NUCLEAR WASTE TECHNICAL REVIEW BOARD

1995 SUMMER BOARD MEETING

EXPLORATORY STUDIES FACILITY UPDATE
REPOSITORY OPERATION AND CONCEPTUAL DESIGN
REPOSITORY LICENSING

Little America Hotel
500 South Main Street
Salt Lake City, Utah 84101
July 11, 1995

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I N D E X

P R O C E E D I N G S

DR. CANTLON: If you'll take your seat, we'll get this session underway.

My name is John Cantlon. I'm Chairman of the Nuclear Waste Technical Review Board. It's my pleasure to welcome you here to our summer meeting in Salt Lake.

As some of you know, the White House has announced that the President intends to name three new members to the Nuclear Waste Technical Review Board, and I think that process is now complete, so this would replace three of our former members who have now--their terms have expired.

We have with us today John Arendt. John, would you raise your hand so people can get a fix on you?

He will be replacing Dennis Price. John is currently a consultant living in Tennessee who has extensive experience in uranium processing, handling, safeguards/accountability, shipping, production, and previously worked with Union Carbide for nearly 40 years. John started his career as a chemical engineer at the University of Chicago, where he worked on the Manhattan Project.

John, it's my pleasure to welcome you to the Board and the first meeting of the Board.

Other Board members with us are Clarence Allen, Professor Emeritus, California Institute of Technology, Specialist in Seismology; Garry Brewer, University of Michigan, Specialist in Natural Resource Economics; Edward Cording, University of Illinois, Specialist in Geoengineering; Don Langmuir, Professor Emeritus, Colorado School of Mines, Specialist in Geochemistry; John McKetta, Professor Emeritus, University of Texas, Specialist in Chemical Engineering.

Past Board members who are here consultants pending replacements, Ellis Verink, Professor Emeritus, University of Florida, Specialist in Metallurgy and Corrosion; and Dennis Price, Professor Emeritus, Virginia Polytechnic Institute, Specialist in Systems Safety and Human Factors Engineering; Pat Domenico, Texas A & M University, Specialist in Geohydrology. My field is Environmental Biology.

On many occasions, the Board uses consultants to augment the skills and experience of the Board and the technical staff, and today we have with us John Reilly, a consultant in engineering, whose specialty is the management, strategic planning and organization for large underground public works programs. John has been spending most of his time recently in the Los Angeles Metro, an undertaking that we read in the newspapers should be a very challenging project indeed.

In addition, I'd like to introduce our Executive

Director, Bill Barnard. Bill I guess has gotten--okay, he's on the fly. Our technical staff, Russ McFarland, who coordinated today's meeting, many of you know; Leon Reiter, Victor Palciauskas, Carl Di Bella, Dan Metlay and Woody Chu.

Today's agenda will focus on the Yucca Mountain project, with special emphasis on the management challenges of the project, progress being made with present and possible future construction and testing associated with the Exploratory Studies Facility, and the conceptual design and planned operation of the proposed repository, should the site prove suitable.

Tomorrow's agenda will begin to look beyond the site suitability evaluation by focusing on the licensing process.

I'd like to now introduce Wes Barnes, Project Manager of Yucca Mountain Site Characterization Office; Russ Dyer, the Project Manager, who will provide opening comments on behalf of DOE, and this will be followed by comments by today's session chairman, Ed Cording.

MR. BARNES: Good morning. It's nice to be here. I'm Wesley Barnes with the Department of Energy and the Yucca Mountain Project Manager.

I've had a chance in the few months that I've been with the project to meet some of the members of this Board and the staff, and some of you I've worked with in other incarnations, nothing too bad. We're not throwing rocks at each other anyway.

I've had a chance to review your agenda for the next two days, and most of the people making presentations work for the Mountain. They have my trust. I believe you're going to get good presentations and accurate data.

My time is limited. I'd like to open it up to any questions you may have for the project manager at this time because this is my one and only moment in front of you.

Thank you for the invitation.

DR. CORDING: I wanted to start the portion of the session related to some of the construction management issues, and the construction bulk of ESF today we'll be discussing, as well as some of the repository design issues.

We're going to be starting off today's session with a presentation by members of Peterson Consulting Limited Partnership. These gentlemen are with us at the head of the table today at this point, and they've been completing a study funded by the Office of the Secretary of Energy to provide an independent management and financial review of the Yucca Mountain project. The study was overseen by Judy Sheldrew, State of Nevada, representative for selection, and Alex Radin, an independent consultant and former chairman of the MRS Commission, who was selected by the DOE.

The Peterson Consulting Limited Partnership was selected to perform the study in a competitive procurement with one of the selection criteria being minimum contractual history with the DOE. The DOE Office of Civilian Radioactive Waste Management was not involved in the selection of the contractor or the management of the study.

That presentation will be followed by an update on ESF activities, including ESF mapping and testing, the mapping and testing in the Exploratory Studies Facility where the tunneling has already taken place. That will include an overview of studies conducted to examine alternative strategies for exploration and testing beyond the north ramp.

THE DOE has examined a number of options for conducting an east-west traverse across the Yucca Mountain block, such as an extension of the north ramp to the Solitario Canyon fault zone. They've also been investigating alternative strategies to provide early access to the Calico Hills formation below the proposed repository horizon.

The results of these studies are being presented to the Board to show alternatives that have been considered by the DOE as possible means to reduce the schedule, the cost of the Site Characterization Program and to achieve the testing objectives for the program.

These presentations are not presented as a change to the baseline or recommendations for a change to the baseline, but to update us on some of the thinking that the

DOE is currently considering--has currently been considering.

This afternoon the Board will hear the presentations on the proposed repository operational concepts, an update on the repository advanced conceptual design and a discussion of supporting studies. The Board last heard presentations on the repository advanced conceptual design about a year ago, in July '94, so we are looking forward to seeing the progress made over this last year.

We're allocating time after each presentation for discussions, comments and questions. We believe this is an important part of the meeting, the presentations, but also being able to interact with the presenters. And we'll be soliciting questions at various times from the audience for their participation to ask questions or make comments related to the topics being presented.

Now I would like to introduce the gentlemen from Peterson Consulting Limited Partnership, and they will be presenting an overview of the study, "Independent Management and Financial Review, Yucca Mountain." And they are from your left to right, Joe Kellogg, Jim Kelley, Charles Wilkins and John Reiss.

Although the Board was not involved in developing the scope of work or the oversight of this study, we are most pleased that the study was conducted. The Board in its March

'93 special report, and several reports since that time, has recommended the management and organizational structure be independently evaluated.

Gentlemen, we look forward to your presentation.

MR. KELLEY: Thank you very much. I'd like to thank you for the opportunity to be here today and to present the highlights of the findings, which will be expressed in our final report, which will probably be made public about the end of the month.

As many of you know, we made public a preliminary report about the third week in May. We've had public comment periods, received oral comments in Washington, D. C. on the 8th of June and in Las Vegas, Nevada, the 15th of June. The 23rd of June was the deadline for receiving written comments to our report, and as we speak today, the rest of our team is in Denver trying to incorporate the appropriate comments that we've received into our final report. We will finish this final report at the end of this week and submit it to Commissioner Sheldrew and Mr. Radin. And at that point, don't call us, call them if you want to see it.

That is the reason that we don't have a handout here today. It would be inappropriate in terms of our contractual protocol to release anything before we do it to them. However, the preliminary report has been around for, oh, several weeks.

You've heard that Peterson Consulting Limited Partnership is the consultant on this. We would be remiss without announcing that we did this work in conjunction with John Reiss & Associates. John is seated two persons to my left. And the report is--at least in part is, and all four of us are going to be speaking to various portions of the highlights today.

We started our work the last week of November of 1994, and we cut off the data for analysis about the end of April. So we had a little bit over a five-month window of opportunity to collect information. During that time we conducted interviews with 114 individuals who were either associated directly with the project, or I would say concerned members of the public. I forget the exact number in that category. It's in the 20s. We also reviewed over 76,000 pages of documents.

The scope of work for our report was written by Commissioner Sheldrew and Mr. Radin. It was incorporated into our contract with the National Association of Regulatory Utility Commissioners, who became the administrative contracting body to maintain the independence of our work.

We have a fixed price in time contract. That is a bit unusual, I think, for many of the people in this room, but we have to live with it.

We're going to be trading off the presentation this morning. All four of us will be delivering different parts of it. After about 50 minutes from now, we'll entertain questions from the Board, the staff, the audience, whatever is appropriate there.

Joe, would you like to start off?

MR. KELLOGG: One of the things that we want to focus on today is the fact that much of what we learned, we learned orally, and, therefore, there were various perceptions about the project itself, how the project was to be built, the basis for the construction of elements of the project. And so we had a diversity of opinions. What we tried to do was sort those opinions out so that we could put the right weight on, I think, not only the parties we talked to, but how many times we heard that same kind of reflection, so that we put the right, I think, perspective on what the final report might indicate.

There's a wide range of very ambitious goals for this project. They're quite esoteric in some situations. The expectations of the project are very high, and, therefore, it has a lot of national attention, as it should.

The vested interests--I think you've all maybe heard the comment that hell hath no theory, is a vested interest masquerading as a moral principle. In many cases, there were very strong vested interests expressed to us, and trying to sort those out so that we came as close to the truth in this very important project was important to us.

What we're trying to do this morning is take the 300 pages of the report and try to hit the highlights so that we can properly convey to you in a very short period of time what we saw as the key observations and some of the recommendations that we provided.

It was an elusive set of objectives of trying to characterize the particular site, and there is a law that is driving much of what is done, and that aspect we understood very clearly.

When we first got involved, we thought that possibly construction was worshipping the throne of science. As we got into it, we began to realize that maybe science is in the devil's den of construction, and it was hard to sometimes sort that out because what was really driving the project in many cases was science. A lot of people talked about the fact that it was--the project is schedule-driven. It is also funding-driven. In other words, those go together, and you'll hear something about that as we go along.

Our role was to sort out the box of conundrums that we see in the Yucca Mountain project. There are a number of questions that were asked, and they will be addressed today.

Can the project meet current schedule? That is very difficult. We're looking at 1998 and the year 2010.

And the question will be addressed today. It is an ambivalent kind of situation.

What will be the cost of the project? That is a brilliant question. We have developed two scenarios for that, which you will again hear about.

Is funding adequate? And that goes back to what the cost might be and what will drive those costs, what are the cost drivers.

Are there adequate contingency plans? And that is a very important kind of question because we'll talk later about the program approach, which tends to address a different viewpoint as to how you manage the project.

Are funds being spent prudently? That's a real difficult question because, again, so many things drive what the cost will be.

And then finally, is the project being administered properly? For any of you that saw the movie many years ago, "The Gods Must be Crazy," and at some points in time, if you ever saw the movie, you sometimes feel like that particular individual, when the Coke bottle fell out of the air and from that point on his life deteriorated, or had some very twists and turns, to some degree we felt that a little bit ourselves.

With that, I believe we'll go to Jim.

MR. KELLEY: Yes. I'm going to tackle that first question that Joe mentioned, what is the likelihood of the project meeting its current schedule.

Our review team is of the opinion that the project has little chance of meeting its currently established major milestones. We base this on several categories of unaddressed risks, which include the incomplete work scope definition, annual funding uncertainties, an unresolved thermal loading issue, the extent of fracturing and faulting, movement of water through the unsaturated zone, and the processes that will be involved in the Environmental Impact Statement and Nuclear Regulatory Commission processes.

Those processes, no matter how well they may be prepared, are just unaddressed as an uncontrollable as far as what external forces may require. I think in short we can say that the exact process that will be followed is undefined.

The current schedule contains very little float, which constrains the project's ability and flexibility to recover from any schedule impacts, and it limits the alternative application of project resources.

Do I need to define what float is? I saw a couple up there, but float is the term used in critical path method, or CPM scheduling, network scheduling, that describes the degree of flexibility in selecting starting and completion dates for work activities. Float is the time frame that an activity can remain unperformed without impacting the overall schedule performance. In other words, if a work activity has 30 days of float, that work activity could be started perhaps up to 30 days late and not impact the overall schedule completion objectives.

The scheduling process used on the project is almost entirely a top-down process, which in practice results in an aggressively prepared milestone driven project schedule. The resulting schedule may be attainable, but it is not likely to be without continuously vigorous management attention to each work activity.

The approach to scheduling was really initiated in 1994, the current approach was, during the preparation of the program approach, in an attempt to achieve high level schedule milestones within the cost parameters.

As I think most people in this room know, there is currently a baselining--a re-baselining effort going on that could clarify many aspects of the project schedule. The thing that appears to be lacking is any significant effective bottom-up input from the lower level managers directly involved, those people that are directly involved in managing those work activities. And we feel that there is a definite need for the top-down to meet the bottom-up and work things out, and hopefully the re-baselining effort will do this, but we haven't seen it to any great extent yet.

The project schedule could be affected by the ultimate non-acceptance of the program approach, the--that's the philosophy of the program approach, and what I'm talking about here is the Nuclear Regulatory Commission, The National Academy of Sciences in the case of Peer Review of Technical Basis Reports. Individuals within these organizations, we are absolutely sure are aware of what that philosophy is embodied in the program approach, but no formal acceptance has been made, at least to our knowledge. Again, we cut off our data a couple months ago, so maybe there is something going on we're not aware of.

We're concerned that the program approach, in an attempt to meet the 1998 technical site suitability evaluation, will result in a de facto schedule-driven project. Remember, earlier I talked about milestone-driven. But we have a situation with a very aggressive schedule right now, coupled with reduced funding levels, which we're anticipating reduced beyond--or below the current levels. We're concerned that that may encourage some risk taking to eliminate or inappropriately postpone the necessary level of scientific evaluation.

If it is possible to get enhanced funding beyond what is in place for the current fiscal year, it may not provide a means to cost effectively accelerate the project, but one thing it could do is reduce the risk of schedule delays by providing in a managed sense a funding allocation to focus on high schedule risk activities.

At this point, Charles will talk about the cost of the project.

MR. WILKINS: Thanks, Jim.

As you know, with any project, regardless of size, cost is always a very important issue, and what I will focus on for the brief time I have this morning is to talk a little bit about the actual cost of the project. In the context of this project, it's put in a general categorization of total system life cycle cost. And then I will talk about the adequacy of the Nuclear Waste Fund.

In lay terms, you can kind of put this in the context of the total cost of the design, development, implementation and then tear-down, if you will, of the site. So it's kind of a concept of "womb to tomb" so to speak. On the other hand, if you consider the Nuclear Waste Fund, you can put in a context of an income statement. It's basically the revenues of the project offset by the cost of the project.

I'm going to speak to these two issues very briefly and at a very high summary level. What I would ask is that in the body of the report and the appendices attached to the report are the details of the information that I'm going to convey to you this morning. If you're interested, I would ask that you look at the report, read the appendices. The assumptions that go behind the numbers that I'll talk about are there. All of the calculations are there, and I think it would be to your advantage, if you're interested, to take a look at those documents.

In terms of the total system life cycle cost, and again, this is the cost of the project from the beginning of the project, the design, development, implementation, actual performance of all aspects of the project, and then the tear-down of the project, if you will, at the completion; that is, any costs that are required to put the site in a condition of dormancy at the conclusion of the project. All of those costs are included in this calculation of total system life cycle cost.

I'll give you just a few numbers here to try to give you a benchmark. There's a requirement in the Nuclear Waste Policy Act that the Secretary evaluate the adequacy of the Nuclear Waste Fund annually, and essentially what that means is it's taking a look at the income that's coming into the fund versus the costs that are going out of the fund. So it's basically looking at the fees that are generated offset by the costs that are incurred.

The one issue that we focused on here in accordance with the Nuclear Waste Policy Act is that the Secretary is required annually to review the fund. That is not being done; at least it's not being done formally. What we found is that the last formal calculation of total system life cycle cost, which is used to determine the adequacy of the Nuclear Waste Fund, was performed in 1990. When we--let me preface that by saying that in 1995, there is ongoing effort by DOE to come up with another formalized total system life cycle cost, and, therefore, evaluate the adequacy of the Nuclear Waste Fund.

