do a better engineering, maybe a copper canister, or something that will last for a very long time. It's not so clear what tradeoffs mean when you're talking about a particular site in deciding whether it is okay for a repository. The site is what it is. You're not trading off something about the site. I think what you are trading off is what Steve raised which we have to think about and that is are you trading off some level of understanding, an acquisition of more data about the site versus possibly putting more emphasis on engineering to compensate for uncertainties. But, you're not actually trading off features. I mean, the site is what it is.

If I go back and look at the guidelines, you know, Steve, you said that while they focused on comparisons, it also--and said you shouldn't use engineering to compensate for a bad site--that that also applies for suitability of a single site. But, even if you go back an look at the guidelines and the language that was approved by the Commission, even there it's not quite as black and white as that. It says that the comparative evaluations between sites would be done twice. Once, de-emphasizing the engineered barriers and emphasizing the natural barriers; and then, another comparison of performance, it takes full credit for the performance of the barriers and that when you make a selection among sites that the--and, comparison based on the performance of the natural barriers would take precedence unless the second comparison which took into account the performance of engineering made a significant difference. In which case, you would give equal weight to both comparisons. So, even in the guidelines, it's not quite as clear that there's just a blanket prohibition saying you can't really take credit for the performance of the engineered barriers, even at the site selection stage.

DR. BREWER: Anyone care to follow up on that?

Felton?

MR. BINGHAM: Leon suggested that since I was formerly tainted with performance assessment, I should try to report a

little on what the latest things in performance assessment are doing. And, since I'm sufficiently removed from them now to be sufficiently ignorant, I can be believed when I say something about it. I hope that what I have to say would be supported by the people who did them.

When I look at those performance assessments, I feel like I ought to remind everybody that when you talk about them, you're talking about parameters; kind of individual parameters and what the uncertainties in them are and how they depend on each other. I think Chris Whipple's little review of what gets out when and what time frames relieves me of the necessity to say a lot of the things that the latest performance assessments are showing because they are showing those things that are almost common sense.

It appears, for example, that under some conditions that are not inconsistent with the data about the way water moves through the Yucca Mountain site, there really isn't any need for containment except for the Carbon-14 problem, the one that keeps Chris Whipple awake at night. Under other conditions that are also consistent, it looks as though containers may play a more significant role than in addition to just holding in the Carbon-14 until things have gotten better. They could contribute to the kind of lengthening of time before the radionuclides start their travel outside, something else that Chris mentioned. But, when I thought

about that, it reminded me of what I thought about in the early '80s when there seemed to be becoming a lot more clamor, a lot more voices in the world talking about engineered barriers. I wasn't around in 1957--or I was around, but I wasn't much worried about radionuclide--I think we were mostly just delighted World War III hadn't started yet. But, at that time, the idea seemed to be that the geologic formation itself was the container. And, we all proceeded along that line. I remember hearing people saying things like what do you need a package for except to get it to the site until towards the late '70s and early '80s when Part 60 seemed to bring them up and everybody seemed to be taking a good deal more interest in them.

So, the thing that bothered us then and still bothers me now is how much uncertainty reduction will it take for a regulator to feel a state of reasonable assurance about engineered materials? Nature has done the million year experiment for us and that's what led the Academy in '57 to suggest that a can might be a geologic formation. Now, nature didn't have the subpart G QA program going during this experiment.

So, it's hard to be sure exactly what lessons to draw from. But, I think the hope has always been that when hydrologists, geologists, geophysicists, and all the folks of those stripes get together and argue long enough, they can

finally decide whether that can is going to work. But, when I think about experiments in corrosion and those are among the parameters that the latest performance assessments are identifying, when I think about the way you measure them--say, a five year experiment and I've measured a weight and I picture an access with weight on the Y and time on the X, and now I try to draw a dot from the origin to that point and then extrapolate it out for 5,000 years--what will a regulator, a reasonable person, say about my extrapolation? I think the regulator will probably feel justified in saying I believe you better be awfully conservative about that extrapolation you just did. If you really become very conservative in the role of engineered barriers in reducing uncertainties and giving assurance, it becomes a lot less than what I think we ought to hope it could be.

Is that enough?

DR. BREWER: Oh, that's wonderful.

I'm about to ask the people who have been or are related to the regulators your take on what Felton just had to say. Malcolm?

DR. KNAPP: First, what I had was that I share the concern about how you would extrapolate, say, five years to 1,000. Back when I was doing something a little more technical and a little less bureaucratic for a living, I worried a lot about fluid/solid interactions. And, after

spending several years studying them, I decided I didn't understand them and I wasn't about to understand them. That what I could say was I could come up with some models which gave me an intuitive comfort that I described what was going on and I could manage to select coefficients that happened to fit the data, but--and, of course, this was back in the Dark Ages; that is to say the early '70s--without some of the gadgets we have today. But, I didn't have enough information to be able to say that's really what's going on. I could simply say I have an intuitive model which fits the data that I have and that made me a little nervous about extrapolation.

And so, I would follow with what Felton has said. I will want to see if either--I think we will either ask that people be very conservative or give me high confidence that we actually truly understand mechanistically what's going on, and I'll be interested in seeing that demonstration.

DR. BREWER: I'm going to ask Julie--because it's your job to convince him that you know what's going on--to comment, to follow up on the line of discussion here.

DR. CANEPA: Someone spoke earlier about tradeoffs and whether tradeoffs were a reasonable topic of discussion if we're not comparing sites and we're not selecting. And, I think, at least in the last year or so, in developing the proposed program approach, I think we've dealt with that issue and I think many of us thought we really were involved

in tradeoffs and I think you've been alluding to the issues here today talking about suitability and the engineered barrier system.