When we looked at the 1995 assumptions and did our own calculations around those assumptions, we came up with some differences. And I think you have to recognize that a project of this size and magnitude and all the various issues that are causing changes to the project, it's very difficult to come up with a real meaningful total system life cycle cost. It's also very costly to come up with a meaningful total system life cycle cost. And, of course, with cost, there's time added.

So I don't want to give the impression that this is the kind of a calculation that one can sit down at a computer and in a matter of a week or two weeks or a month come up with meaningful numbers. It's a very difficult process.

To give you a benchmark, based on the 1995 assumptions, with some tweaks that we made of our own, which are summarized in the report in the appendices, the total system life cycle cost for one repository setup is a little over $35 billion. That is contrasted by the 1990 DOE calculation, which produced a number of a little over $25 billion. The equivalent number for the 1995 assumptions to our 35 plus billion is a little less than 35 billion, as calculated by the DOE.

Now, those numbers may not be, you know, again, that meaningful to you, but I just want to share with you briefly what's included in those numbers. They include several categories, which are the development and evaluation of the project, transportation, and there are two different scenarios here. One of them is a single repository, and the other is a two repository scenario. So in the first example, there is one single repository. In the second example, which I'll give you the number shortly, there are two repositories. There's a category of waste acceptance, and then there's a category of benefit payments.

So all of those items go in to make up the numbers that I just gave you, $35 billion for a single repository. In the two repository scenario, it's a little over $46 billion, as contrasted by the 1990 number, which was a little over $33 billion.

These numbers assume that the first repository will accept radioactive waste in the year 2010, and the second repository will accept radioactive waste when it's needed, actually.

You heard both Mr. Kelley and Mr. Kellogg talk about our concerns, the review team's concerns, about the project meeting its current schedule. Because of those concerns, we decided that we should look at some options or alternatives to the numbers that I just gave you based upon the single and double repository scenario.

And we looked at two different scenarios, one being a three-year slip of the schedule, the other being a five-year slip of the schedule. When you look at those slips and the likely potential for those slips, the numbers that I gave you earlier increase fairly substantially. For example, the single scenario, or single repository scenario, goes from around $35 billion to around $37 billion a three-year slip, and around 50, right at $50 billion for a five-year slip. And under a two repository scenario, we go to $39 billion and $50 billion, a little over $50 billion. So there are some substantial changes as the schedule pushes out to the total system life cycle cost of this project.

Now, when you take the total system life cycle cost and you overlay it now with the Nuclear Waste Fund revenues and you get back to this income statement concept that I talked about earlier, the cost or the revenues offset by cost, here again, we took a look at the adequacy of the fund based upon the best case scenario, which is the base scenario, a three-year slip scenario and a five-year slip scenario, and the numbers range from around a--they're all deficient. You know, we projected there would be a deficiency, the Nuclear Waste Fund would be deficient to the tune of around $3 billion up to around $7 billion, depending on which of the three scenarios you look at; base case, three-year slip, five-year slip.

And with that, I will turn it over to John--or back to Jim.

MR. KELLEY: I want to discuss the question on contingency planning. Are there adequate contingency plans?

We're of the opinion that there has been insufficient emphasis placed on contingency planning. The program approach alludes to a contingency planning function, but we were unable to identify any real evidence of a contingency planning function. In fact, the only efforts towards contingency planning that we could see was what's the funding level going to be, and if this is the funding level, what are we going to be able to do with annual funds next year, that type of an exercise.

This is unfortunate because we think this kind of a function is at the core of identifying potentially significant problem areas, identifying scenarios, and if this scenario happens playing "what if" games, and trying to work out some kind of a procedure for coping with that existence.

On any major complex project, such as Yucca

Mountain, that does not provide for contingency planning strategies, will most likely suffer dire consequences.

We think that the ability to achieve the scheduled milestones is a case in point, paying attention to not only the schedules, but very sensitive areas. If we don't get this particular body of science done in this time frame, what does that do to the subsequent activities, and couple that with maybe some funding problems off in the following year, and that could really delay the project. And we'd just like to see a lot more of the contingency planning take place at that level.

Then we get into the ultimate of contingency planning and what happens if the site is determined to be unsuitable. The Nuclear Waste Policy Act is very clear on what are the duties of the Secretary in that eventuality, and that's basically work stops and the Secretary has to notify and recommend to Congress changes in the legislation for the objective of permanent nuclear waste disposal.

There are a few things that could be done there. One set of contingency planning could be to prescribe cost effective procedures for winding down the project, for terminating the project, and there's another aspect of this, too--what constitutes unsuitability. Is it--you know, could an engineered barrier system be enhanced to the point that it might be suitable? But then you get into the situation where it might be economically not viable, but we think this is a good target for some contingency planning.

At any rate, the long and short of it is we don't see any extensive amount--any real significant amount, I should say, of contingency planning being done. We think it should be greatly enhanced.

At this point, I'm going to turn the topic--or the presentation over to Joe Kellogg, who's going to talk about whether funds are being spent prudently or not.

MR. KELLOGG: In this particular area, it's in the eye of the beholder. I would imagine one of the things that we did was try to take a look, a very hard look, at where the money was being spent. Roughly 50 per cent of the money is time related, and that says the longer you protract the project, the greater the cost, and you've heard Charles talk about that in that sense.

One of the things that we do see and observed is that the Yucca Mountain share--in other words that money that was spent at Yucca Mountain from 1992, then went up to 1995, from 58 per cent to 75 per cent, which is a positive move. The infrastructure expenditures went down from 55 per cent to 41 per cent. Obviously, as more work is accomplished in the field and the actual repository characterization, that per cent will go down. Science, which in 1992 represented 27 per cent of the funds, in 1995 is 47 per cent of the funds. In other words, the amount of expenditure for science has gone up.

The program approach--one of the things that we did when we looked at the program approach, we said that that was a positive step in the right direction. We had a lot of critique from that of parties that said that--and they were the detractors--that said that really the program approach is really a deferral of cost. In other words, 1.3 billion was not a savings. It was, in fact, the shortening of certain activities that then cut that particular cost from a particular time frame, moved it to another time frame, which is true. It can be a savings if during that process, you don't spend the 1.3 billion and the site fails the characterization study.

What we do see, though, that there is an argument about, is the program approach within the law, and this has been brought up by a number of parties saying the law--it does not fit within the law since you are not carrying out all of the science that should be carried out in order to demonstrate the site is applicable or characterize the site appropriately.

We take that back to the risk. What is the risk you're willing to assume, and that the program approach does take a risk that is anathema to the parties that feel that taking that approach might assure that that particular site in Utah--I'm sorry, Nevada, will be the site--I didn't mean to scare you--in Nevada would then be a fait accompli. And so we recognize that.

One of the things that we say is very important that is not done is making an analysis of the cost impact of decisions that are being made. We see the decisions being made without that kind of analysis in depth.

The root cost drivers, we say that the project lacks an evaluation of what the root cost drivers are for the project. We say how can you spend the money appropriately if you're not sure what drives the cost, and that we recommend it be done.

Maximizing the attention to science--the question, as I indicated, does science drive the project, does construction worship the throne of science, one of the things that we say, and I'll throw this out as a for instance, not necessarily to say that's what we recommend, but if you wanted to get a cost effective project, what you would do is set science aside and drive all the tunnel; in other words, at the most cost effective way that you could do it.

Now, that would fly in the face of a lot of people saying you're getting the cart before the horse. But we say if time is the essence, then you go in and drive the tunnel; at worst case, you've got a hole in the ground that you paid for. However, then, science can go in and do what they choose to do at any schedule that they think is appropriate.

Right now, the two are locked together, the construction, speed, as well as the science, and we say it's an inefficient process. There will be a lot of arguments against that kind of approach.

The other is, as we've suggested in the report, that you could drive the other tunnel, but do that on a lump sum unit price cost. In other words, take the current system, which is cost plus, and look at it again in a lump sum unit price cost describing the geology, and then the cost for the specific geology you might run into. You could go one step further, put in two machines, and you can then drive to two alcoves, and then take the crew and put it to the next machine and drive two alcoves. In other words, you've got them the efficiency of the crews that are driving tunnel, leaving open the alcoves to do the science.

These are some of the things that we say could be considered. We know that there are vested interests that say they want the science to be concurrent with the opening of the mountain, but it depends on how you want to look at what cost and to what risk you might want to take in that regard.

The organization structure issue--how is the project organized? The DOE role is attempting to move some of the responsibility to the M & O contractor, and we say that that's appropriate. We say you should hold the M & O contractor accountable or get rid of him, and I mean in that sense, that if you don't, he's got a free ride so that he's there for a particular purpose, and that's managing a very large project. So having him accountable is important.

That then means what is the M & O role and to what level do you go? We have indicated that to go to Level 2, we don't mean entirely Level 2, but we mean some portion of Level 2 on accountability. We say that DOE always must have the strategic part of that role. They must also have the criteria to be set as to how you measure the performance of the M & O contractor.

We have another project that we're on, making an evaluation of the A project in Boston. That particular project has some of the similar kinds of characteristics, not that they're characterizing the site, but trying to build it. One of the problems is the budget has gone from some two or three billion up to approaching 10 or more billion. And one of the things it has done was bring in an outside contractor to manage the project, basically taking responsibility for the management and the administration of the project.

One of the very difficult things right now is for them to hold back, to withdraw, and let that contractor that was hired manage the project. It's a very difficult thing because the people were used to taking the responsibility, taking the blame of the credit for what went on in the project, but trying to then wean that away, and that's something that DOE needs to do in the particular case of the M & O contractor; a very similar kind of situation, difficult to do.

The structure of incentives to drive performance, that's one of the things that we think is lacking. That's not an easy thing to do, but we think that there can be built into the program an incentive program that will drive a better performance for the project.

A more strict evaluation of the process--we do not see that there is enough strictness in making evaluations of how things were performed, whether it be science, whether it be the construction team, whatever part of that particular operation.

One of the things for sure that we saw is the importance of reducing the layers of authority and get it down to a leaner kind of team.

There's an issue of chief scientist, and that we thought was a simple kind of answer that, yes, they should have a chief scientist, that that scientist could impart to the project a great deal of knowledge, of evaluation, of critiquing, and then we ran into the buzz saw, who does he report to? And that is the conundrum, I guess you might say, that then pauses to the point of saying, is it going to be a figure head, or is it going to be really listened to. One of the people said that we ought to put him in charge of the project, and we said that's anathema to, you know, really having a chaotic condition because that won't work.

We basically in the report have indicated that we think that's a good idea, but again, we can't get a unanimity of an opinion as to how you might posture that and structure it.

The program and project management administration, the program is done on a cost plus award fee kind of concept. That's very well understood in particular contracts. We say it lacks the performance standards to keep the project objectives in tow. There's no reward for risk taking. I guess you could say that this project has enough risks inherent in it for the end product that the risk taking is inappropriate to do along the way. And I'd say that that's probably true. But we say that inside all that process there is an absolute opportunity within the risks of the characterization of the project that you could accomplish some risk taking. What I illustrated was drive all the underground tunnel first and then go back and do science. That's a risk. But again, we espouse the idea of risk taking.

There's little kind of incentive to excel. That's one of the feelings that we have. There's a lot of dedicated people at the site, but not instilled in them is, what we think is very important, is how do you excel, how do you make it the best you've ever done.

Development of impact studies before major changes --there should have been an impact study to some extent on the program approach; in other words, to a depth.

Demonstrate a resolve to dealing with unacceptable performances, and we don't see that as coming down hard in that regard.

Bid contracts that are carefully crafted and also administered.

The last element is something that we spent a fair amount of time with people that were providing input that saw the program approach as violating a law of legal elements, and one of our comments is, well, there's lawsuits that are trying to determine the language, so that we said that it would be inappropriate for us to interpret certain language.

But we do feel that you can then go into the program and decide what element of risk you're willing to take. The program approach we still think is a step forward. It's only been a year. We can't really truly evaluate the total effectiveness, but at least it takes a step, we think, in the right direction. The legal issues as to whether it bypasses the important steps of the characterization of the site we think is a matter of what kind of risk you might want to take to improve the cost and ultimately get the project in the most cost effective way.

Jim?

MR. KELLEY: What I'd like to do is move on to something that we recognized. It's marginally within our scope of work, but very quickly in the process of gathering our data, we recognize that in 12 years OCRWM has had eight directors. Five of them were acting and three of them were confirmed.

Typically the term of office is less than two years. This is not, you know, a director of a Social Security Administration or something like that, where maybe a few numbers change or percentages change and some new checks are cut occasionally. This is a very complex project. It's going to last over decades, and when you get a new director at the helm of this project, it takes a little bit of time, on the order of probably a year, just to learn the intricacies and then decide what to do with it, take it a different direction. That may take a little bit of time to define, and by the time this is put into motion before any momentum is developed in this new style, a new president gets elected, and this person is out and another one comes in.

Now, the solution to this problem is also complex and very definitely would require legislative action. One possibility would be to name the program director for a term specified in years as opposed to what's the remaining term of the president, and another possibility which has more far-reaching solutions, but also is very complex, is to take the program outside the DOE into a Fed Corp or something similar to that.

These would--remember, the thing that we identified was a management and financial aspect, and that is that this turnover is, in our opinion, very detrimental to the longevity of the program. And however Congress wants to deal with that, that's up to them, but we think it's a problem that should be dealt with somehow.

I'd like to move on to stakeholder and issues related to public trust and confidence, and basically the public trust and confidence is not there. It hasn't been inspired, and I know this is very difficult within the DOE. There are many very active, what I would call professional interveners involved in this thing. How you deal with these people is extremely difficult. At the public hearings, one of the people got up and said DOE ought to take a firmer stand when they're criticized in public. I did a little bit of work on this after that public meeting and found out that DOE used to do that. The newspapers who are read by a lot of these anti-project people would dwell on the fight that was between the two as opposed to the substance of the fight.

I know it's a very difficult issue, but one thing that we did find is that there is no plan in place, policy procedure plan, strategic plan, whatever you want to call it, at the project level for dealing with stakeholder involvement and dealings with the public, things like that.

I think the time spent by appropriate people to sit down and brainstorm a few ideas that might be incorporated into a plan and development of a plan is something that is very definitely needed because right now, it truly is not happening right now. And as a result, public trust and confidence continues to slide.

Obviously, if some of the scheduling and funding issues are resolved and the project, you know, really gets on schedule and starts to meet some milestones, things like that, public trust and confidence can only improve.

One of the things that we were asked to look at was whether or not the Nevada test site should be severed from the project, or should I say the project severed from the test site. There's an economic consideration there, and there is also a public perception consideration. We looked at it at first and looked at the economic side of it, and in terms of a very, very small percentage of the overall project expenditures, yes, it is economically viable to stay linked to the Nevada test site, but that is very, very, very marginal.

The other side, we found that many people in Nevada would like to keep the two linked. What their reasons for may be linked to personal reasons associated with labor affiliations, things like that. There are other people who think that the optics of going out to the test site and the secrecy and the issuance of badges and a very awesome gate--I'm talking in terms of people that aren't experienced in entering military or high secret--top secret type of installations might feel. But, you know, is this something that is serving public trust and confidence, or not? I'll tell you, we thought that the perception was a big deal, but after the public meetings, we found that it may not be as big a deal as we had originally thought, and we're still open on that, and I can't tell you what we're going to write finally on Friday yet, but we're still working on it.

We had several other things that we wanted to bring to the attention of the readers of the report, and they were definitely beyond the scope of our work. These things were things that we thought--we stumbled across, we heard a little bit about, but we couldn't do any in-depth analysis about them because of scope, and remember, we're in a hard money basis and a hard schedule basis. But we thought we'd bring them to the attention, but there is absolutely no analysis outside of a brief explanation of what we mean by these, and I'd like for John Reiss to go over these with you.

MR. REISS: I seem to be the lucky one today. I got the tail end and the short end of this presentation.

I would like to take an aside, and on behalf of the review team, thank a lot of the participants in this room that had to put up with us during the interview process. I know it was difficult and trying at times to see us sitting at your front desk or the front of your house, for that matter, which is the last thing you wanted to see. But we do thank you for your cooperation.