In essence, when we began the proposed program approach and we were dealing with some of the data collection and the modeling, say, that Livermore was doing with the hot repository concepts, we started to deal with that issue. And, I don't know if it's a real issue of tradeoffs, but all of a sudden, it started to perturb our world and we had to deal with it. I think the issues that--in listening to Bill and trying to continue a focused and directed characterization program that truly is addressing suitability and we don't lose sight of that, I think reasonable designs on the EBS are obviously critical for our evaluation of a reasonable suitability data set that would support or not support, I guess, a suitability decision. Bill mentioned, you know, basically, the uncertainty is the water contact and that's the uncertainty no matter what your thermal load is. It's currently the uncertainty on our system is water direction and water contact. And, basically, what he said and what we've learned is that current SCP designs, maybe that was the worst load, so to speak, that you had to deal with. So, we know that we have to look at the mountain under a very low load, but you're trying to control the water movement and water contact; or a very high thermal load

because you're trying to control the water contact. Now, for the geologists and chemists involved, it's important for us to determine essentially what is the perturbation of that natural system. And, almost more than just what the specific perturbation is, how much perturbation can the system handle and what the bounds on those perturbations are.

Now, you get into the difficulties of a couple processes. How much data do you really need to know in order to bound that perturbations to the system? I still maintain the greatest uncertainty in the system is your hydrology and that's really the perturbation that you're going to be--that you have to focus on regardless of the thermal stability. But, we certainly know, you know, the years, they're immaterial to us, the geochemists. We know exactly what nuclides we're supposed to be looking at. We know full well it's selenium, technetium, neptunium, plutonium, uranium. Regardless of your engineered barrier system, regardless of whether it's 1,000 year, 10,000, or 100,000 years, we know that's what it is.

So, we can handle--it's not unusual. We can handle the perturbations of the system in looking at the geochemistry. I think we're still within the bounds, but I worry very much that we are going to be locked into a very, very full, complete understanding of a couple processes and having a really secure, confident thermodynamic database in a

very short time period. I don't think anybody is sitting at this table that believes that that's really going to happen. I still believe you can make progress towards a suitability decision even without that.

DR. BREWER: Around the panel, anyone care to follow up on Julie's comments about the availability of data and the capacity to do the work? Anyone like to take that one on? Steve?

MR. KRAFT: Well, not to comment directly on the specific data set that Julie talked about because I'm not familiar with it, but let me just comment generally.

It may very well be that there is a data set that you can--because you can do it, you can do it out to 10^5, 10^6 years. But, unless you take that data, apply some expert judgment as to how it might work in the system, and run it through some kind of models I was talking about earlier to assess the effect on real people in a real population because when you get to B, that's only the edge of the accessible environment. I want to know what goes on beyond B, as well, to that radionuclide.

The point being that you may very well learn in all the modeling that more investment in developing the data set doesn't matter because it doesn't affect the answer one way or the other, good or bad. Some radionuclides are going to just float through and get out into the environment and

you're going to have to look at natural processes because that's the nature of the radionuclide, and some will be retarded in the manmade structures or in the natural structures and never get out. And, more data isn't going to change your knowledge on that. So, forget it and go on to the next one.

DR. BREWER: Chris, did you want to follow up? Chris Whipple?

DR. WHIPPLE: I want to comment on the general flow here and what I've been hearing.

It seems that there's kind of a steady stream since 1957 of a view that the engineering is very short-lived in comparison to geology, that we've moved through the period in which Part 60 said it may be true, but you've got to look at engineering anywhere. But, that was widely interpreted at the time to say, but we also limit the credit you can take for engineering. I know Bob Bernero clarified what was meant there, but it had a lasting effect that 1,000 years is all you get for engineering was the perception for while.

Similar views, such as Steve's talk today, which is we don't want to give you credit for fixing fundamental flaws in the site anyway. But have all that to a perception, as I understand it by the TRB and certainly by the NAS board in its rethinking on the high level waste report, that we've under-invested in work on the engineering side. And then, to

mess everything up, the Swedes come along and claim a million year package and can make a damn good case for it. And, I thought Ned's talk, in which he pointed out really the four kinds of evidence starting with corrosion rates and then going out looking at old ships and metal laying around and then older artifacts and then finally natural deposits of minerals, walked up a chain of evidence in which the short-term corrosion measurement case was clearly recognized as the most tenuous. And, extrapolation from that was indeed weak, but there were other principles of evidence, his Eh/pH tables, for example, that could give you higher confidence.

Now, I guess my observation through all this is that somehow in our effort to be conservative here, we've set high hurdles for accepting evidence regarding the capabilities of engineering systems to augment the performance of the geology. And, what we've perversely come up with is a disincentive to do any work in the field. I think that's the issue that TRB ought to try to address is how do we remove the disincentive that has since 1957 been felt by the program to do engineering work since it doesn't appear that they can get much credit for it.

DR. BREWER: To speak on the TRB's behalf, I think we have been nudging the subject along and trying to be constructive. At least, it's been mentioned in the last three reports that I have had a chance to read and

participate in. Ellis Verink is sitting there smiling and shaking his head yes, so I know I'm right.

Anyone else want to follow on the general point? It's a good one, I think; it's important.

MR. CLARKE: I want to get back to one of Felton's comments and he's absolutely right; trying to extrapolate to a long time is a very difficult process. But, I want to remind you that several years ago we faced the same problem in the nuclear industry. And, I remember that in the boiling water reactor business, we launched off on a 10 year effort to develop models to predict first time to failures and nuclear--and most of that work was done at Schenectady in the research facility there. And, after 10 years, they came up with a model based on all the mechanistic studies that we can do in that period of time which it very, very accurately now predicts first time to failure in a BWR plan. And, of course, they've gone to many, many mitigation processes to try to eliminate that and, in fact, we've gotten buy offs from the NRC to allow plants to continue running with cracks in them through a mid-cycle inspection which saved them a lot of money. Now, that's obviously only for a 40 year period, but in this case if we understand the processes, if we can develop the models, and one of the comments I made to Steve Brocoum when the plan was first introduced to the staff several months ago was that if we then could monitor those

packages in an open drift for 100 years and there's nothing wrong with another 10 years or whatever, then I think that we would have more confidence in making at least the substantially complete containment period with a much, much higher confidence than we had several years ago in the nuclear industry.

DR. BREWER: Anyone care to follow up on that? Bill, I think that's appropriate.

MR. MAGAVERN: Well, listening to some of the optimism about engineering, I just think that if we take that to a logical extreme, then it raises the question of if we can make packages that are so good, then why do we want to bury them, particularly given the importance of retrievability that Chris Whipple talked about?

DR. BREWER: Well, there's the question. Why do we want to bury them?

MR. KRAFT: I don't--why? I don't want to bury them. Certainly not within the first couple of hundred years, I'll know that it's necessary. I think that there are--there may be political and aesthetic reasons. There's probably no technical reason. The industry argued for many years that there was a technical reason to begin disposal, but that had little to do with the safety of the spent fuel. The most violent environment spent fuel ever sees or fuel ever sees is in the reactor itself; high pressure, high flow, large energy

content. The second probably most potential violent environment that it sees is in the transport accident. I mean, I don't mean to be flippant about it, but I think you can take spent fuel and put it in a paper bag underground for 100 years and not violate anybody's standard except worker exposure. And, Felton made an interesting point about the early versions, early vision of what the package was for was really for handling and exposure. I, at one time early-on in my misspent career, I was on the ANSI 14.9 subcommittee and I was sitting at the table when we went from low level waste being disposed of in the ground in the package only for transport to the package being part of the disposal, and now you're at high integrity containers and all sorts of stuff. The point I'm trying to get at is that you don't necessarily have to do it, you don't necessarily have to bury it for the first 100 or 200 years. I think what you have to do and I think this came out in the Blanchard-Issacs report from last year or the year before--last year; I think what you have to do, I think, is make the commitments to generations that says we're going to keep on trying to figure out what to do in terms of ultimate disposal while we protect this stuff on the site or maybe underground in some storage facility, but not to dispose of it right away because there are things we need to learn.

DR. BREWER: Okay. I've got a followup from Tom and I

wanted to follow that. I'm wanting to think about it. Ned, in talking about how the Swedes get away with putting it all in a pool, just think about that. But, Tom next?

DR. COTTON: Just a quick response to Bill Magavern. And, that is I don't think anyone is claiming that the packages are so good that you can just sit them on the surface and leave them alone. I think that the idea, even with the Swedish one, is that you need a nice, stable, benign environment which the site provides. So, it really is a-- and, even though they're emphasizing the life of the canister, the site and those chemical conditions are what you need in order to make the long life argument. So, even in those cases, there is an interaction between the need for a stable underground site and the canister.

DR. BREWER: Ned, your sort of take on the Swedes and why they're able to do what they're doing with it for 100 or however many years they're going to stick it in the pools?

DR. PATERA: Yeah. The CLAB facility was built to bring the waste to a storage facility and let it cool off prior to disposing of it. They have plans for expanding it, as I said, to all the spent fuel date are going to have, but they don't claim that they're going to store it forever. They want to have disposal, but gee, you know, after what Steve said, I think that what we see happening in a trend internationally is more discussion about long-term storage.

We see the case in the Netherlands where their environmental policy basically claimed that they had to have infinite retrieval for a geologic disposal. They said this is ridiculous in a salt environment; we'll just store it on the surface. We see the same thing in Korea, we see the same thing in Italy which is at reactor storage at the moment. The French are studying this also. Perhaps, it's time to open up the debate, whether geologic disposal really is the preferred method or whether long-term storage is the way to pass on to the next generation of a more responsible solution.

DR. BREWER: Gene Roseboom has thought about this and talked about it. Go after it, sir, if you would?

DR. ROSEBOOM: All of the sites that we've been talking about and other countries are, of course, saturated zones. And, in disposing in a saturated zone site, you have to try to reduce the amount of ground--you're going to be in a tunnel that is filled with groundwater and you have to try to reduce the rate of contact of such water with the waste. In an unsaturated zone site, we are simply largely dealing with drip water and perhaps some rapid flow of water down particular faults or fissure systems that hopefully, once we have explored the site, we can avoid. Furthermore, in an unsaturated zone site, we do not have to--because of this, we do not have to backfill and seal everything up forever. And,

I think there is a great value in trying to maintain long-term retrievability.

One of the arguments that I keep seeing in recent articles against mine geologic disposal is the fact that we are doing something that's irreversible and, therefore, it's much safer to leave it on the surface. Well, I would question what the certainties are with regard to society over the next 100 years or longer. We clearly facing a lot of problems in the next century and there's considerable literature on this subject.

DR. BREWER: Thank you very much.

I think, unless there's an immediate followup by one of the panel members, I think we've probably reached the point where it might be useful to turn to the DOE members of the panel who have been amazingly silent to just get your general--except for the opening comments from Steve--to get your general take on the things that are coming out of this roundtable; the idea of revisiting geologic disposal, the idea of tradeoffs, the idea of being citizens being able to cover up a lousy site with good engineering for a long period of time, to put it in the technical vernacular.

Steve, do you want to go first?

DR. BROCOUM: I'll make a couple of comments. I think the concept that disposal came along, the philosophy that

accompanied it, the generation that created the problem should be the generation to souse it. I think that philosophy is kind of imbedded in our program and in the Nuclear Waste Policy Act. One can make rational arguments for keeping it on the surface for a period of time, but I think the time the Act was passed, the thinking was solve the problem and remove it from the biosphere. I think Tom Cotton made the point very nicely about the Swedish program; that, again, it's a systems approach and it's underground and, regardless of whether you have a million/a billion year life, a billion year package or not, they're just having it 1500 feet under the ground, I think it was--500 meters--adds a margin of safety even if you cannot quantify it.