As Jim had indicated, some of the things that were a recurring theme during the course of our study, both in terms of the documents that we reviewed as well as the interviews that we conducted, and there are a number of them here, they're not new, and they're not unique. They've been addressed in the past either by the Board itself or other entities, but we thought they were significant enough to again appear as a reiteration in our report.

One of the issues was a strategy concern, not only a site suitability strategy, but a license application strategy. Some of this is a part of the program plan, but throughout the course of our study, one thing that was a recurring theme was the science. What science was being done, what science was not being done, what science was being changed, and what science was being deferred? Not a very good understanding by any party as to exactly what that means relative to the Site Characterization Plan, which is the basis for site characterization work at the site, or in terms of 10 CFR 60 or 10 CFR 960.

If there were a better articulation and clarification of that issue alone, it would go far to a lot of the issues that we brought up in the course of this discussion this morning, one being trust and confidence by the public, or as we call them, stakeholders. And I'll go through these pretty briefly.

The other was outside technical consultants. Of course, the Board has oversight with regard to this project, but we concur on a number of times where the Board has indicated the need for geotechnical or geoengineering type of committees to be set up to perform an additional oversight on some of these very critical technical issues that come up periodically during the course of the evaluation at Yucca Mountain.

So our concurrence with that concept is certainly something that we wanted to include in this report.

And I think two of the things that--or two instances that we used in our report was the decision with the TBM in terms of its size, as well as the LM-300, and some of the issues that were raised during the course of those decisions that were being made, which in our opinion could have used high-level technical outside expertise to deal with those two particular issues.

The other is a criticality of the Exploratory

Studies Facilities, which you'll be talking about today and tomorrow obviously as a part of this presentation.

But again, we wanted to re-emphasize the need for as much resources from the technical standpoint, as well as the funding standpoint, to proceed as aggressively with the ESF as possible to satisfy a lot of the requirements from the standpoint of site suitability as well as license application, and performance as well as construction, if it gets to that point, as far as Yucca Mountain is concerned.

The government radioactive waste--there's been a lot of discussion with regard to what kind of wastes are going to be emplaced at Yucca Mountain. The Act does call for 70,000 metric tons of spent fuel and a limited amount or quantity of Department of Defense waste. Now, there is other discussions that DOE weapons complex may contribute some more material, as well as DOD may be contributing additional materials. I think that's a critical issue from the standpoint of the viability of the site, depending on how much volume is going to--and the type of materials that ultimately will be in place at Yucca Mountain.

And the last issue is transportation. Again, this was a recurring theme. We understand that the DOE has done extensive work with regard to transportation issues, but the public at large, or the stakeholders, are of the opinion that they have not been a part of that process, and transportation, as far as the local governments are concerned and the local jurisdictions, are extremely concerned with regard to the transportation issues.

So again, it was one of those issues that during the course of our work was a recurring theme, and we thought it worth being placed in our report.

And that's about it.

MR. KELLEY: That's all we had planned to present today. I think we're open for any questions that you might have.

DR. CORDING: Thank you, gentlemen. We would have time here for questions and look forward to that.

Questions from the Board at this time? Don Langmuir?

DR. LANGMUIR: You mentioned the possibility of an outside corporation as a way to manage this program. I'm wondering if you looked at that not only in terms of efficiency, but when you looked at your total system life cycle cost analysis, did that include a consideration of that, of the choice of an outside corporation versus the current program management?

MR. WILKINS: No. The total system life cycle cost did not include that as an assumption.

DR. LANGMUIR: Do you have any thoughts on what those costs might--what might happen to those costs?

MR. WILKINS: Honestly, I do not. It would take some analysis, understanding the structure of such a corporation, how it would operate, what its duties and responsibilities would be, et cetera, et cetera, and we did not go into that effort.

MR. KELLEY: To add to that a little bit, obviously if the funding could be--the funding levels could be stabilized, the project could be managed with a lot more control, if you will, and I think the government type corporation could--you know, if they could get the funding, get the directorship, to have some continuity to it, I'm sure it could improve. Obviously it's a question of having the right people, you know, to run that corporation at the Board level and the right person, you know, to direct it, and obviously the assistance and all that.

There are problems with that that could impact the total system life cycle cost. These corporations are usually not formed overnight, and it might take several years to get that formed, and, you know, the board members on the board and, you know, just the mobilization, which would delay things and probably disrupt--you know, even assuming that a lot of the same staff would move over from one to the other. Being through a few changes like that myself, I know that there are lots of rumors that abound and it has productivity ramifications.

DR. LANGMUIR: It sounds like one of the things that you suggested could occur along with that was very sensible; namely, a long term director for the program potentially in place, which provides management continuity as well as funding continuity.

MR. KELLEY: Yes.

DR. CANTLON: Having spent 20 years of my life administering budgets that have to be derived from political processes, I'd like to press you a little bit on your examination of contingency planning. I know that in my experience anybody that represents their budget to a political body doesn't come in and tell them how to do it cheaper. In other words, there's something inherent in the way one approaches any project that has to be funded by the political process. You don't come in and tell them how to do it in case A happens, B happens or C happens, or you end up essentially undermining your case.

Did any of this kind of discussion get into your interplay? It's very difficult for administrators to say that candidly. I'd have to--

MR. KELLOGG: I can say that we ruminated around it. In other words, we recognize that one of the key elements here is who takes the risk, and right now DOE has the risk of that. When it transfers to another organization, does DOE, as the government representation, represent the public in a risk aspect?

And so one of our concerns was, to someway address what you're saying, is the budgeting process we think could be then done in--outside the political arena. You could then--and then you could plan work. You could then, I would think, scenerialize risk taking put before some body that was ensuring they were taking care of the public's interest. But I think our intuitive feeling--and we've done a lot of management audits on very large projects--our intuitive feeling is it would improve. The question is, could you sell that politically?

DR. BREWER: Garry Brewer of the Board. As I'm sitting here listening here very carefully, it sounds as though you look at the dates, the milestones, as being probably not attainable, and if so, then perhaps storage as an option is something that would enlarge. Did you do any thinking in the scenarios, particularly with respect to total life cycle cost, for what might happen if the schedules are not met and the need for interim storage occurred? Did that occur to you as being something useful, important, and did you do it?

MR. KELLEY: It occurred to us very definitely as being something useful and important, but was not truly within our scope of work. I think that would be a very interesting study, to show scenarios of--various scenarios of storage, what that might do, obviously in view of the Nuclear Waste Fund. I mean, we did a lot of little thinking, you know, sidebar conversations and that sort of thing. Yes, we thought extensively about it, but we were bound by a scope that didn't allow us to put anything down formally. But I think that would be a very beneficial exercise for somebody who do take the various temporary storage type scenarios that might be out there and look at ultimately characterizing the site and going ahead with the repository on a different schedule basis with maybe the sense of urgency for ultimate disposal being put off awhile, but no, we were unable to do that within the scope of our work.

DR. BREWER: Thank you.

DR. DOMENICO: Domenico, consultant.

Was it your recommendation, or perhaps just an option, that the ESF be driven expeditiously and the science done--science done later. I noticed you mentioned that. I'm not quite sure whether you thought that was an option or a recommendation.

MR. KELLOGG: To recognize that what I said isn't necessarily incorporated precisely in the report. We have said that there should be options to drive tunnel and do so under some kind of cost incentive. One of the things that we're very aware of is the cost of time, and so you could run off the numbers and you can drive the tunnel, and you want to look at time by the day. If you get the tunnels done in a very short time frame, you have a substantial amount of money that you have saved. The risk is will it be characterized in the end in license, but we say you can go all the way to the end with the way you're doing it, and you still have that risk.

DR. DOMENICO: In coming to these conclusions, did you check the down time for let's say just the equipment failure or the down time to "do the science," and just what part of that five-month period you were making tunnel, what part of it you were doing testing and what time you just had other problems? Was that part of your database?

MR. KELLOGG: We just know that if you want to drive a tunnel, how fast you can do it, just on historical experience. We didn't sit down and say--because again, it was outside the scope of what we were directed to do. But in just running rough numbers, you can indicate that you have a substantial amount of savings because of time, but you also have the risk, which you drilled a hole in the ground and you found out very quickly that you couldn't get it licensed.

DR. DOMENICO: Thank you.

DR. LANGMUIR: I was going to ask about that same issue, but I have a different slant. In defense of DOE, this tunnel is being built to characterize amount, and if you put the tunnel to--first and you blow shotcrete on the walls and put up steel ribs, you have lost information that you went down to find. You've blocked off the sources of water in fractures, you've eliminated the chance of doing a whole lot of test work that you have to do. And if construction requires that these engineering practices be put in place to have tunnel stability, you destroy what you were going to do.

So you're stuck with the fact that you have to characterize amount, and that's what the tunnel's going in. And the information will not be around for you to find out about later in many cases. After you come back to it once or a year later, it will be gone. You can't sample water that's disappeared perhaps, and if you ventilate the system, you've changed the properties of the rock, and the pneumatic tests would no longer be meaningful.

So a lot of things are going to be affected by expediting tunnel to save money, and as you say, you may not be able to license because you won't know about the system. You haven't made the measurements you had to make along the way.

So there's a Catch 22 in this. There's a real problem of how you can optimize both, and I certainly hope DOE is doing that, but that needs to be done.

MR. KELLOGG: You can log the tunnel as you go, and you can also do alcove work that can get accomplished very shortly. In other words, there aren't years after the time frame if you just go ahead and drive tunnel, or the other alternative, drive alternative tunnels.

DR. LANGMUIR: But then certainly chronologic testing and sampling has to be instantaneous. If you find water in a fracture, it's critical that you sample it that instant, practically.

MR. KELLOGG: And you could do that, certainly.

DR. LANGMUIR: Yes, but not if you're going to drive the tunnel to the end. Obviously there's a lot of give and take that has to be built into the program methodology in the ESF.

MR. KELLOGG: But if you found that instantly, you could stop at that point.

DR. LANGMUIR: You'd have to.

DR. CORDING: In regard to this, we had the opportunity to visit the tunnel several times during the--three times in the last year over the last few months. And the Board had been very concerned about this interaction between construction and science. I mean, obviously, it's a very major investigation. It's also a very major construction. And those types of projects are a challenge. And I felt that we had felt also in some of our comments and recommendations that in proceeding as efficiently as possible with the tunneling--because as you say, time is money, was helpful.

And I think one of the things I've seen is that there has been a real major effort to try to integrate science and construction. We were very concerned, for example, about one month delays to build an alcove. What we've seen is that some of the--and the idea of delaying alcoves seemed to us to be also a good idea where you could put several in at a time later.

One thing that did happen was that one of the alcoves that's been going on has--for the most part, as I understand, it's been going in--it is going in concurrently with TBM operation. They haven't taken the fan line down. They've been doing some of the alcove work on maintenance periods with the TBM. So it seemed to be working more efficiently than perhaps it might otherwise be. So I think there's been a strong effort there.

And one of the questions I have is in terms of looking at the progress of the underground operation, it seems to me that things that are--a lot of things that are going to control the ability to complete the tunnel, it goes beyond the science construction interface. It really relates to items of the way the management and the contracts are organized. And it would seem to me that one could accommodate a science investigation with delay or even concurrent cooperation, even under situations in which you say you go with perhaps more of a hard money type contract, but you still allow delay times for doing certain things, and make sure that you accomplish the scientific objectives that are necessary.

But one of the concerns I've had is that the contractor is limited in his ability to do those things because he doesn't have control of his resources. He is in an environment where the funding--whether he has certain pieces of equipment, things depend on a long procurement process, which he has not control of. Design of construction equipment may be done by others rather than the contractor himself. The quality assurance issues of the quality of initial support as being part of the QA, that whole process, then, affects the ability to develop and modify effective support systems.

So those are the things that I've seen as influencing this progress, and really what I'm trying to ask is a question, how you look at those other interfaces.

MR. KELLEY: One thing that--when I first saw this, I wondered why are we paying cost plus for a tunnel. There's a lot of things of cost plus. One of the things that cost plus provides is no incentive, no real incentive to make money. Obviously, there's a risk of losing money.

But I got to thinking there's a contractor out there who's contract form could be negotiated into a hard money; maybe someone else come in and bid it, keep them honest, that sort of thing. But he already knows that piece of equipment. He wouldn't be required to purchase the support materials only to install them, keep that in place the way it is.

But what if multiple zones could be defined in advance? In other words, if you have this type of a zone, you're going to be working 24 hours a day or some prescribed number, and in this zone, you can expect to be down four hours during the 24 for the purpose of science.

In this zone, it's a little bit different. You might expect to be down six hours per 24 for the purpose of science, and maybe eight or whatever. And you might be paid the unit price on the steel set. You might be paid a unit price on the rockbolt. You might be paid a unit price on shotcrete, if that's required. And if you are down for the purpose of science longer than what that zone called for, each one of those zones would have a different unit price. But if you're down for five hours instead of four for the purpose of science, there would be an hourly cost plus, if you will, measured per the hour, which might provide an incentive for the scientific part of the management of this thing to keep that to a minimum. In other words, it would be nice if we had just a little bit more. Do we really need a little bit more?

These types of things can usually be settled up at the end of the day on quantities of payment in minimal amount of time. A similar type of thing could be installed for surface drilling, different zones, different sampling, different casing requirements, so that it's a unit price type thing based on some kind of a presumption of what the hole might look like.

I'm not saying it's a very easy thing to do, but I think it would provide incentives.

DR. ALLEN: I'd like to look at a little bit larger picture regarding the science. You've talked several times about the science element of the total project and their ultimate objectives.

Having talked to many people now on the project, including scientists and managers and so forth, do you come away with any general feelings that in terms of the ultimate objectives of the project that too little science is being done to support the necessary engineering decisions on a timely basis, or perhaps that too much science is being done that may turn out to be irrelevant to the fundamental decision that we made?

MR. KELLOGG: I'll respond to that and then turn it over to John, but it goes back to the chief scientist again; is there a party, a guru, who could make some of those judgments? I think what we're challenging is the idea that every day is business as usual, and that's not a critique of the people. That's what you're--that's what you're in in this particular environment. And we're challenging that to say can there be some creative thinking as to how you might approach a more cost effective way, since cost is one of the elements here that is being critiqued.

As far as some of those judgments, I'd want John to comment on that.

MR. REISS: I think what we came away with was both ends of the spectrum, that of all the people that we had contact with and the documentation that we went through, some felt that not enough science was being done, some felt too much science was being done, but it depended on what area you happened to speak of, be it hydrogeology, rock mechanics or whatever--or geochemistry, whatever that particular area was.

The gauge for it is the Site Characterization Plan. That lays out the basis for the testing that will be done at Yucca Mountain. And again, it goes back to the uncertainty of where that Site Characterization Plan is at the present time relative to the program approach, and previous to that, the Mission 2001 study. So you don't get a good feeling as to being able to make that judgment as to whether too much science is being done or little science is being done.

We did come away with the fact that there is some duplication of effort. There's some overlap of effort, which is somewhat wasteful. But again, going back to the basic core, if you're using the Site Characterization Plan as your starting point, where are we in that process relative to, then, the site characterization, the suitability issue, and then superimposing those casks on the mountain to change its character that we can live with, which will be the license application?

DR. DOMENICO: I don't know if this can be answered, but how many of these difficulties can be alleviated by some new structured contractual agreement? Is that the heart of the problem, or is there other things?

MR. KELLEY: A contractual agreement with respect to--

DR. DOMENICO: With respect to the progress of the--

MR. KELLEY: I think a lot could be done in the case of the tunneling.

DR. DOMENICO: Because it is, obviously, the largest absorber of funds, at least over the data period of which you looked at things, I believe.

MR. KELLEY: Actually, a couple of observations about the tunnel. It's the only visible product that the public is well aware of every day; how many feet did you get yesterday? You know, how far did you progress on a ground transport model is something that never reaches the press, but the tunnel progress is something that is quite visible.

I look at that tunnel as simply providing the access to science and not so much science itself. In other words, without the tunnel, all the scientific work that needs to be derived from the tunnel is made accessible by the tunnel. Obviously, some of the science needs to be--data needs to be gathered as you go through, but some of it could be acquired at a later time through alcove construction.