Let me make a comment--two comments I want to make and I would like to take my DOE hat off for a few minutes if I can to make these comments. First, let's talk a little bit about mitigating a bad site by engineering. Let's think about that. What makes a good or a bad site? Let's put 960 and 60 aside. Let's take the example of Ghost Dance Fault. Let's look at the Ghost Dance Fault. One could say, oh, geez, we have a fault in the middle of the site. That makes it a bad site. Let's assume water flows along that fault. Well, that fault drains, if you like, the site. I can see an engineering design where a fault that drains the site might --you might make a design so that is an advantage. In other

words, you're draining water away from the waste packages down this fault. Now, is that mitigating for a bad site or is that a good feature of that particular site? There's a lot of philosophical questions one can ask about features like this. So, in my own mind, I find it very difficult to talk about individual feature as good or bad. And, when you use engineering to take advantage of features of the site, is that mitigating for a bad site now putting 960 and 60 aside?

The second point is let me just raise another issue on the suitability of a site. One way one could look at the suitability of a site is is there anything I know about this site that prevents me, based on the currently available technology, from designing a repository for that particular site? Is not that the question we're asking about a site like Yucca Mountain? Putting again the regulations aside.

These are just comments I wanted to bring up to stimulate the discussion here. You know, if you--and, I took my DOE hat off so I could do this because I'm sure over the next meeting Mr. Frishman might raise some of the comments I made and throw them back at me. Now, I'll put my DOE hat back on.

DR. BREWER: Now, I wonder if Mr. Frishman wants to put a hat on or take it off or--Steve?

MR. FRISHMAN: Well, your point about what makes a good or bad site, I have to come back to something that I said

that at least a couple of people obviously heard when I was speaking earlier. And, that's that the real key to the natural barrier is being able to demonstrate that you understand it and that you understand that it is going to do things that greatly reduce your uncertainty about whether that waste is going to be isolated or not. The good and bad features or factors are essentially measured by how much uncertainty do they override into your ultimate confidence that you have isolated this waste from the biosphere?

And, I think you've got to start--even look at--there's a page in the 1980 EIS that selected geologic disposal. Look at the table in there. There's a table. I can't remember the page, but I've used it before. It lists a whole bunch of features that it suggests you may want to use as just rational excluders right away. The reason for that is because these are the things that throw very high uncertainty into your ability to predict that you will maintain isolation for a long time. And, the idea of trying to take things that create uncertainties and somehow, you know, translate that into the silver lining is--it's just kind of ridiculous to me when you have the option of not being in the position where you've got to decide and try to convince somebody that it's a good thing that fault is there and it's full of water when you could find a site that didn't have that fault in the first place.

DR. BREWER: Steve, did you want to come back?

DR. BROCOUM: Hat or no hat, I don't care. I'm not familiar with that table. But, that again was the view of the people that put that document together at the time. I think when you look at it in some total systems concept with a design in mind, those features may be irrelevant or they may be very relevant in terms of uncertainty.

DR. BREWER: Okay. Anyone else from DOE? Jean, you are amazingly quiet.

DR. YOUNKER: I think I maybe said everything I had to say on this topic earlier. I guess, the one comment I would make and this is kind of a philosophical sidestep from some of the more pointed discussion and that would be that my perspectives--I keep thinking as I listen to the discussion that some of the points made about, well, maybe we don't really have to move forward with permanent geologic disposal, there are options for either surface storage for a while that may make some sense, and, I think Steve Kraft said there may be reasons political or, you know, outside of the technical realm as to why that may or may not be possible.

DR. BREWER: What he said was "here comes the waste".

DR. YOUNKER: I heard that, too, yeah. All right.

But, I guess, just from a very philosophical viewpoint, I have the feeling that we're at a point in this program, a lot of money has been spent investigating this

particular site and the whole concept of geologic disposal. And, kind of stepping aside also from my DOE contractor--taking off my DOE contractor hat--as a citizen, I kind of hate to see us not go ahead if this is a good solution. I hate to see us not go forward with it in one form or another that's acceptable to the political situation that we find ourselves in. My inside information--I've answered this question when Leon Reiter asked me about Yucca Mountain--is that if you're going to go forward with some form of geologic disposal, everything I know about the site leads me to believe that this is probably a pretty good place to try it and probably also would make a pretty good place for an interim storage; all waste material that you'd like to keep away from the environment.

So, you know, I listened to all the scenarios that are possible and just kind of with the dollars that have been spent, I kind of have a sense of hoping that there's still a chance for a solution and some definition of a solution. You know, once again, philosophically, I think nuclear energy is an important energy source for the country and for the world and I worry about the impact of this program, the various outcomes of this program, on the total reliance on nuclear generated electricity in the world. So, kind of a philosophical sidestep, but I don't really have anything very pointed to add to the discussion, I believe.

DR. BREWER: No, that's fine. That's fine.

Yes, Marty?

DR. STEINDLER: Yeah, let me just make a couple of comments. The argument about whether or not you should, in fact, bury waste is ongoing and unresolvable by technical means. It's a societal decision. It's based on what society will accept as a risk. And, I remind you that a risk of 10^{-6} from nuclear is much worse than a risk of 10^{-6} for driving a car or anything else you can think of if you go out and talk to people. The whole general notion of resource destruction by burying something that has clear value is another set aside issue. But, it seems to me that we keep talking about site suitability as though this was an isolated process or a thing that we're going to look at without having any particular relation to everything else that is supposed to go on in that site. Site suitability is an almost non sequitur taken in isolation. And, I think the central issue is site suitability for what which gets you to the question of can you quantify the uncertainties? And, the size of the uncertainty in any particular aspect of that site is again a non sequitur. It depends on the sum total by the time you get down to your total system's performance assessment. Unless you do that, all the other discussion is likely to be viewed at least by some of the technical folks, me included, as an excursion into politics. Not that that isn't necessary

for some folks, but it isn't necessary for me in this discussion.