I just don't see the cost benefit studies. What if we went through there and got the tunnel done and then came back and did four or five times as many alcoves? What would the cost of that be? I think it would be a shocking number, quite frankly.

DR. DOMENICO: Well, there's windows of opportunity that you have to take advantage of.

MR. KELLEY: Obviously.

DR. DOMENICO: You certainly agree to that?

MR. KELLEY: Obviously. You have to look at things as you go. You, obviously, have to map the conditions as you go to find out where to come back to in the event that you may decide you want to come back to. But basically the tunnel itself, I see as the access to scientific data. Some people will argue that it's the repository, and that's a political issue, which that's another argument all together.

DR. PRICE: I've got an easy question for you. After all of this work that you've done and the many things that you've looked at, if after doing all of this you could only deliver one message to the DOE, what would it be?

MR. KELLOGG: You might get a different opinion from all four of us. Maybe we'll go down the line. John can start, and then we'll go down and we'll take Charles and then Jim and myself.

MR. REISS: I wasn't so lucky after all. We spoke about this on many occasions in our meetings, and I don't think we came up with a simple answer. Obviously, there is no simple answer, and, obviously, there's so simple advice either.

From my standpoint, I guess the science is an issue. In terms of looking at exactly what's trying to be done at Yucca Mountain with regard to science, I didn't get a clear picture at all with regard to what all people are trying to do. And my first question would be, what are you trying to achieve?

MR. WILKINS: I'm going to go way out on a limb here. My background is in public contracts. I'm a CPA, and I've worked--my specialty and consulting has been in public contracts for several years. After working in the defense industry for almost 20 years, I've been in consulting for now 11 or 12 years, all focused on public contracts.

I've seen a pattern of public contracts, whether they be federal or state, that seems to also apply here. My counsel to DOE would be get tough. Act like you're running a business as opposed to acting like you're spending funds.

I think that counsel goes to the root of your question over here about structuring--restructuring contracts. I think it goes further than that. I think it's a total combination of management acting like they're running a business and essentially trying to make a profit out of that business. You know, the profit aspect is in a little different context here than it would be in a for-profit organization. But I think that being the beginning point, the DOE needs to go through the same kinds of processes for decision making as a normal company--as a company would do, whether they be buying equipment, whether they be digging tunnels, whether they be staffing the project, hiring contractors or subcontractors, whatever the case may be.

I just feel that if they looked at this project as a profit-making business and made decisions as if their job depended on them making the best decision for the project, I think they would be much better off.

MR. KELLEY: I thought about this when we first became involved in this thing, looking at an organization structure, for instance. You only start out with what's the definition of what it is you want to do, what is it you want to accomplish. What's this program, what's this project supposed to accomplish, forming the organization around there to carry out the various functions. You look at planning. You look at implementation. You look at corrective action; in other words, mid-course corrections. Revise the plan, revise the implementation.

But there's one thing that in addition to what the others have said so far, there's a lot of critique on this project, and some of it, obviously, can be thrown out the window, and some of it is very good critique that was not heeded, quite a few recommendations that came out of the TRB. I see the lack of external consulting by the DOE, for instance. A lot of these things, you know, a fresh look at it--I'm not detracting from TRW and all the other participants, you know, what they might be bringing to the table. I'm just saying sometimes a fresh look at particular areas of it can help the planning, the execution, the process, just the process in general. Revise a plan and heed the advice of the true critics.

Now, the ones whose opinions are cast aside, obviously, will continue to criticize, but there's been a lot of, I think, very good criticism that has not been heeded by the DOE over the years.

MR. KELLOGG: I think that as we got into the project, we recognized that science and construction was not an easy match; in other words, to put together. And one of the things that we felt in looking at it, there needed to be a better kind of working as a team in that area, but defining what science was trying to accomplish, identify what the cost drivers are in trying to drive the tunnel.

I think that one of the things, again, that we would talk to DOE, which I think we do in the report, is that as long as they're in charge of the project, then be assertive about it. There's a lot of criticism at DOE, some not founded, possibly others founded. But we think that they have been too timid in not stepping out and being more assertive about being in charge of the project, being responsible for the project, setting the criteria for it, and managing the parties that are under them. There is a historical kind of consideration of M & O contracts, and DOE does a great amount of M & O contracting. And so, in essence, hiring out for expertise.

Once you do that, it's absolutely crucial that you either find, hire, or within the organization find the kind of people who understand how to handle those kinds of operations, and then set the criteria, be very adept at being hands-off on the day-to-day kinds of decisions that are being made, but do a lot more cost analysis about what are the perturbators of the cost system, what are the drivers. We don't see enough of that real aggressive, I'll call it private sector look at how the job is being run in terms of where you're spending the money, what kind of return do you get for that money. I think those would be the kind of things that we'd say.

DR. PRICE: In regard to almost every one of your comments, what do you think about the way the DOE uses the National Labs?

MR. KELLOGG: Can I say a comment before John starts? How the National Labs might use the DOE.

MR. REISS: I rest my case.

MR. KELLEY: I have one set of observations. It's very obvious that in terms of public trust and confidence, you have to have what I would call a Good Housekeeping Seal of Approval, which using the National Labs is definitely an option, a very strong option for doing that. Whether you have to use four or two or, you know, that many, I doubt it. I can't tell you, you know, which ones to drop, and I wouldn't even attempt to do that, especially in public. And I truly don't have an opinion on that. But I think for the public trust and confidence, that type of--you know, National Academy of Science, National Labs and that sort of thing is definitely--I think there would be a lot more problems without it than there are with it.

DR. PRICE: May I ask one final question, and that is--since I'm talking, I guess I can.

DR. CORDING: It may not be the final question, but for you.

DR. PRICE: I mean for me. With respect to your comment about transportation, do you have any comment? I realize out of your scope, Mr. Reiss, but do you have anything to say about their use of the transportation coordination groups? I thought transportation was making a rather strong effort to address the problem that you fingered.

MR. REISS: I came away with just the opposite I know there have been internal studies and aggressive discussions with various groups and so forth, but a railroad is a client of mine, and they have questions, and I couldn't answer those questions. To what degree they've been notified or informed of the plans, they get very nervous when they look at Germany and taking waste from the southern part of Germany to the north part of Germany to 6,000 troops. Is that one of the pitfalls that we face with the transportation issues here? Some people say, no, obviously not. Some people say yes. Some people don't know.

And there seems to be a general lack of understanding within the stakehold or within the public domain and within the business area as to what's happening with the transportation issue.

MR. KELLEY: I'd like to add one thing with that. The studies that I looked at on route selection, whether it's highways or railroads, a large share of this waste would probably come through the state of Missouri. They're one of my clients. The chief counsel for the Transportation Department Commission of the State of Missouri doesn't even know that yet.

DR. CORDING: I'd like to ask Wes Barnes, if he would--if he'd like to make any comments here, I certainly would want him to feel free to do so.

MR. BARNES: My selection was--firstoff, looking at these four gentlemen, a song kept coming to my mind, "Somebody Loves Me, I Wonder Who."

My selection was announced, I think, in December. I was sworn in in January. They told you the time frame that they accomplished this study. They did not talk with me.

Rick, did they talk with you?

MR. MEMORY: Yes, they did.

MR. BARNES: They certainly didn't communicate with me.

There are incentives in the contract. You went two years without a project manager. You accomplished a worldwide search and picked me. The incentives in that contract will change for the last half of this year to reflect the dollars being sent. If 70 per cent of the dollars are being spent at the project, that's how they're going to win their incentives. Dr. Dreyfus has already assured me that that's going to happen. Next year we will totally revamp the incentives.

By September there will be a critical path to TSS, and, therefore, everybody will know what their mission is in regards to doing technical site suitability for this mountain.

All of this assumes that the Congress is going to fund us. We don't know. But I plan for that, and that is my contingency plan. That is my contribution to date in just five months. What is this project manager going to do? He's going to direct a critical path to TSS, so everybody knows where they're going, and we will be on time. The schedule will be on time. I will accomplish that if I'm funded. I don't know what else to do.

I spend 30 per cent of every dollar I receive on compliance. I only spend 10 per cent on overhead. If I was running a company, I would be very proud of that. I'm forced to spend that 30 per cent. This study was part of that 30 per cent. NEPA is part of that. The State is part of that. The affected units of government are part of that.

When a utility wants to talk to the NRC, they must file a license before the NRC even talks to them. I have no idea when I'm going to reach LA, but I have two resident NRC inspectors today.

It is a difficult project. It's something nobody has ever done before. You'll find out when Rick talks to you today, or he told you he has my confidence, that we are doing something about that outside board. We have brought on board--I have brought on board some big time consultants. Bill Derrickson is now working for us. He's the only man in America that has built five nuclear power plants on time, on budget. So, therefore, he had to build five surface facilities; somebody I'd like to talk to.

We are finding people like that. I realize they do need some help, some other help. Dr. Dreyfus is making changes. He put the program in place. He hired me, brought Rick on board. I hired chief counsel. I've got a new MA. There are changes. There are new voices and faces coming into the project. Will it make it any easier? Somebody loves me.

DR. CORDING: Thank you.

We have a few more minutes left for any other comments from Board and the staff, and our consultant, John Reilly, is with us, also.

John, did you have some questions or comments?

MR. REILLY: Thanks. I guess I understand a lot of what's been presented because it's pretty common to the management of very large transportation infrastructure on the ground projects.

Now, what I hear, and this is more of an observation, is that there needs to be a much better integration of the fundamental goals and objectives of the total process. And I haven't had a chance to read enough, to study enough about that, but it seems to me that some of the struggles that are going on about the specific performance measures, the incentive, the hard money relative to tunneling, need to be put in context with an overall management plan that includes contingency and risk and analysis and brings together the fundamental stakeholders within and outside of this particular team.

We haven't used the word team yet, but team is a fundamental concept to making something like this work, and I would like the opportunity to read more in depth about this, and then perhaps offer you some observations later in the day.

DR. CORDING: Thank you very much.

One more comment from the Board, and then we need to take a break.

DR. LANGMUIR: Langmuir, Board.

One of the things that the TRB has observed and have been a little frustrated about over the years has been that the DOE in response to the vagaries of budgets annually has chosen to put off we think critical projects, but critical program activities, namely, for example, the engineered barrier system analysis, what it would play in the overall performance of the system, long-term corrosion tests, long-term thermal testing.

These sorts of things have over the years been put off and not been done as we felt they should have been done in parallel as opposed to in series. And because of that, the program is taking longer than it might have taken to get to the point where they understand how to apply that scientific information to performance of the repository and how it might perform.

I just wondered if you'd looked at the series versus parallel question in your analysis of DOE's management of its activities, if you had any critical comments on that, constructive or otherwise?

MR. REISS: We did look at it as part of the study. Obviously, the first thing that concerned us was the thermal loading issue and the sequence of events leading to some conclusions with regard to the thermal loading issue. The engineered barrier system was another outstanding issue.

We did not look at it beyond the fact that we felt that these things should have been done earlier and should be done in a manner where the data that's generated from these various studies will support the site suitability license application issues.

Given the schedule as it is set under the program approach, we just have questions of whether or not adequate information is going to be available at those key milestone dates to make those assessments.

DR. CORDING: Okay. Thank you very much. We need to break now. We will reconvene at--try to take as close to a 10-minute break as we can. So let's make it 10:30.

(Whereupon, a break was taken.)

DR. CORDING: The next presenter is Richard Craun. Richard is Assistant Manager, Engineering and Field

Operations, at the Yucca Mountain Site Characterization project, all this, in other words, in Nevada and the project. And he's been on the project here at least, I think, for six months or more, a little bit more than that, and he's made several presentations to us and described some very interesting changes and progress that have been made over the months. And, Richard, we're interested in your current update on the ESF.

MR. CRAUN: Great, thank you. I'm glad to be here and have another opportunity to give a presentation to the Board and to the public. I am Richard Craun, the Assistant Manager of Engineering, Field Operations.

I have the pleasure on my first slide of showing that we are still ahead of schedule. I wish I could say below cost, but I'm not. I've not asked for any more money, but we are ahead of schedule at this point.

If I can find a pointer here. The green line represents the baseline. That was the original plan for '95. The red line represents the actual performance on the excavation of the ESF.

This section up here is our projection. We're nearing the end of our outage where we tied in the conveyor to the TBM, did a 500-hour warranty work on the TBM, those sorts of things. That outage is coming to a conclusion.

Before I get into a lot of detail, since I've seen some of you out at the tunnel, but not all of you recently, the ESF appearance--I hope this comes--well, it looks fairly good. The appearance has changed. This is the conveyor system that is being installed. This is what will take the muck on out to the exterior of the tunnel.

You'll see that we're in non-steel set, non-ribbed ground conditions at this point, but that's exactly what the tunnel looks like.

We had another week or so of excavation before we shut down, so the machines are a little bit further down, obviously daylight out there at the end. It's nice to see it get smaller and smaller.

This is Alcove 2. I looked for several--I looked at several different photographs, and this one doesn't do it very much justice. This is where we're nearing the completion of Alcove 2. I believe we had our last shot last night. We'll have to do some leveling of the floor, but as far as the main--the excavation itself of the tunnel proper, it is complete. So we'll be leveling the floor and then turning it over to the science community.

That, unfortunately, is behind schedule, was behind schedule. We got started late on that, and the design and construction dates were both behind. Once we started construction, though, we did complete it on schedule as far as the original duration.

The next slide--and this is my last slide, and I'll get into then some of the other facts. This is a view--it's kind of a fun view of the outside. The portal is right over in this area, and that would be the external conveyor going out to the transfer tower up here on the upper right-hand corner. That fairly much at this point in time is complete. We're hooking up the electrical equipment at this point in time on that conveyor system.

There's been a lot of discussion in the brief six months that I've been here about tunnel advance rates, and what I want to just kind of do is give some information to the Board on how we've been doing. So we broke it up into different sections or segments, and as one can see, originally we started out in the first 300 plus meters, averaging about 3.8 meters a day. We've been able to improve that from Station 3+75 to 5+60 to about 6.2. We're up to 11.9.

We've been able to accomplish some of our highest day--our highest day is 23.6 meters, and our highest week is about 96. This does not yet meet my personal targets and goals, but we are getting closer and closer and are making improvements.

I also wanted to kind of highlight what some of the accomplishments are thus far in the construction of the ESF. We did start out six weeks late. The TBM started September

20th. We were approximately 20 days behind on Station 3+75. We were one day ahead, and that was a very difficult day, but we were one day ahead on Station 5+60, and we're currently about 55 days ahead for the baseline schedule, that baseline as published at the beginning of '95.

This is the part where the risk factor goes up a little bit, and this is some of the projections. Our '95 baseline schedule shows excavation of 12+80. It appears to us that we should be about two months ahead of schedule on that. That would be the end of July, 1st of August, we should meet that milestone.

Alcove 2 will be completed actually a little bit ahead of that. The charts should be changed. We're a little ahead of that.

Alcove 3, we are going to start that on August 18th. What we're doing is, I put a note up there that says we're using a generic design. We're trying to take some of the lessons that we learned on the ESF, where we took the north ramp and took the ground support design and projected that into the main drift. We're taking the same sort of application in our alcove designs, where we're taking an Alcove 2 design and projecting that into Alcove 3 and Alcove 4. The dimensions of those alcoves may change, but the fundamental designs will not. The fundamental calculations will not.

So we've been able to cut quite a bit of time off that schedule. That was, up to about two weeks ago, running behind schedule. We are now ahead of schedule, only by one day, but we are currently ahead of schedule, and it appears to be possible for us to meet that.

The subsurface conveyor is intended to start up. Our original target date was July 12th. I've had to move that to July 17th. We will be going through the initial rooting out of the conveyor. There's a fairly sophisticated control system on that conveyor. We will be going through-- between the 17th and the 24th of July, we'll be going through a lot of starts and stops.

In order to facilitate continued excavation of the tunnel during that start-up period, we've modified the TBM. We've installed a bypass conveyor system that will allow us to fairly painlessly transfer to the main conveyor, or from the main conveyor, on over back to the muck cars so that we can--if we have a problem with the main conveyor, we'll be able to go back to the muck cars and continue excavation under that mode of operations.

I've got a series of slides now entitled "Continued Enhancements." That's ways in which we're trying to get better.

When we first started, or when I first joined the project, we had a lot of issues taking place between the field and the original design, a lot of difficulty in getting it constructed and a lot of issues, and the resolution of those issues was taking a lot of time on the engineer's part and on the contractor's part.

We've gone through--we've made a series of changes to try to transfer some of the authority and responsibility out to the Title III engineer out in the field. There's a series of decisions that they should be able to make, which will allow us to support construction in a more timely fashion and stay ahead of construction and keep the machine running and keep the construction forces busy--or excuse me, on schedule.

And that seems to be working. I think, personally, we have more to do in this area. In fact, I had some meetings with the new head of engineering, and also Bob Sandifer, head of construction, last week to talk about even yet some further changes and enhancements that we're wanting to make in this area to, again, empower more of the decision making authority out into the Title III community.

The other area is a communications issue. We've had a lot of difficulty in getting everybody to focus on what the end result was. We needed to excavate a tunnel. We needed to acquire the data from science. We needed to have the mappers. And so what we've initiated was a series of weekly meetings, a variety of different ones, and the purpose of those meetings is to improve communications.

And we've really seen a lot of benefit there. We're starting to get the engineering organization to be more responsive to construction. We're also getting the constructor to be more responsive to engineering. In other words, oftentimes a constructor doesn't realize some of the details behind the engineering, how difficult they are to change.

The communications has been also enhanced by some of the, I would say minor organizational adjustments. Sometimes it's personalities and conflicts and those sorts of issues. So we've made some adjustments in those areas, and actually feel that we're making some improvements. Construction is happier with engineering, and actually engineering is sometimes happier with construction.

Procurement has been an issue. It was discussed a little earlier today. We've taken--we've issued several blanket purchase orders on a lot of our commodity items; ventilation materials, piping materials for underground support systems, and also the actual ribs, the steel sets, et cetera, so that, in fact, we have shortened then the release time that it takes for us from the time that we need more materials to go ahead and release or cut another release to that purchase order and get out and on the streets.

Some of the other things that we're doing in this area is we're trying to decide what is a tool and what's a designed product. The constructor can buy tools. Is a TBM a tool? Well, that may be stretching it, but it may be a tool, and that would make the process for procuring those types of items a little more expeditious.

We are looking at those and coordinating with the administrative side of the DOE's house because there are lots of DEERs and FARs associated with procurement to make sure that we're maybe stretching the envelope, but not breaking the envelope, but to give us the latitude necessary in order to get materials there as we need them, and also the tools there as we need them.

We have gone through an exercise which both DOE and the M & O participated in, where we reviewed the procurement process itself and the number of steps and the series of sequences that one has to go through in order to actually release a procurement action. We have modified that. That has just been a recent change. I'm not sure what the impact is yet, if anything. I talked to Toby Wightman, I guess Monday and also Friday, to see if there's yet any visible evidence of any improvement. Have we made things worse? Have we helped it? I haven't gotten any indication yet that that's had an effect, but that should come to the surface shortly.

Several times over the last few months, I've heard of a quality assurance problem. Well, to me, I may have a different view than some. I think quality assurance is doing a great job. They're ensuring that we get exactly what engineering specifies. Now, sometimes when engineering is very robust in their specifications, and that has an impact on delivery, cost, ability to construct it and a few other things, they would rather have more latitude in that area. But QA is doing exactly what they're--what we're asking them to do; that is, to read the specification and to ensure that we're getting precisely what we specify and precisely what we ordered.

We are looking at the design specifications to see if we can simplify them. An example of that would be the steel sets. We went to the--actually two or three different manufacturers looked at our specifications, and have made changes in both the specifications and also the construction requirements. In doing so, we've been able to accomplish or effect approximately a 300 per cent reduction in steel set costs.

We have another crew out there, I believe they departed Las Vegas last week to go back to the manufacturer again to see if we can--now that we've realized the first round of improvements, to see if there are additional improvements that we can yet make.

As we continue to make projections on improved TBM performance, steel set availability is still an issue. There's a lot--they are very time consuming. They take a long lead time. So if I change my assumption from 20 meters today to 26 meters a day, I quickly run out of conveyor, I quickly run out of steel sets, I quickly run out of rockbolt. So we're trying to see if we can improve our ability to provide material just in time, without spending millions and millions of dollars in stockpiling of materials.

Now, this has been--this one is near and dear to me, TMB performance in faulted ground. Well, six months ago, I didn't know what faulted ground is. I now know what it means, and I know what it will do to a machine, and I know that I don't like it.

We've done a variety of things to try to help our machine. We do not have a main beam machine. We have a shuffle shoe machine. It's third generation type machine. In order to help it, we've made some modifications in the ground support systems that go with that machine. We have made modifications to the lagging design so that it is easier to install. It is still steel, and thus it's heavy and difficult to install.

We have just recently, and it's really a lesson learned that we're trying to carry over or carry back from the Portland machine, the sister machine up there, the use of an interwoven metal fabric, and that also uses a rib design to support it. It will also use--we've got, in our design documents now, not only a rib design support system, but also a bent channel support system, which would employ rockbolts. The intent is try to do as much as the Category 3 ground support in a non-lagged fashion, in a wire fabric fashion, and with either a bent channel or with a rolled steel.

We've been able to make some wonderful progress. You know, originally, we were wanting to--the original estimate on the tunnel showed a lot of rockbolt installation. On several occasions, even though we were in the ground conditions as indicated by Q, or by the Q of the--by the scan line, we were unable to set the Williams rockbolt. The Williams rockbolt reminds me of a Hiltie in the commercial nuclear world, but it's a pinning type of device, which allows--there's a small section of it that is a compression fit down in the base of the hole. Well, if there's a void in that area, if the rock is too soft, we simply cannot set the Williams rockbolt.

To improve our ability to install rockbolts, we have added as Q ground support--the Super Swellex is now authorized. We are now also using split sets. I now know when one wants to use a split set, also.

So what we're doing is trying to expand our tools, or the tools available to the contractor, to go ahead and install the tunnel. And again, we are starting to use now channels with rockbolts instead of the ribs.

So we are making several modifications to our ground support system so that we have really more tools for not only the Category 1 and 2, but the Category 3, which really envelopes both Category 2 and Category 4. We just have more available to us on the installation.

We're also looking at some modifications to the TBM to improve our drill rig capability, also, so we can have a little more latitude on where and when we can install rockbolts.

We have made some modifications, and I think the next slide is going to get into the actions that are planned. One of the main problems that we've had with--not problems--one of the characteristics of the machine's performance has been the rate at which it will release its gripping action, shuffle, slide the grippers forward, and reset. That action was taking upwards of 20 minutes on each reset. We have made some modifications. We then cavitated two of our hydraulic pumps and went through a series of four before we actually got some of those issues solved. In doing that, we found that we had to--as we increased the performance of the pumps and to try to speed up the hydraulics, we've had to re-plumb some of the hydraulic pumps.

We have been able to effect some improvements in the gripper speed. My target is eight minutes on regripping.

I've gone from 20 to--well, excuse me, the project has gone from 20 to 14. We still have more modifications to make to the machine to get it down to where we need it to be in order to improve our performance.

Again, this comes back to the regripping. We're still trying to boost that so that we can improve our stroke. We have now procured and have, I believe, all of the hydraulic cylinders have arrived on site so that we can make the thrust modification, push off the invert, that's now available. The flaps are being installed now. Between the grippers on the upper section, there will now be some hydraulic operated flaps, which will allow us in very poor ground to close those so that the rock fall onto the miners is controlled.

We do have, also, the hydraulic cylinders for the--we're increasing the motion right now. We have, I believe, a three-inch travel on the extension, and we are trying to, I believe, increase that to seven inches. That is not as much as I would like, but we may--to go beyond that, may require extensive modifications to the machine.

We also have the hydraulics for the three gripper action. In certain ground conditions, the machine has a tendency to over-excavate above it, so the upper gripper no longer has proper contact. So what we're doing is forming a triangular three-gripper operation between the two horizontal and the bottom gripper. That should allow us to continue to propel in poor ground.

Some of the other things that are on the books, yet that have not come out, that we are pursuing diligently, and that's the use or the design of a lighter rib or a lighter steel set. And especially in the Category 3 ground conditions, we're looking at ways in which we can go with a much lower, lighter gauge that will improve the installation, that will cut material cost down. It will just be a benefit all the way around. That is underway now. I don't have any projections yet at this time as to when that might come out.

We're also looking at changing the spacing on the steel sets from four feet to six feet.

I guess the underlying message there is that we on several different fronts are trying to improve the machine in faulty ground so that it can have a reliable performance.

Some of the fun things we've looked at in the management, in the outage management, we've really--Kiewit and TRW, MK, the team members have really come up with some fun and creative solutions on how we can do operations concurrently. For example, we're still installing the conveyor, yet this morning as soon as we get the machine up and running, we have a plan set aside so that we can continue installing the conveyor as we go back into a machine operation, so that all of our down times on the machine, we look at why it's going down, how can we alter the evolution of that so that, in fact, it can be done concurrently with tunnelling.

And that has taken several of the original--on the baseline that I showed you, some of the original projections of four and five-week outages have been reduced to one-week outages, two-week outages and partial outages, i.e., where we're never down for a prolonged period of time.

And we've also been looking at some alternate ways, as far as blast shields and that sort of issue, so that we can continue mining as we're doing alcove construction.

One of the areas that I am an avid supporter of that I think will be a valuable tool to me will be the formation--we have decided to go forward with a Yucca Mountain Project Board of Consultants. That will be a chairperson and three board members. We will also have a--we've identified a list or a pool of technical resources for the board, numbering of about 35 to 40 people we have on that list. We've received input from really all over the world on candidates for that list and on board members.

We are talking with the board--with potential candidates, and until those discussions are finalized, there will be no names.

The charter will be primarily focused on the cost effective tunneling, safety and design adequacy. As a minimum, they will meet every two months, and there will be reports on every meeting.

The expertise that we were looking for in formulating the board was geotechnical engineering, construction management, project management, TBM design and modifications. We're really wanting to get the ESF construction in concert with the data acquisition for science. We'd really like to get the ESF construction as near commercial cost as physically possible.

So with that--with the expertise from the board, we hope to get some suggestions and recommendations on how to improve our operations and how we do business.

The status, as I kind of indicated earlier, the chairperson selection is in process. The names have changed three times now, so that's not quite final. We have identified candidate board members, and we do have the technical pool identified, and have identified contracting means so that they will be readily available to the board.

My next issue is a slight variation. We are looking at an option for Calico Hills access and across repository drift. We're looking at seeing if it's possible to move it from 1997 baseline program plan to '95. This is really a study, and you'll hear more about the study a little bit later, but I'll give you some of the details from my perspective.

We are looking at a drill and blast for a shaft access down to Calico Hills within a roadheader drift intersecting the Ghost Dance Fault and terminating at the Solitario Canyon Fault.

The option is decoupled from the main ESF loop and is not intrusive into the repository horizon.

I need to stress the last bullet. There is a lot of funding exercise, as all of you are aware of, taking place right now, depending on what scenario takes place. It really has a tremendous impact on us in this option. We are looking at ways in which we can do it so that we can minimize our cost, and I'll get to that in just a second.

I'll show just a couple of sketches. This would be the placement, this would be the shaft, and, again, there will be another presentation later that can cover this in more detail--and the cross drift, a cross repository drift, and there's a slight dog leg in it.

I'll skip the next slide.

What we were looking for was the lowest cost, the best schedule and the smallest amount of capital investment as government-owned equipment. In other words, I didn't want to buy another machine. I didn't want to buy a roadheader. I didn't want to buy anything, and I wanted to be--kind of the goal was to see if we could construct the shaft in about a year period of time and then do the cross drifting in the second year, and get it started soon.

One of the things that I liked about this is it allowed us to look at this really in a very commercial way. So right now we are developing engineering. TRW engineering is developing what I would consider to be a performance-based procurement specification. We will not identify all of the details. We will identify those critical elements that we are interested in, and we're formulating the basis now for a specification that we could go out on bid with.

And I may be ahead of schedule, but in summary--I left plenty of time for questions if you have any. In summary, the surface construction, all but the change house, is proceeding. The change house is behind schedule, but all the essential support to the TBM is continuing as needed in order to keep the TBM running.

Subsurface, we're meeting our milestones. In several areas, we are ahead of schedule. We are attempting to apply a lessons learned mentality to the process, and so far we've got a very good safety record.

With that, I'll turn it over for questions.

DR. CORDING: Thank you very much, Rick. There's a lot of good things happening here.

I would ask the Board and staff for any questions they might have. Don Langmuir?

DR. LANGMUIR: Maybe a little cynical question, was--am

I reminded, is this a little bit like how the airlines stay on schedule by allowing 20 more minutes than necessary for a flight? Did you set up a schedule that was so conservative that you couldn't help but to meet it? Is it realistic in terms of what one could expect for this sort of a project?

MR. CRAUN: Well, I've asked that same question. I'm glad that they gave me a little bit of latitude so I can be ahead of schedule. It's nice to be up here and be ahead of schedule.

But I've also asked the same question, is how do we compare to the Portland machine? How are they doing from when they turn the machine on? How do we compare to other projects?

What I'm finding is in the beginning of any new operations with a TBM, there's a learning curve. It's really the design has to be integrated with the ground conditions so that the characteristics of that machine's performance are identified in situ and then you adjust the machine.

My goals next year will be much higher than they are this year, and that in part answers the essence of your question. We still--we do have a lot of modifications to this machine, in my mind, that we must accomplish in order to get its performance to be consistent in a variety of ground conditions.

So I'm appreciative of the opportunity to have some schedule or latitude, but it's been a lot of work. I need to state that the team, TRW, the M & O, there have been a lot of barriers that we had to effect in order to get the machine to move and a lot of barriers to stay ahead of the machine. So this is a government process. Let there be no doubt that there are a lot of requirements.

DR. LANGMUIR: Yeah, I'm wondering, as you get further into the mountain away from the shall horizons, of course you're going to reach parts of the system which are of considerable interest for characterization.

MR. CRAUN: Yes.

DR. LANGMUIR: And that presumably means you're going to run into things that you don't expect, which you need to study. And I can appreciate that that's very tough to integrate into a schedule with any kind of numbers on it. How do you plan to deal with that? I mean, you're going to have trouble, obviously, speeding things up to the extent that you find unexpected areas of the mountain to study.

MR. CRAUN: Well, to some extent, I would answer that by saying the TBM was designed so that the acquisition of data from the mappers is really not critical path. They have never slowed me down at all, and so as long as it can be done on the mapping, gantry platform, it should pose no impact. If we find something very unusual, which we have procedures for, we'll define the actions necessary at that time. But those, I had heard a couple of times this morning, that the science and TBM operations are not very compatible.

This machine was designed so that the mapping and the acquisition of the data from the walls of the tunnel has not had an impact on me at all. So it should not be a problem.

DR. ALLEN: Clarence Allen. Are we doing any better in producing visible geology for the people to map?

MR. CRAUN: Producing visible geology?

DR. ALLEN: Let me--

MR. CRAUN: Is the question in regards to reduced utilization of lagging? Is that--

DR. ALLEN: Well, making the--

MR. CRAUN: Making--getting less steel in there and a little more air, so to speak?

DR. ALLEN: Yeah, right.

MR. CRAUN: Yes, in fact, that was the intent of designing, or coming up with alternate designs for Category 3 ground conditions, which was initially a metal fabric with rockbolts and then also shotcrete. And by going--and during many of those times, we were installing steel sets. We've been--with the introduction of the channel and the woven fabric and also the ribs in woven fabric, we should be able to actually provide more surface area for the scientists to look at. And so that has, I think, been improving.

DR. CORDING: My impression in looking at the tunnel is that there is essentially a continuous profile along the side walls. There may be some places where lagging comes down, but you do have that continuous profile. But certainly there are places when the lagging was going in that it was blocking the visibility of the crown. But I agree that that lagging should--or that mesh should--it's got the safety and capabilities of whatever is being used now, but it provides more visibility. You're in the process of procuring that at this time?

MR. CRAUN: Actually, we've got it on site. Before we shut down, we had a brief period of time where we were actually able to start using it, so we have a little bit under our belt as to the utilization or installation of that, not enough to really say that we have refined the installation series or sequences yet.