DR. BREWER: Tom Cotton wants to follow on that.

DR. COTTON: This is on the subject that's come up a couple of times. You just raised it and it was raised earlier. That is this issue of whether to bury it or to store it for some period. In my view, that's a total red herring issue. It's totally unrelated to the question of whether we should go ahead and get an option for disposal. And then, the decision whether you actually then go ahead and bury it is another societal question and we may want to leave it on the surface to cool off. But, my sense in looking at some foreign programs--I won't name particular ones--is that the heat that they're trying to avoid by storing it for a long time on the surface is not the heat being put out by the waste. It's the political heat. Okay?

So, you know, when you look at what's the obligation to the future, my own personal view is that the price that this generation needs to pay is the political and intellectual prize of trying to figure out what is an acceptable solution at this point and go ahead and at least make that available for people to use and for our kids to use. Otherwise, if we say, gee, it's a wonderful idea, we'll store it, and wait for some non-obtainium (phonetic) canisters in 100 years, is that my kids or my grandkids or

going to be sitting around saying, oh, God, what are we going to do with this mess that they left us out at the site with the storage facility? They will not necessarily do that as a favor.

DR. BREWER: Ned, did you want to follow up?

DR. PATERA: Yeah. I think that when we discuss storage versus disposal, what we're talking about in disposal is a final solution and we walk away from it and we think we've washed our hands of any further responsibility for it with regards to future generations. I don't think this is the case. The human intrusion scenarios that run and a lot of safety cases say that, yes, we are passing on some degree of risk to future generations. The waste will always be there and they will have to deal with it one way or another.

When I talk about opening a discussion on storage, we can talk about maybe a hybrid solution. Utilize Yucca Mountain or some other place where you actually develop a hybrid concept for repository storage. But, you don't have to make the decision to close. Okay? Because the decision to close is based on this "prediction" that we seem to have to make that gives everybody heartburn. And, I think that the uncertainties are what we're really talking about here.

So, maybe what we pass on to future generations is a Yucca Mountain where we turned into a storage facility. We drain it, we vent it, we watch it. And, we also provide

future generations with the option to close it. We can provide them with our current state of technology, plans, and maybe even a trust fund to do that. That may be a very responsible way to go. But, there's a variety of things that we can do. I just feel like we're trapped into this sort of final solution and we're really wrestling with this idea of predicting to long-terms with great uncertainties and lots of heartburn.

DR. BREWER: Bill Magavern and then Steve Kraft.

Bill?

MR. MAGAVERN: Yeah. I also want to comment on this generational issue. I don't consider myself a spokesman for a generation and certainly not an advocate of generational warfare, but I may be the youngest person on this panel and I think that it's already clear that the generation that created the problem is not going to solve it. And, your kids and your grandkids will be saying you left us a mess. There's no doubt about that. And, what we're trying to do now is just to keep that from getting worse than it already is. And, in the environmental community a lot of people are very skeptical about the politics that have driven the site selection process up until now and I think it will only get worse and it is also reopening the whole question of whether geologic disposal is the way to go to begin with.

DR. BREWER: Steve Kraft?

MR. KRAFT: I think that I answered what Bill Magavern just said earlier in saying about I can easily envision that you don't have to go to disposal right away, but we need the capability to do it. Let me just--what I really wanted to comment on was what Ned said and take it one step further.

In the model that we envision--it is possible here --is that I like the idea about you put in the storage, perhaps in an underground setting, you don't make the decision to close because that requires then a belief in the models and everything else. What you can do is borrow some concepts from the advanced reactor--and say, okay, here's the deal. And, you go to Mal and you say I will do the following. I will put it underground and we'll do what you said and we'll drain it, we'll watch it, you know, everything; but at the same time, I will make a commitment in my license to a series of--let's call them for lack of anything else, ITACS; you know, things you're going to do over that 100 year period which, of course, is reviewable in the future by future generations if we selected the wrong things that will lead to greater confidence over time to a closure decision. And, after 100 years, if we still don't know enough, we'll go another 100 years. But you will have to make the case to Mal that you can at least pass the 100 year test; whatever that 100 year test happens to be, whether it's current Part 72 or current something else, some other

version of Part 60. So, at least, you've got the confidence that your licensing something for that 100 years, be it on the surface or underground. So, I think that that's what you need as a legacy.

Now, you get down--and then, the other point that I want to respond to is you get down to actually a point of personal points of view and personal values. Leaving spent fuel in a responsible manner as an available resource to the future generations, in my view, is the responsible thing to do, not the irresponsible thing to do. There are people who think that's going to be irresponsible. And, sometime in the future, future generations may discover a use for that material that we haven't thought of like curing male pattern baldness or something. I don't know. Whipple and I are going to patent that process.

DR. BREWER: Steve Frishman and then what I want to do next--we'll let Steve sort of follow--is turn it to my colleagues on the Board to see if there are some questions for members of the panel and then to open it up to the public after that.

So, Steve?

MR. FRISHMAN: I think the concept of storing underground at Yucca Mountain, of course, is an interesting one because in 100 years you're not going to know any more about the long-term performance of that tunnel system that

you have built from a natural barrier side than you're going to know with a concerted effort up front. Storing underground in those tunnels would--the promise that you won't close it until you know more. The only thing you're going to know more about is whether the engineered barrier that you've built works in a tunnel full of air. You're not going to know anything about disposal. And, frankly, I'm really surprised that you would advocate storing it underground when that's just totally squandering the waste form. Why would we want an expensive hole in the ground?

DR. BREWER: I don't believe we can leave it there.

Steve Kraft and then Ned?

MR. KRAFT: I think it--okay, store it above ground, but the fact of the matter is is that it's not that you're going to learn that much more about the waste package and air in the tunnel. Jean and her future generations of people in her science will get to do 100 years of basic research in geology and be that much smarter about how geology--

MR. FRISHMAN: But, the rock isn't going to change.