DR. CORDING: As you go through a process like this, things that are on the critical path start changing. As you improve one thing, something else is going to come up because it's all a linear process. Everything is a chain. Everything has to go together. One link will stop the operation or slow it.

So, you know, I think the--it does seem to me that you're going toward--in a direction that will allow you to get more--to make more daily progress and get rates up to--I think you're indicating your expectations are getting better --going better than what your long term schedule has been--

MR. CRAUN: That's correct.

DR. CORDING: --forecast to be, and I think that should be achievable. And I would hope that just as you're trying to get ready with the steel support or the purchasing required to keep up with that--I mean, you get this thing moving, and then you don't have your support, you know, or something. And the same thing, I think, goes to some extent with the science side being ready to turn their tests on and get in and take advantage of what you can produce for them.

John Cantlon?

DR. CANTLON: As you look at such things as widening the distance between the steel sets and so on, that obviously requires an examination of the safety considerations that led to the first distance. How is that process engaged in of the tradeoff between risk taking and looking at the cost of the thing? Explain to me how that goes.

MR. CRAUN: Well, it will go through the same design process that the original steel set went through. So basically what we've done is proposed an alternative design. It will then go through the series of what are all the inputs required for that design. It will then go through a detailed design to make sure that it's technically viable. Following that, it will go through the installation verification process and make sure that it can be installed properly. It's compatible with the inverts. It was structured originally so it matched with the invert size. It will go through the safety review.

So it goes through all of the same hoops that the original--the steps that the original design process went through. So it would be reviewed by the safety personnel, ES & H, et cetera.

DR. CANTLON: I guess what I'm really asking, if you're separating, you're increasing by 50 per cent the distance between the sets. Somebody must have made a consideration that the initial spacing was what was required for safety. If you now increase the distance by 50 per cent, is there--was there an additional margin of safety, or is the new set performing in a way that's better, or it's that tradeoff I guess I'm digging at.

MR. CRAUN: Well, with any design, one has to define the inputs and the loads that one anticipates, and then as you get your product into the field, especially in a tunneling operations, you find that those loads may vary from some of your original assumptions. So you can force it on the front end of the equation or on the tail end of the equation. We're looking at both sides of it.

DR. CORDING: It seems to me, one of the parts of that is that in some cases, you've been putting in more steel support than anticipated, and then there's been some discussion of the ground conditions. If you look at the ground, it's really better quality than what was--I mean, excuse me. Perhaps the other way to say it is that the support is going into ground that you would categorize as better ground than the support would normally be used in.

And the question is, why are you using heavier support in ground that is mapped as being better? And this is not the first time this sort of issue has arisen. It's been involved in tunneling ever since--well, as long as I can recall whatever I've read. And I think a lot of this has to do with how safe is it to install the support in the heading? A lot of it has very little to do with the total loads on the system because the loads often are not very high. It's just, is that rock block going to fall on me, and can I get my support in in a way that it won't fall on me?

So you back off of systems that are installed bald out there, and you go to systems that can be installed under the protection of the shield. And so if you can install rockbolts under the protection of the shield of the channel, you have more of a possibility of making that a safe support.

MR. CRAUN: And that's exactly what we're trying to do, and that's why we're coming up with alternate support systems to allow us to--originally when we started out, we basically had a series of five support systems that were allowed for use. For example, if in the beginning we had trouble setting a Williams bolt, as I indicated earlier, then, in fact, we simply could not set rockbolts. By now adding Swellex--Super Swellex, rather, and split sets as alternatives available to us, that improves our ability to set rockbolts that are a variety of different rockbolts, and allows us to--and the contractor to provide the safety that he needs to in the tunnel and minimizing the ground support system to that to the maximum extent possible.

DR. CORDING: The further one gets into the project, also, the further your supply line is into the tunnel, the more difficult it is to make rapid changes in the support. And if you're going in--if you're tunneling getting up to rates of 100 feet or so a day, and you're putting in a certain support, you can't--you say, well, there's 10 feet of rock in here that maybe we ought to--or 50 feet even of rock in here that we ought to support a different way. You don't have time to do that. You have to stay with that, and to be efficient, you try to stay with the same support.

So if you can use a support where you make moderate changes, perhaps you add another rockbolt or another piece of channel, or whatever it is, that you're going to adjust perhaps to take care of some of that, but you don't have to, you know, suddenly make a major change, then you can become efficient.

But I think that as one looks at the tunnel, you have to put in support that is conservative, but you can't just make changes every--even 50 or 100 feet sometimes once one is making high progress further into the ground.

So I think those are all things that I know your people have been thinking about and--

MR. CRAUN: Absolutely.

DR. CORDING: --it's part of the equation.

DR. LANGMUIR: Langmuir, Board.

Richard, some of my concerns about TBM progress versus science may be unfounded and may reflect my ignorance of how it's been planned by the DOE. Maybe you could, or someone in the audience, could clarify this specifically.

Is it true that you have the flexibility that you could proceed on as efficiently as possible with TBM itself, and if you encounter water, and to me this is the critical reason you're down there, you could then go by--conceivably come into that fracture zone, if it's a fracture zone, with an alcove on the spot away from the TBM operation and then study that sort of a fracture zone flow system data, perhaps do testing of characteristics in a fault, without slowing down TBM progress beyond that point?

Is this sort of flexibility built into the program and how the TBM operates?

MR. CRAUN: Well, if we were to add another alcove, would I say that's in the baseline schedule? No, it's not. But the concept that you described, where, in fact, we take the TBM as rapidly as possible beyond the point where we want to establish an alcove, finish the design, make the final selection of the orientation, the depth, et cetera, exactly what the purpose of that alcove is, and then commence construction, that is exactly how we're doing it.

For example, Alcove 3, we are, I believe, at this point getting the final location as to where the scientists want it. On Alcove 2, the same situation was there. We made some minor adjustments as to exactly where we want it, how deep. In fact, that alcove went through a design change where it was originally supposed to be a certain depth, and then we increased that substantially. And that, again, is to meet the needs of the scientific community.

So we have that flexibility. To say that I could add another alcove to my baseline and not affect my base funding profile, then I would want to slow down just a little bit.

DR. LANGMUIR: But then the issue that was raised by the Peterson review was that the speed of the tunnel itself is a money saving aspect of it potentially. And you certainly ought to have the flexibility to put in more alcoves if it turns out the water is in more places.

MR. CRAUN: That's right. The only thing I would say relative to this morning's report, TBM progress is not being limited or controlled by science at this point. Right now it's TBM operations that's limiting it, and it's how effective I've got the machine working in the underground environment. It is the machine that's affecting us, not the science community.

DR. CANTLON: Yeah, let me pursue that a little bit. Early on, there was a supposition that when the conveyor got in place, the TBM could move double or more its capacity. You're just saying that right now the TBM itself is the time --is the rate limiter. Is that still going to be the case after the--

MR. CRAUN: What I meant, I think probably a more correct way to respond to that question would be that the TBM is really a system; everything from muck removal to cutter head speed, cutter head pressure, transference of the muck within the conveyor, within the machine itself, the machine operations, there's a variety. So to say that one specific item, no, it's really an integrated system. The conveyor will free up several critical timing elements for us so that it would allow us to go faster. The machine itself, we do have to make modification to the ram so that we can get the ability of the machine to degrip, so to speak, transition forward and regrip. We've got to improve that in order for the machine to obtain the production rates that we're wanting.

DR. CANTLON: A follow-up on the conveyor. You were indicating that it had a highly sophisticated control system. Is this going to be one full of bugs and have a lot of down time?

MR. CRAUN: No, no. Why, no. How do I say this? Most of the controls will be jumpered out. We will basically go initially with a simple on/off conveyor system. We will then, as we get some experience running the conveyor--I guess the right way to say it, it will be a staged process and a phased process, so that we get all of the controls in place and activated that are in the original design. We will have the minimum set of controls necessary for the machine and the conveyor to function properly, but it will not all start up at one time.

DR. ALLEN: Clarence Allen. To what degree is the improved advance rate due to better operating procedures and equipment modifications, and to what degree is it simply related to getting into better rock gradually?

MR. CRAUN: Part of it is rock oriented. Obviously, as you get into a better ground, we can--it's just easier. Most of our improvements have been changes in ground support system, improvements in the hydraulic system to allow us to regrip a little bit faster, the addition of a California switch to allow us to do dual trains. I think part of it also is a learning curve. I mean, steel sets and ground support systems are--you know, yes, the tunnelers have done that before, but I think in the environment that they're in and under the oversight that they're currently in, it takes a while to get used to that. So I think a lot of it is--

DR. ALLEN: Rock conditions are getting better?

MR. CRAUN: The rock conditions vary. I mean, right now we're in very fault--excuse me, we're in a very blocky ground at this point in time, and I'm hoping to get out of that. So it kind of--if you were to look at a profile on the ground classification, you would see that it is not stable. It jumps up and down, as was expected on the north ramp.

DR. CORDING: To go back to this issue on quality, you went through the process of some of the changes in the initial support system, and traditionally, the initial support system is put in to provide safety for the operation, and then ultimately if there's a lining placed--there's a permanent lining placed for the operation of the facility, requirements of the facility. And I think--it seems to me that the process of going through those changes, they certainly are more complex, and there are more sign-offs on making those changes. There's more involved in that because of the quality system that you have than I've seen on basically any other type of tunneling project. And that has something to do with the learning curve and your ability to--

you're recognizing some of the concerns and things, but your ability to get those changes in place, and you've been working hard on that, it seems to me it's still part of what's the problem, being able to, you know, make the adjustments in a timely way so that you don't have to keep going back over the fact that the Williams rockbolt mechanical anchor, you know, doesn't work very well, and which, you know, is the type of anchor that largely the industry hasn't used for the last 25 years because of that.

So I guess, do you see ways that the quality issues on the support can be simplified, and how would that, for example, be handled on the Calico Hills when the support itself, it may be in the project, it may be there for a number of years, but it doesn't necessarily have to be part of the permanent repository in terms of support? You just have to make sure that the material there isn't incompatible with other things that are in the project.

So I'm wondering how you're looking at that quality issue, and particularly in regard to support.

MR. CRAUN: Well, you've asked a whole series of questions there. Let me see if I can break them down and address them.

First of all, in this environment, I think it was Lake Barrett that gave a presentation that said it's an interesting marriage of two different cultures, or three different cultures. It's a marriage of the scientific community, the mining or tunneling community, and then something they called NQA-1 community.

The ESF ground support system is Q. It has been identified as a quality ground control system. So with that comes all the 18 criteria of 10 CFR 50, Appendix B. And with that comes paper and a lot of definition and a lot of verification, and, in fact, you're getting exactly what you want and you need so that that basic component can perform its safety function on demand as required. So with that is a lot of assurance in the design of the ground support system.

One of the variations would be on Calico Hills, is that would not be Q. Our initial look at that would be that that would be a non-Q aspect.

So what does that mean? If we're able to get that issue to closure, in fact, we can then say, yes, in fact, that access, that tunnel in the shaft can be designed with non-Q ground support systems. That would allow me to be completely commercial grade, and that would be exactly what I would intend to do.

There would be some controls that would be required from the determination of importance evaluation, but those would be minimal compared to those that would be associated with having a Q-HEPA filtration system or a Q ground support system or a Q hot cell. When you go Q to non-Q, your hot cell, your ground support, your HEPA filtration system, all those things change a lot as far as the degree of assurance that we provide as to its ability to perform a safety function.

DR. CORDING: And the safety function we're talking about is--a lot of that is just--I mean, even on the main tunnel now, that's really construction safety, which is not necessarily an NQA-1 function, is it?

MR. CRAUN: It's not a safety function as such. I believe it's a waste isolation issue, and I think there are some people in the audience that can help me a little bit on that. I believe that was the basis for--I believe there's three categories, waste isolation, importance to safety, and also health and safety to the public, and then also retrieval, I believe are the three that will allow me--if I affect any of those three, I activate the NQA-1 program on any of those three elements. And that would be the same in a commercial power plant if I had a safe shutdown circuit on a reactor, the same level of controls, the same basic design control system, procurement into all of those systems are activated.

DR. CORDING: I've always had difficulty in understanding how that support system relates to that. You know, it doesn't seem to be the same type of example as the one you--

MR. CRAUN: Waste isolation, I believe, is the basis for determining that is a Q ground--the ground support is being Q.

DR. CORDING: But at any rate, I think what you were trying to do was make--you have to do it at this point, you're trying to make it as efficient as you can to get through that process. But it is taking more time to do those, to make adjustments in the support and thing. Is that right? Is that correct?

MR. CRAUN: When we start back up, we're doing--we have two additional programs that we're initiating when we start back up. We've got a team of, I believe, three people, maybe four, that will spend the first two, couple days of operations of the TBM looking at precisely what steps, what sign-off, what inspections are required that are being driven by the fact that we have got the ground support as Q.

And so we will be looking at the installation procedures and installation inspections that are associated with that to see if we've met what I consider to be necessary and sufficient. I can meet an NQA-1 program in a non-graded fashion or in a graded fashion. I can identify those elements and attributes that are essential and critical to me and make sure that I cover those elements. If I've got a non-critical attribute, then I can have less inspection on that.

So we are looking at, when we start back up, the physical details of how they're installed and the inspection associated with that on the ground support system.

We also, as I indicated I believe earlier, we do have a team back at the steel set manufacturer, again going through the same basic view; what are we doing, why are we doing it and how essential is it? Is that a critical attribute that we're verifying or not? If not, it will be brought back--excuse me. If it's thought that it's not, then it will be brought back to engineering. We'll see if we can loosen that up. But we adjust it.

DR. CORDING: Thank you.

DR. CANTLON: You mentioned that you thought the Calico Hills shaft and drift would be a non-Q. When you put the slide up there to show its location, it looked as though the shaft would be the repository footprint.

MR. CRAUN: It's underneath the repository horizon, that's correct, but it does cross underneath the footprint.

DR. CANTLON: But the shaft?

MR. CRAUN: Oh, I'm sorry, the shaft. No, no, no, no, the shaft is not--

DR. CANTLON: Is well outside the--

MR. CRAUN: It's by UZ-16, if I recall right.

DR. CANTLON: Oh, okay.

MR. MCFARLAND: A question on the machine. You've mentioned the process of going through and trying to shake out a new piece of equipment, the learning curve on the machine. At a point several months ago when there was some considerable overbreak, you brought in consultants--

MR. CRAUN: Yes.

MR. MCFARLAND: --to provide advice on just what was happening. And part of that--the results of that review was that there appeared to be a basic cutter head block interaction problem, and that the overbreak that was occurring could be perhaps reduced by modifications to the cutter head.

So far, we have heard how the machine will be modified to accommodate to the larger--to the overbreak, but I haven't heard anything in regard to reducing that overbreak. Could you comment on that?

MR. CRAUN: The comment will be short. We haven't proceeded in that area. We chose to identify those items that we could support at this time and go ahead and get the designs going on those and initiate procurement. That doesn't mean that--for example, a couple of areas where they had recommendations, I believe they recommended that we completely redesign the front drilling rig apparatus. That will be the next phase. They also recommended, if I recall right, a reverse rotation of the head with a smaller pick-up bucket design, so that in an extremely bad ground, I can go ahead and instead of going in and putting grizzlies and blocking off some of the intake structures as we do now, we can make that more of an automatic operation where we would just reverse the rotation.

I do intend to follow through on those items and those recommendations, as those aren't being supported at this time.

MR. MCFARLAND: You used the terminology faulted ground. Is it possible that this is more blocky ground, ground that you would find perhaps excavating through the total horizon of well and tuff?

MR. CRAUN: I really would want the science community to respond to that. I'm not a geologist. I'm just trying to make the machine go faster, so I'm going to pass.

MR. MCFARLAND: It may not be an isolated issue. It may be an issue of--with that cutter head of excavating the highly fractured hard rock.

MR. CRAUN: To that I agree with you, and that is also why I think it's important that we follow through on those head recommendations. That's also why I was really--am an avid supporter of starting a permanent board so that we can look at those. Those are relative. Some of those can be extensive modifications to the machine. For example, if we're wanting to increase the gripper travel from three inches to three feet, that's not a minor design alteration to the machine. That would be a major outage for us. And so I'm really looking to get the best advice that we can get in the United States to help us make those decisions.