MR. KRAFT: I'm sorry if I've consigned you to hell for that, but that's my point. That if you're going to learn, you're going to develop techniques and learn more.

MR. FRISHMAN: The rock isn't going to change, though.

MR. KRAFT: To learn more about the rock and more ways to assess the rock--

DR. BREWER: Ned?

DR. PATERA: What I was talking has nothing to do with actually learning more about the rock in 100 years. What it has to do with is passing on the minimum responsibility to the next generation, and I believe part of that minimization of that responsibility is providing the next generation with choices. And, the choices may be that they decide to retrieve; the choices may be that they decide to close; the choices may be that they decide to pass it on to the next generation. Okay? And, it basically has nothing to do with learning more about the site itself. It's a minimization of the responsibility that we pass on to the next generation.

DR. BREWER: I think that that's probably a good ending comment for the panel, as such.

I'd like now to offer up to my colleagues on the Board and staff any questions you have about the discussion, questions directed in general to specific individuals. Colleagues?

(No response.)

DR. BREWER: I can't believe this. You guys always have questions. Yeah, Don? Yeah, you have to go to the microphone and say who you are, please?

DR. LANGMUIR: I'm a little uncomfortable coming to specifics from this great general discussion here.

DR. BREWER: Well, why don't you get it down to earth

and then underground?

DR. LANGMUIR: Some questions for Jean Younker. I thought you did a terrific job of laying out where people were, where the DOE was going, and what they propose to do. It left some very titillating issues hanging out there for us to think about and I hate to be this specific, but Page 27 of her--

DR. BREWER: From the sublime to something else, is that what's--

DR. LANGMUIR: I look at the list here which is a summary of key uncertainties related to waste isolation and these are things that we've been talking about in Board meetings for some time now and we agree this is what they really are. My sense is from where you are now and where you might get in the next three years that you'll be saying in '98, at best, the site has not yet been shown unsuitable. These are very tough questions to resolve, tough issues to get answers to. They're going to require more data collection, presumably surface-based and ESF-based sampling and analysis and modeling and so on, much of which will never get accomplished by '98. So, we'll be into the bounding analysis and the expert judgment realm of things which makes me very nervous because I don't like to see those as substitutes for data.

I guess, I'd like you to comment on where I've

gotten in this discussion?

DR. BREWER: Jean Younker, good luck.

DR. YOUNKER: Thank you, Garry.

I think that those of us who have tried to put the proposed program approach together which kind of tries to look at a phased approach to that reduction of uncertainty that's built against those key points on that page, you know, all have the same concerns. How far will you be able to carry it in terms of understanding? You know, I think I tried to show you in the presentation that we certainly are going to get a fair amount of new information about kind of the fundamental site conditions through the excavation of ESF and through the surface-based program carefully focused, I think, in the next couple of years. I think that we all have the sense that with the increased focus on getting the waste package through Title 1 and big emphasis on the 1,000 year container--you know, at least, 1,000 year container--being a key part of the strategy that we're going to spend as much as can reasonably be allocated on that engineered barrier system research and development, material corrosion, rate testing, and the things that need to be done there.

So, I have the impression that we'll probably have more in '98 than what we would have had if we hadn't overhauled the program with the PPA. Now, I may hear from Bill Clarke that that isn't the way it looks to him. I'm not

sure about that. But, given the focus that we tried to spend on the importance of the safety in the early period, being full containment within the waste package, you know, I guess I have the impression that we've got a lot of people thinking about how to increase the slope a little bit and the information you need in order to make that case by the year 2000 in our license application.

I can't give you very many facts, Don. I think we have to turn to the people who are really trying to plan the details of incremental increases in information in those areas. You know, Bill Clarke, maybe a quick comment on this, but I don't know if that, at least in part, responded to your comment.

DR. BREWER: Okay. Bill, did you want to respond or, Felton, either one?

MR. BINGHAM: Yeah, I'd like to point out a naive expectation. If you look at the total system performance assessments, it's very clear that the worst uncertainties of all have to do with the way water moves through the site. Julie brought up, probably for the ten thousandth time in the last 10 years, percolation flux is something we've got to know about. But, the really big one is is the water coming through uniformly, is it coming through down faults, where is it? And, I have the optimistic feeling and have for a number of years that if we could just get underground and walk

around and look at the ceiling, is it dripping or isn't it? We might go a long way toward resolving what I think is clearly the most basic uncertainty in the total system performance assessments. It's still a long, long way to go, of course, but gosh, I would have felt better if we could have walked around underground 10 years ago.

DR. BREWER: Bill, would you have felt better or did you want to respond here?

MR. CLARKE: I'm in enough trouble in DOE already. I'm not about to touch a budget issue.

DR. BREWER: Maybe Chris Whipple will.

DR. WHIPPLE: Just to throw in a bit of pessimism here, I am concerned to hear people associate data with reduction of uncertainty. I don't know why on earth anything in your experience would lead you to believe that there's a correlation there. Certainly, on the WIPP performance assessment, the data says, damn, the models are wrong. We've got to start over. But, they do. I mean, you make progress, but it gets worse before it gets better.

The other thing is the environment you're working in. I mean, if we're lucky, the NAS report on standards will be out in, maybe, March. If we're lucky, the EPA report will be out, maybe, two or two and a half years after that and the NRC report, maybe, two years after that and you'll be in the year 2000 before you know what the standard is, but you're

going to show the sites are suitable two years before you know what the standard is? I don't see that happening.

DR. BREWER: Jean Younker?

DR. YOUNKER: I don't have a well thought out response to what Chris just said, but I do want to bring up one point that I just think is really back to Felton and Julie's observation that the spatial distribution of flux passing through the system is really a key variable no matter how you look at this site. One of the things we asked for and I don't know for sure if I'm really supposed to be sharing this with everyone, but since it seems like an appropriate thing to do, I'm going to do it. We asked Ed Quickless--if you remember in your last--I think it was in your last Board meeting, Dick Luckey told you about what he thought the saturated zone studies could and could not bring to technical site suitability and this was in the last Board meeting. Well, Ed Quickless, who has a really good feel, I think, for what the unsaturated zone studies will be doing, gave us a similar list for the unsaturated zone studies and what they would bring to technical site suitability and it addresses what Felton said so well. I just want to read you one of the bullets on his chart. "Identification of the dominant hydrogeologic controls on the UZ hydrologic system including assessment of the hydrologic significance of fractures, faults, capillary barriers, and perched-water." Then,

there's another one that talks about an understanding of the spatial distribution of infiltration. So, you know--

DR. BREWER: Is that like the roof leaks? Is that what fits?

DR. YOUNKER: I think something like that.

DR. BREWER: Okay.

DR. YOUNKER: I mean, I see some--I'm looking down into the PIs and the project and looking at what they're telling me. They think they'll have some understanding of it, and they are some of the most sensitive variables we see in the performance assessments that we do. So, on the other hand, I also understand Chris' point that, boy, when you first start giving us some information of a new kind or from a new source, you generally find out that some of what you thought before just isn't the way it is and, you know, your air bars go up rather than close in. So, that's a fact that we're going to have to deal with.

DR. BREWER: Okay. Steve Brocoum to follow and then I'm going to go back to my colleagues and then the audience.

DR. BROCOUM: That's an interesting discussion that was started by the question Don Langmuir asked. And, I guess, the heart, can we characterize a site and can we characterize it for the amount of money that Congress is willing to give to us? A lot of things we're hearing here is, well, we're not even going to have a standard in place by the year 2000.

Why are you guys saying, hey, you're going to make a license application? I think--and, if Dan was here, he may make some comment; Dan Dreyfus. He did say something this morning that we don't have all that much time to demonstrate real progress. That's one of the questions we have to ask in a philosophical sense is if we can't characterize a site, the regulations require us to disqualify it. And, in a sense, "can characterize" can be defined different ways. If you can't do it under the budgets in the number of years that society through Congress are willing to give us, we may disqualify the site.

The other point I want to make is disqualifying the site itself is a very weighty decision because what we're doing in a sense is we're disqualifying the site very early in the whole process of studying it, licensing it, constructing it, and confirming it which is, say, 50 years or 100 years. And, you'll have a lot more information after 50 years or 100 years to decide you should close it or monitor it forever or whatever you may decide to do at that time. But, if we disqualify the site for whatever reason because we can't afford it or we don't have enough time or Congress gets tired, then we're in a sense, de facto probably, saying geologic disposal will not work in this country at this time because it's unlikely we're going to get another site. I just wanted to just make that point.

DR. BREWER: That's a good point; an excellent point.

Any of my colleagues on the Board have other questions/comments? Dennis Price?

DR. PRICE: Just a quick one. I think the only member on your roundtable who hasn't spoken is our foreign representative and I'm wondering what he thinks of all this stuff.

DR. BREWER: And, first of all, before we go to J. Van Miegroet, my apologies. I was trying my best to include everyone and I didn't.

What do you think of all this stuff?

DR. VAN MIEGROET: I don't know what to think.

DR. BREWER: He's puzzled.

DR. VAN MIEGROET: I still feel that it's a hopeless task to compensate the lack of credibility of the geological medium by--and the type of engineering development. I don't see--with all respect that I have to all Swedish colleagues, I don't see how you can convince, at least in my country--how you can convince the population in general and even the scientists who at some point will have presented the population and those scientific commissions that you have to deal with--I don't see how you are capable of convincing those people because it's--well, you can indeed from the chemical standpoint--you can indeed make nice demonstration that your canister will last for one million years, but can

they still--material, they have weldings, they've been formed. So, you're just--well, for me, just undemonstrable, this type of thing. So, either the geology is good, good enough, or it is not.

DR. BREWER: Certainly, one of the extreme points of view and quite consistent with what Belgium seems to be doing.

DR. VAN MIEGROET: I also want to say that nothing is black and white.

DR. BREWER: Yes.

DR. VAN MIEGROET: So, when I say and I repeat it, in all cases, we are not really giving to the engineered barrier more than the role of limiting or preventing the amount of disturbance. When this engineered barrier which has that as main role is there, we are taking some advantage of it to, if possible, use it for some aspects of additional protection. I mentioned, I think, the possibility of having some--in the Bentonite layer to limit the iodine migration that at the moment it's not quite satisfactory in the layer. Well, there are some such things. But, the real trust is not there.

DR. BREWER: Yes. Thank you very much.

I think it's time to open this up to questions from the audience. And, if there are questions, please go to one of the microphones and identify yourself and so on, please. We need to know who you are and if you represent something or

someone besides yourself.

DR. MCGUIRE: My name is Robin McGuire. I'm a consultant for EPRI. I'd like to try to tie together three things that I heard this afternoon. One was the statement by Steve Kraft that we ought to look at the effects--go past Point B on that one diagram to Point C which would be the effects on the population including some measure of the biosphere which I support. The second was the statement from the gentleman--I apologize for not remembering your name--who said that we can design these engineered barrier systems to be damn strong and last for a hell of a long time. The third was a statement, one of Chris Whipple's four points on what you use an EBS for and that specific point was to control the rate of release. What I'd like to point out is if we design these EBSs to be damn strong under one environment, there may come along at some point in time, maybe it's 90,000 years or 150,000 years from now, a different environment and that may cause them to all fail at all, more or less, the same time. That may be in this case a flood environment which has perhaps a minuscule probability of occurring, but not a zero probability of occurring. The result will be a large dose, a large release, and consequently a large dose to the population. It may be--and, my interpretation of Chris Whipple's point is that we may be in a better position designing an engineered barrier system to fail over a period

of time, a long period of time, releasing very small amounts each year or each decade or each 1,000 years than trying to make it massive and robust and making it possibly potentially subject to catastrophic failure over a short period of time with potential consequences on future population at that time.