DR. CORDING: In regard to the board, are you looking at that board as one that is essentially reporting to DOE at your level, or how is that--M & O, is within the M & O? How do you look at that, or is it a combination, or is it not defined?

MR. CRAUN: Thank you. It's not defined. I know what I want, and to me, we have a very effective team relationship with the M & O, and I feel comfortable. We have a lot of very skilled people. We've been able to work through a lot of very challenging issues. So there's a team environment that I do want to support. I do own it, and I do pay for it, and I do represent the government. So there's an ownership issue, also, and there's some--there's an active discussion on that Friday. There's one scheduled for tomorrow. So that's still very current.

DR. CORDING: I assume you, yourself, have an active interest in interfacing with that board yourself?

MR. CRAUN: Oh, yeah--no, no. I haven't seen anything that would say I don't get to work with the board, no. That wouldn't be acceptable.

DR. CORDING: All right.

MR. CRAUN: No, that won't work. But I think it's also incumbent upon us to go ahead and implement the recommendations of the board. I think that's--not only do we need to have formed the board, but we need to follow through on what their recommendations are.

DR. CORDING: Yeah, the ability of a board to function is really very dependent on people that are--you and the others who are championing it and supporting it.

The Calico Hills--going back to the Calico Hills, are you planning on the Calico Hills a schedule on a design schedule, or what's the status on that shaft tunnel system? Do you have a plan for going ahead, or is it still a conceptual thing at this point?

MR. CRAUN: Right now, as I indicated, we're putting together a performance base specification for the design so that if, in fact, we have the right funding and we can support that, we can go through a baseline change, which it will be a change to the baseline of the program, and pool that from '97 to '95.

That is very much driven by funding. If I can get the performance base spec out, then that would--if everything was very positive, then you could actually be in construction in '96 on the shaft. But, again, that is very dependent on funding and getting the baseline change. It's a change to the program on the approach on how we're getting access.

And, to me, it's essential--and someone mentioned earlier the engineered barrier system. It's essential that we provide a solid funding profile to the EBS. That's one area that I have some oversight responsibilities.

So there's a balance in tradeoff between construction, design and science, and it's fun to build things. I like to build things. But it's imperative that we get the right science and design going, especially to support a TSS in '98 and hopefully a license application in 2001.

DR. CORDING: Going to the science, in the thermal test area, of course, one of the objectives is to get thermal testing started, as I understand, as soon as possible. And we have been hearing the concern to be able to develop thermal tests that cover a large enough area of thermal load being applied to the rock surface, that you can see some of the effects that they're concerned with. For example, buoyancy effects and convection.

And I wondered what the status was of bringing the thermal test setup into your construction plan at this point? How would it be constructed? What is the present plan for initiating thermal--the facility in which to perform the thermal test?

MR. CRAUN: Right now, what we're trying to do from my standpoint, and I can leave it to some other people in the audience that have more data and are probably more current on the strategy, on the thermal testing, et cetera, but I'm trying to provide access to the thermal areas that they need on the as-fast-as-possible basis. So from my standpoint, I'm doing everything I can--excuse me, we're doing everything we can to get the machine down and excavate the ESF and provide a testing alcove to them, whatever they might want, and that's really their call, not my call, on a as-rapid-as-possible basis.

So that's why, to me, accelerating the TBM gets us to the testing alcove locations sooner, et cetera, so that the defined tests can be initiated sooner.

So from my standpoint, I'd like to respond to your question saying that I'm just trying to provide access in the shortest possible way.

DR. CORDING: At this time, do you have a layout for the type of alcove--supporting alcoves? I know there's some cases they're looking at side access so that they can put instruments across to the thermal drift and things like that. And I'm not sure whether you have a plan at present for that or you know what you're going to be doing with that.

MR. CRAUN: I see Dennis Williams standing up, which I'm going to thank him. Go ahead, if you'd like to respond to that, Dennis?

MR. WILLIAMS: Do you want me to take over for a minute, Rick?

MR. CRAUN: That's fine.

MR. WILLIAMS: Dennis Williams, DOE.

There's a couple things related to the thermal. Of course, I think you've seen our presentations in the past where we had laid out a sequential process of thermal testing, going from small scale testing up to larger scale testing. We're in the process of re-evaluating that with the push that Rick is making, with the different funding profiles that we are dealing with. However, for the scientific programs, thermal testing is one of our highest priorities for '96. One of the things that we are considering is going --jumping over some of the smaller scale tests, some of the sequential parts of it, and possibly going--bailing right into high risk venture into a drift scale test.

I think in Ned's presentation you'll see a typical layout of an alcove for that, but I want to point out that this is in the planning stage now. This is some of the things that we are thinking about, but we know that if we jump to that large test, it is a bit of a risky venture. However, DOE folks are being told to take more risk. We are probably embarking on that kind of a course here shortly.

DR. CORDING: Thank you very much.

Other questions, comments? We're on time, and I appreciate your willingness to use your time for questions. Thank you very much, Rick.

We're going to now go to our next presentation, and

I'm trying to find out what it is. Okay, we're on the Calico Hills update, and this is Mike Cline, who is with the M & O of Woodward-Clyde. He's the office manager for compliance support of the PMO. And we're interested in seeing what they've been looking at in terms of the Calico Hills evaluation of going to the Calico Hills and getting early--considering the possibilities of early access.

MR. CLINE: Thank you very much.

What I intend to do today is to briefly summarize three studies related to the future development of the ESF. The first study is the Calico Hills System Study, and that's presently in final review--the report's in final review. And I have memory here to respond to specific questions that may arise from this presentation.

I'm also going to talk about the Calico Hills--briefly talk about the Calico Hills access option, which is currently in the planning effort, and I'll also talk about the north ramp extension alternatives exercise, which has been completed.

May I suggest that since we've got a lot of material to cover, that if--it might be of value to have a more detailed briefing later on the Calico Hills Systems Study. We will try to just summarize findings today.

The three activities were an effort by DOE to address the need to reduce uncertainties associated with

Calico Hills performance through drilling and drifting, to identify operational and configuration options that would allow for early access to the western block of the TSw and to Calico Hills, and to address the major uncertainties as they're defined in the waste containment and isolation strategy.

As a result, the activities provide a basis for the DOE to use in evaluating benefits of operational and configurational options for access to, again, the western portion of the Topopah Springs and the Calico Hills and options for early access to the western repository block and Calico Hills.

Now, I just wanted to show very briefly the current layout of the Program Plan. You have in the heavy line, is the Topopah Springs area, and the dotted is the Calico Hills.

I'd also like to show the current schedule. This is an excerpt from the Program Plan schedule, which shows the TSS, of course, as we all know in 9/98, but right now we have the start of the north ramp extension in 6/98 and completion in 9/98, and the Calico Hills access not completed until 2000.

Calico Hills Systems Study approach was to establish data needs from exploration for exploration in the Calico Hills unit, and PA analyses were used for this to evaluate exploration options for assessing the Calico Hills unit, considering four criteria, and I will focus on the scientific understanding and confidence in scientific understanding, and from this seven options that were identified, which we'll summarize, and to assess the benefits of acquiring data from the Calico Hills in the context of remanded EPA standard and potential alternative standards, such as dose.

The process of the Calico Hills Systems Study was to characterize or identify the characteristics that could impact Calico Hills performance, identify or review the data needs related to these characteristics, characterizing these characteristics, to identify the Calico Hills unit features and desirable attributes, and then pass those off to the engineers to come up with the options and to assess those options where we looked at scientific understanding/confidence, cost, schedule and the test interference and waste isolation impacts.

Focusing on scientific understanding, relative scientific understanding, a multi-attribute utility analysis was done using expert judgments. The group, the experts, looked at 22 tests for improving scientific understanding related to seven processes, features and events that were identified in the study. These are also referred to as conditional failure modes in the report; the ability of the seven different exploratory alternatives, to field the 22 tests, and then a weighting factors for the importance of the seven processes, features and events that could significantly impact performance.

The exploration options, as they're identified in the report, are first--that should be Program Plan drilling. That's a typo. I apologize. That is the first option. That's Program Plan drilling or boreholes only. The second is the modified base case without boreholes. The third is the modified base case with boreholes. The fourth being the minimum excavation with boreholes, and you'll note that that's access from the south portal. The fifth is extensive excavation with boreholes. Now, the boreholes are those of the Program Plan throughout, as defined in the Program Plan.

The sixth and seventh options are more extensive exploration in the Calico Hills, but because they are similar to five, they were combined, and actually five options were fully evaluated.

After the team went through the MUA for scientific understanding, they were then canvassed to evaluate the confidence in the scientific understanding, the confidence being the level of certainty in judgment of scientific understanding.

With respect to each option, the experts were asked if additional data were to be significantly changed or to significantly change the expectations of Calico Hills performance, it would be one of these five.

Now, in the report, there's a much more detailed description of each one of those five--let us call them surprise factors.

As you see here, we have the five options, and I'd just like to point out that Option 1 and 2 are relatively similar in the scientific understanding. They do provide different information, and one is boreholes, the other is drifting without boreholes. And then we also have the minimum excavation, which gives a fairly significant increase in scientific understanding from the assessment that's done.

The scale on the--vertical scale is relative scientific understanding. Zero is where we are now. That's not zero, that we have zero understanding, but zero in terms of the relative scale, and one being the extensive excavation.

On the extreme right you see confidence, and these are averages from the expert panel that was canvassed, and our confidence is about 1.35 out of 3.65--or out of 5 I should say.

With respect to the performance assessments that were done, the first, which you have seen before, I think, in a previous briefing, shows the TSPA to the extreme left, and then various forms of fracture flow all at 90 percent fracture flow, and the green being the extreme case where everything is essentially--you have 90 percent fracture flow in the TSw, in Calico Hills in the saturated zone, and 90 percent flux. That's extreme case. It comes within one order of magnitude of--within an order of magnitude of exceeding the standard.

However, the results--what I want to point out is the results of this suggest that there is no technical imperative for extensive drifting in the Calico Hills.

And I'd like to add one more view graph. It's not in your report. We do have copies of it on the table.

In the last briefing, there was a question as to the sensitivity of doing something less than 90 per cent fracture flow, and you can see here that we went back and looked at 10 per cent, 50 per cent and 90 per cent.

As stated earlier, the team addressed the potential for dose standards, and here we have 90 per cent fracture flow in both the TSw and Calico Hills, and you can see that we have considerable releases under a dose standard, or potential exceedence.

With respect to the results on this exercise, it was considered that considerable uncertainty exists in the Calico Hills and that there would be value in reducing these uncertainties, and you can achieve that through the Calico Hills drifting.

Again, we wanted to show you a long term release where over 100,000 years, the black line being the TSPA of '93 with zero fracture flow, and you can see the shift to the left with 90 per cent fracture flow, where you get major release between the 20,000 and 80,000 year time frame.

Now, these are related to the poorly sorbing radionuclides that were used in these cases.

A summary of conclusions from the Calico Hills Study: There is no technical imperative, as I stated earlier, no technical imperative to further explore the Calico Hills unit to demonstrate compliance with the remanded EPA standard.

Demonstrating compliance with a hypothetical standard, such as dose, during the next 10,000 years would require reducing uncertainties about the performance of repository system elements, Calico Hills saturated zone dilution, these sorts of things, retardation.

Further exploration of the Calico Hills unit would contribute little to a demonstration of compliance with a hypothetical standard for peak doses during the next 100,000 years, or longer, because calculated doses are insensitive to the Calico Hills properties, based on the studies, performance assessments.

Additional exploration would support an improved level of understanding of the groundwater travel time, and this would come from exploration to Calico Hills. However, additional exploration may likely not rule out the potential for groundwater travel time less than 100,000 years.

Next, it would be--it would not be surprising if the expectations of individual scientific experts from the panels for the performance of the Calico Hills unit were to change significantly as additional data are collected. Okay. This is from the confidence evaluation.

Minimal drifting plus drilling, this is Option 4, would be required to reach a confidence level where it would be surprising if additional data were to significantly alter expectations of the Calico Hills performance.

Next, I'd like to briefly summarize. Rick Craun covered the exercise on the early access option. I would just like to go on to say that the option is both compatible and comparable to Options 3 and 4 of the Calico Hills Systems Study. And then, again, as he was saying earlier, the option utilizes a shaft on the eastern side of the repository block and a western drift in the Calico Hills.

And just to show the configuration there in the east-west drift, with the shaft being at the top of the screen.

Next, summary of the north ramp extension activity. This activity focused on acquiring information in the western portion of the repository block prior to TSS. There was concern about representativeness, geologic and hydrologic features and major uncertainties. So there is an effort to look at how we might be able to speed up that north ramp extension.

Early access to the Calico Hills was not part of this exercise.

First of all, we set out to address a set of ESF options for the north ramp extension based on a common set of assumptions, and they all addressed early completion of the east-west drift.

We've then established a set of evaluation criteria to discriminate and rank the relative importance of the criteria and the options. And then we evaluated the options against the criteria, I'm sorry, and then ranked the options by their weighted scores to come up with a preferred option.

The options were--we came up with 12 options, so they can be grouped in a set of four different categories. The first was essentially the base case, and then a schedule modification for design.

The second set were various forms of construction and procurement, such as drill and blast, leasing versus purchasing a TBM, and that sort of thing.

The third addressed the possibility of drifting through the central portion of the block. In one case, we drifted at the repository horizon; in the other, the configuration was just below the repository horizon, between that and the Calico Hills. That was to minimize impact for repository design.

And the fourth set were somewhat different. It was to assume that there would be no north ramp extension and that you would only have Calico Hills access to the western side of the block.

The criteria that we came up with, and this is by order of importance, there were 11, and primary testing, representativeness and repository interface are the top three. The top five were those that we really focused on in the exercise.

They were then normalized--after they were ranked, they were then normalized to 10, 10 being the most important.

The evaluation of the options is shown here on this matrix, where we have all 12 options across the top, the criteria vertically presented, and the total scores, the weighted scores, and then the raw scores. The weighted scores are average of the--of each of the scores and then multiplied by the weighting factor of the criteria, and the total scores are just the total scores added up.

You will see that 2D falls out as somewhat preferred over the others, although there is a close set between 2B, 2C and 3A.

With respect to 2D, it allows for early access using an 18-foot TBM. It's essentially the same configuration as the base case. Total cost is the same as the base case at the time. Both the 18 and 25 foot TBMs would operate concurrently. We would begin as early as 1/96 and complete it four months later, actually 6/96. Daylight to TBM, the 25 footer in 5/97, unless deferred due to cost and that sort of thing, and complete the Calico Hills in 9/97, again depending on funding.

This also allows for the thermal testing alcove to be constructed in the north ramp extension, rather than a separate alcove or a separate drift off the main.

Results of the three studies: We've learned that extensive drifting may not significantly enhance confidence or reduce uncertainty over limited drifting. Demonstrating Calico Hills unit performance may be important, depending, of course, on the standard that is adopted or used. And DOE has now a set of options for drifting in the western block of TSw and the viable option for early access to the Calico Hills.

Thank you.

DR. CORDING: Thank you. The first question is you have described a number of different options, but it would perhaps help a little bit if you could just discuss what those involve. A limited drifting or extensive drifting mean a lot of different things, and certainly--sometimes limited drifting across--at the right locations is better than extensive drifting in the wrong--using this in the wrong.

MR. CLINE: If you go to your backup, for the Calico Hills Systems Study, there are the layouts that were selected. Minimum excavation is shown here.

DR. CORDING: Minimum excavation for the Calico Hills, with a ramp from the south portal; is that correct?

MR. CLINE: Right.

DR. CORDING: Okay.

MR. CLINE: Now, when we say that the--that this one is compatible or comparable with the early access activity for the Calico Hills that's going on now, the east-west drift is, I believe, a little bit to the north, but it is in the same configuration, coming across. It just doesn't move back.

DR. CORDING: All right.