I guess my question would be is that what you meant, Chris, by your point?

DR. BREWER: Chris Whipple?

DR. WHIPPLE: Yeah. Robin, it's not what I meant, but it may not be an awful thing if it happened. No, what I meant is I think that we--for example, we saw on the slide the Swedish cask. It's got two layers. We might make a two layer cask that one layer is for the present environment as we understand it and the second is a belt and suspenders that gives us some coverage against a second layer. And, I guess, I just--I think, first, pushing releases further out in time and controlling them, for example, with air spaces around the canisters and so forth, are things that can release the rate. I don't think trying to engineer a time release waste repository is a very good idea. I think that's what you describe.

No, again, to pick on the program which is my role in life, to see that two different conventional alloys are proposed for the waste package says, you know, we're not

trying hard enough. Well, you know, have you really looked at ceramics and titanium and so on? This isn't my field, but from what I understand, you know, for some increment of effort, you might get a waste can that's just as happy as a clam down there in whatever place you park it.

DR. BREWER: Clams like water.

DR. WHIPPLE: It will be humid there. That is what I had in mind; more of a smarter, higher tech approach.

DR. BREWER: Good. Thank you very much.

Anyone else from the audience have questions or comments? Your name and identification, please?

MS. TREICHEL: Judy Treichel, Nevada Nuclear Waste Task Force.

I see a real contradiction or a real dilemma here. It would seem to me with a project as important as this one is and with the sort of potential for--we always hear the word "catastrophic" or the kinds of results that could happen throughout the life of this project that could have such severe effects on the population that you would almost need to be assured that the population was behind this effort. And, we have very good reason to believe that it's not. We know that the population of Nevada doesn't support the effort and I know that Bill Magavern would be able to respond to this about what the public in general thinks about this because his organization deals with a whole lot of the public

and he deals with other national organizations that do. But, we're continually being told that you can't have an independent review or you can't stop now and go back and re-examine whether or not there should be geologic disposal or you can't take the time to really examine this, and yet we're also told that public confidence is a very important element in this thing. Well, you don't have public confidence and you're expecting a whole lot of it not just from Nevada where, as Steve Kraft says, here it comes, but from people in a whole bunch of states that are going to have to see this stuff go by and believe that it's not going to kill them while it's doing that. So, you really require a lot of public confidence if, in fact, you think that's important. And, I think we need to determine if that's a real important thing.

And, when you're talking about the sorts of time periods, you know, that are just out of the realm of people's understanding, but yet on the other hand, we don't have time to take a look at the thing and see if it's really what we want to do, there's sort of a disconnect here. But, I know I get--I'm on the phone all day long with national groups, regional groups, individuals from Nevada and elsewhere, and there's everything from skepticism to real anger. And, I wouldn't want to be in the position of some of the people up at the table there where you're accused of being just

outlandishly arrogant to take it upon yourself to make these sorts of decisions without checking with the public or having a kind of a national examination of this thing. I certainly know you're not arrogant. I know all of you and I know how great you are. But, there is that feeling out there that there's some people making awfully important decisions and they shouldn't be. And, the time, if you're talking about a year or two or three or whatever, the worst case scenario on a review of the program isn't going to make a whole lot of difference when you're talking about the kind of time periods that you do.

DR. BREWER: Good. Thank you, Judy.

You had offered a lead to Bill Magavern. Would you like to follow up on that a bit?

MR. MAGAVERN: Well, just you don't have to take my word for it. Listen to what DOE says about the trust in DOE. Hazel O'Leary has said that there's less trust in DOE than almost any other institution in the country based on their surveys. I think it was lower even than Congress and the media, if you could believe that.

In terms of an independent review, certainly my organization, many other public interest groups, many members of Congress, the GAO, a lot of different entities have called for some form of independent review of the program and DOE has still not undertaken one and I don't think has given a

persuasive reason not to have one.

DR. BREWER: Okay. Thank you.

Any other questions from the audience? Name and institution, please?

MR. WILLIAMS: I'm Bob Williams and I'm recently retired. I have developed a new avocation in retirement. Instead of squandering my money going to Super Bowl games and football games, I've decided to attend meetings of the Nuclear Waste Technical Review Board. I say that with some light-heartedness because in my 20 years of watching this program, this is perhaps the best informed discussion of the role of the engineered barrier system that I've seen. My compliments to you and the staff and the organizers.

At the same time, I'm appalled. I think there will be plenty of sport for me in the next 10 or 15 years because I see hardly any movement to introduce this into the system in a way that the system can capture it and move forward. So, I would pose that to you as a challenge for your next annual report or whatever. How do you capture the substance of what has been said here and move ahead with it because many of the same thoughts have been rattling about for the last 10 years.

DR. BREWER: Well, I can speak for myself and other colleagues on the Board can do as well. I mean, we had lengthy discussions and considerations about this very

subject. The setup of the meeting and the format and everything else was really designed to elicit conversation of the sort that I think we've had. And, where we go from here, I mean, we do what we can do.

Would our chairman like to comment on this particularly personal reaction? John?

DR. CANTLON: It's always my pleasure essentially to give you the sign off. I'm usually blessed by being brief. I think I want to thank all of the participants. I would agree with the last speaker's statement that we do get some informed discussions across a much broader spectrum of people and one of the things that has always impressed us is that the level of interchange between the people who are actually involved in the process sometimes is improved in these kinds of discussions. So, we hope that rubs off on the program.

So, on behalf of the Board, let me thank all of the participants and the attendees here. We thank you.

We're now adjourned.

(Whereupon, at 5:25 p.m., the meeting was adjourned.)

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