MR. CLINE: And then the moderate (sic) is coming off the north portal as it's--I'm sorry, I said moderate--modified. It's a modification of the base case. It comes off the north portal and wraps around and intersects the Ghost Dance Fault at at least two locations, possibly three.

DR. CORDING: And then the description that Rick Craun was giving on the shaft and coming across, you're equaling that with something related to a moderate or limited--

MR. CLINE: It's more--it's really more to the minimum.

DR. CORDING: Well, it is going across--

MR. CLINE: Yes.

DR. CORDING: --you know, the block east-west.

MR. CLINE: Yes, it is.

DR. CORDING: You're getting a full traverse--

MR. CLINE: Yes.

DR. CORDING: --where a lot of major structures cross.

MR. CLINE: Yes.

DR. CORDING: Okay.

MR. CLINE: And the extensive is, again, initiated at the south portal, and you have lots of secondary drifts--or I shouldn't say lots--a number.

DR. LANGMUIR: You've depended fully on expert judgment for an analysis of whether it was appropriate to even bother with the Calico Hills, and several things come up in that connect. And one is, how much noise, uncertainty, do you think personally there is in that expert judgment? I mean, how likely is it that a different set of experts, given the limited date that it's available, would reverse that and support going to the Calico Hills is an important thing to be doing?

MR. CLINE: I'm going to defer that to Rick because he led that effort, and I think he should respond.

MR. MEMORY: This is Rick Memory, M & O.

Really, I think the conclusions on whether we should access Calico Hills, what's needed, were based more on the performance assessments that were done. We did do the understanding to give a feel for comparison of the particular options. That's really what the MUA analysis was used for. But the conclusions that we quoted were based on the PA analyses.

I think to answer your question, yeah, the answers could change depending on what group of people are giving their opinions.

DR. LANGMUIR: You presumably had input from hydrologists and geochemists and so on within the program?

MR. MEMORY: Right.

DR. LANGMUIR: Presumably represented a sampling of them at the labs?

MR. MEMORY: Yes.

DR. LANGMUIR: So one would assume--Larry Hayes sent us a memo, or sent out a memo, which indicated that he felt there was a significant amount of information already available on the Calico Hills from some of the drilling that had been done.

So your sense is that that's fairly representative at this point, even without an ESF approach to it? How do you feel? How comfortable, I guess, are you with what you know, if that was all you ever learned?

MR. MEMORY: Well, that, again, would depend on what the standard is. If the standard remains accumulative release 10,000 years standard, then I think we can say we're comfortable with how performance--how Calico Hills might impact our meeting that standard, in which I think it won't be terribly important given what we know right now and what we--given what we know right now, no more investigation.

By the way, there were two people from USGS in this group, and they both reflected Larry's ideas that the borehole program was very valuable.

DR. CORDING: I'm sorry, did you want to just follow up, Don?

DR. LANGMUIR: Yeah, I just had a couple. Actually, not so much on that. I had a couple of clarification questions. Just you were very efficient about covering your material. It was tough to follow all of it.

But Overhead 14 in particular, I'm just going to show my ignorance here. The total release plots, you showed a curve for TSPA '93, which was well below the fracture flow in the Calico Hills projections, and I guess I don't remember what TSPA '93 said and how these assumptions that get you closer to violations differ from what TSPA '93 did.

MR. CLINE: Zero fracture flow.

DR. LANGMUIR: Zero fracture. All matrix, in other words. In other words, that Calico Hills was a barrier, in effect, to release.

MR. CLINE: Yes.

DR. LANGMUIR: A physical barrier, so, therefore, a chemical barrier, okay.

And this is a--I'm going to, again, I think show my ignorance here, but is the Calico Hills basically the formation that underlies the observed perched water systems that have been found? It's below the perched water horizons which have been identified at the mountain?

MR. CLINE: Yes.

DR. LANGMUIR: To what extent are its properties responsible for the perching that's been observed?

MR. CLINE: Dennis, can you help us here?

MR. WILLIAMS: Dennis Williams, DOE.

We see perched water above the Calico Hills towards the north end. It's up in the area of the vitrophyre that sits at the bottom of the Topopah, and then in the very upper portions of the Calico Hills towards the south end of the block.

So I think we would probably form a tentative conclusion that the Calico Hills may provide some perching capability on that perched water--

DR. LANGMUIR: I would assume that this is a major concern I think the Board has had, that how much of this perched water is there? How did it get there? How old is it? Where might it be going? How much in the way of surprises might there be in perched water? And I would assume that all of this was in the minds of the GS people involved in the assessment of the importance of getting to Calico Hills because clearly these are properties of Calico Hills that provide the perching.

MR. CLINE: Right.

DR. LANGMUIR: And it seems like this is a very important property of the Calico Hills. Am I correct in my assumptions?

MR. CLINE: Yeah, there are some very strong opinions that the information we have--in the survey, that the information we have now is adequate when characterizing Calico Hills.

DR. LANGMUIR: Geochemists have said a lot about the importance of Calico Hills for absorption and properties of that kind. I would assume that given the times that you're looking at for performance, that this is simply a storage effect, and, therefore, doesn't have any significance in the long term. Is that how they're viewing it?

MR. MEMORY: That's correct. For the 100,000 year and beyond, it's just a delay factor. It doesn't reduce it significantly.

DR. DOMENICO: Domenico. I seem to recall at least five years ago there was a study on the Calico Hills, and I think the conclusion of that study was we really don't have to go down there, but we're going to. Is this essentially the same finding that evolved several years ago?

MR. CLINE: Let me make one comment, and that is that this study actually ran PA analyses, whereas the CHRBA, it's my understanding did not. These were actually quantitative analyses that were done before this exercise, and we did not have that for the CHRBA.

DR. DOMENICO: For the what?

MR. CLINE: I'm sorry, for the earlier study, Calico Hills Risk Benefit.

DR. DOMENICO: Yeah, that was the name of the study, that's correct.

MR. CLINE: I'm sorry.

DR. CORDING: You had analysis on it. I don't know, you're showing the same curves, types of curves, on the Calico Risk Benefit Analysis, I think.

MR. MEMORY: Well, the thing that was done five years ago that was referred to, my best understanding was it was all qualitative, expert elicitation of how they thought Calico Hills would perform. There was no quantitative evaluation done at that time. One of the major differences between that study and this study is that we did do a quantitative analysis of how it would perform.

DR. DOMENICO: But the conclusions are virtually the same?

MR. MEMORY: They're not--

DR. DOMENICO: We don't have to, but we might.

MR. MEMORY: That's correct.

DR. DOMENICO: I'm sorry, Steve. Go ahead.

DR. BROCOUM: I think we--five years, we--a lot about scientific confidence, and I think that the end result was that it would increase our scientific confidence. Although on the earlier part of the study, it didn't change, based on expert judgment, the amount of releases you were getting. As I recall, we also briefed the Board extensively on that study. It was a long time ago, five years ago. I'm not sure there's anybody in the audience here that actually ran that study.

MR. VOEGELE: Mike Voegele with the M & O. I think the most important point to remember about the study that was done previously is that we did it twice. The first time we did it, we concluded, based upon simple value of information, that you could not present a scientific document that would justify characterization of the Calico Hills. However, when we redid it the second time and we elicited with respect to expectations of our regulator with regard to how one would have to deal with this issue, the conclusion was different.

DR. DOMENICO: One more point. With regard to these normalized releases that you just had on the board, I think I heard something that as long as you stay within certain probabilities, you feel that you're pretty good.

Well, you know, if you go to the extended dry, and that seems more and more likely every day, these diagrams of normalized releases mean absolutely nothing. These are isothermal model calculations, and I don't think you can put any value on those for guidance or otherwise, in the event that you go to the extended dry repository.

I might turn the question around that if you did go to the extended dry repository, what aspects of the Calico Hills would you be concerned with under that type of scenario, if any?

Did you understand my point? I'm talking about these--you had the one right up on the board. Yeah, they mean nothing under the extended dry. They mean absolutely nothing because that's not the way that it's going to operate. Presumably, the extended dry is going to be there, so there won't be any discharge, presumably, in theory.

But going with that scenario, how else would you view some investigation of the Calico Hills, especially with regard to maybe the zeolites or the sorbers or the things of that sort? Is there any value for going down there at that--under an extended dry scenario? This is a long question, but I got it out.

MR. SATERLIE: Rick, I wonder if I could clarify a little bit of that question and see if I can answer part of it. This is Steve Saterlie. I'm also with the M & O and working on systems engineering. I've been working on thermal loading.

Let me first clarify, the curves that Rick shows, TSPA '93, and those curves that were done subsequently for this Calico Hills study--

DR. DOMENICO: The release curves?

MR. SATERLIE: The release curves, yes.

DR DOMENICO: Okay.

MR. SATERLIE: --did, in fact, have some thermal predictions in there, and it had to do with the time at which the package temperature dropped below boiling, and it was assumed that re-wetting would then occur. There are certainly some simplifications in those calculations, however. Since that time, other predictions have showed what you talk about, extended dry, and the fact you may push the water off.

Those types of calculations, or idealized calculations, we're still investigating whether or not that, in fact, is going to occur, and that's one of the big primary emphasis in the thermal testing program is to, in fact, verify whether or not those models are predicting what occurs in reality.

DR. DOMENICO: This is one of the objectives of the thermal test, to actually make measurements that reflect whether or not this is going on?

MR. SATERLIE: To determine how accurately, yes, the model can, in fact, predict the dryout and how that--whether or not that occurs as we anticipate.

DR. DOMENICO: Yes, but none of those processes are incorporated at all in the release curves that we have been seeing produced by Sandia, produced by INTERA, produced by all the many, many groups. And I'm a little disturbed to see the statement that says when you fall within this range, you feel comfortable, because that's not the way it's going to operate.

MR. SATERLIE: What I'm saying is there are some simple thermal predictions that are in those--inherent in those curves. The temperature of the waste package is--

DR. DOMENICO: I see. But only as they probably affect the solubilities of the radionuclides and not necessarily the transport mode, which would be entirely different under extended dry?

MR. SATERLIE: Well, there was a corrosion formula taken into account there, corrosion temperature, that also was considered.

DR. DOMENICO: Yeah.

MR. SATERLIE: But, you know, you're--

DR. DOMENICO: But that's an advective model. That's a purely advective model. The transport is by advection. There's a little dispersion going on. The temperature modifications that you incorporate there just gives you information on release--quicker release, faster release to the corrosion, things of that sort, and doesn't really--what I'm saying is I think the temperature modifications that you incorporate in those models does not imbed the physics that's going to go on under extended dry.

MR. SATERLIE: It doesn't completely, and what I was trying to say, also, is that we're, in fact, trying to verify whether or not the extended dry does, in fact, occur, and that the rock dryout does occur.

You know, those predictions do indicate that in the center of the repository that dryout does occur, the temperatures stay high for extended periods of time, but there is edge effects. And so some of those releases that you saw in those predictions are due to the edges cooling faster, and there are thermal management techniques that we are looking at now to determine whether or not we can do something about that edge cooling.

DR. DOMENICO: I think my question was that in the event you go to extended dry, would that change your views on whether or not you should go down to the Calico Hills. I think maybe that's not a very serious question, maybe the heat effects are not going to be very effective down there. But it seems to me that your whole conclusions were based on retardation, transport, the normal things, fracture flow, the normal things that we consider under isothermal conditions.

And I think that's the conclusions why you said we don't have to go, but we might go. But I just wonder whether other things should be considered.

MR. MEMORY: Well, it depends on what the physics actually turns out to be, but my initial reaction would be that this is--these cases, which you're correct, were run at, I think, 57 kilowatts and don't have any thermal effects on the flow once you get the past the repository, that this is more of a worst case than we would hope to find in the extended dry in terms of flow. That's my initial impression at this point.

DR. CORDING: Your statement on the graphs describe 90 per cent fracture flow.

MR. CLINE: Which page? Which page are you on?

DR. LANGMUIR: Fourteen, and--the insert and 14.

DR. CORDING: Page 14, for example. What does 90 per cent fracture flow mean?

MR. MEMORY: That simply means that 90 per cent of the flow out of the repository horizon is through the fractures, and that it's a very severe fracture flow in the sense that there's no imbibition back into the matrix. Once it's in the fracture, it stays in the fracture.

DR. LANGMUIR: Could I ask a related questions? Langmuir, Board.

You mentioned that this was a consensus of experts at the USGS and others that brought you to these numbers to do the modeling exercises with. What percentage fracture flow did the consensus of experts endorse? It certainly wasn't 90 per cent, I don't think. What were they--this is certainly a worst case, I would assume. What did they think was the most likely fracture flow per cent?

MR. MEMORY: I don't know the answer to that question.

DR. LANGMUIR: Does Dennis Williams?

MR. WILLIAMS: Dennis Williams, DOE. Dennis Williams does not know the answer.

MR. MEMORY: What I was about to say was that these results, these parametric results, were presented to this panel of experts, and then once these results were presented, they went through the MUA analysis. But I don't know what the consensus fracture flow is.

DR. PRICE: Ed, could I ask a question?

DR. CORDING: Yes, please, Dennis Price.

DR. PRICE: Dennis Price. On 13, the--I just really need to get straightened out here. These who are responding here indicate, I guess from a scale from zero to one, scientific understanding, one being we understand it completely; is that right?

MR. MEMORY: No, no. It's supposed to be relative scientific understanding. One would be the understanding that you would get from the extensive excavation option with boreholes, plus 110-year monitoring program. So it's relative of the seven options that we looked at, the seventh option was rated 1.0 in terms of scientific understanding, and zero relative scientific understanding is not zero. It's what we understand today, which is greater than zero.

DR. PRICE: Okay. Thank you.

DR. BARNARD: Bill Barnard, Board staff.

I'd like to follow up on a question that John Cantlon asked earlier concerning the early access option, where you have a vertical shaft that's just off block, and if I read your diagram correctly, it's somewhere on the order of 500 meters off block; is that right? Have you decided that you'll never want to use that part of the block or that part of the area for a repository in the future? I mean, as I understand it, the NRC has great heartburn over vertical shafts in repository areas.

MR. MCKENZIE: Dan McKenzie with the M & O and repository. We don't have any plans to use that area. The cover is kind of low over there, and so on the other side of the imbricate fault system, all the expansion areas that we show are either to the north or to the west of the primary area. So it's probably not an issue from that standpoint.

DR. BARNARD: Okay, thank you.

DR. REITER: Leon Reiter, Board staff. Could you show Slide 15, please?

Yeah, I'm not sure if I'm reading this right, but it appears to me you're showing at 10,000 years a dose of 20 rem from neptunium. And that's, I think, far higher than anything I've ever seen in that time period. It certainly is orders of magnitude above any dose standards that's being considered now, and I just want to know if that--you don't consider that a significant conclusion on your part.

MR. MEMORY: No, I think we do consider that a significant conclusion. This is a real worst case example, 90 per cent fracture flow in both Topopah Springs and Calico Hills. It's pretty worst case in terms of how wet the packages are getting. But, yes, you're reading it correctly. It's 20 rems per year after 10,000 years.

The contrast at the TSPA result was at about 10^{-2} rems per year at 10,000 years. And the conclusion we made from this is that if you do have a--this is peak dose, peak individual dose. If we do have a standard based on that, then Calico Hills can become an important player, and the point I wanted to make, also, was that we could reduce our uncertainties in the performance of Calico Hills, or we could look elsewhere, saturated zone, enhanced reliance on the EBS and so forth. But this is an important result.

DR. REITER: Yeah, and if I remember correctly, the WEEPs model assumed 100 per cent fracture flow, and doses were nowhere near this.

MR. MEMORY: Yeah, the WEEPs model didn't get the packages as wet as this model is getting them.

DR. REITER: Well, even if you didn't have a standard, would this be a concern--something of concern to the people at DOE about the safety of the site?

MR. BROCOUM: Of course, it would be a concern, but the issue is, is this a realistic case, and is it likely to be that kind of fracture flow--I mean, as opposed to matrix flow. I mean, obviously, it's a concern.

DR. REITER: Because you're like a factor of 200 above center--Johnston's 100 millirem standard--a factor of 2000 above a 10 millirem standard.

DR. DI BELLA: This is Carl Di Bella. A quickie. On your option, I think it was 4A, the drill and blast of a shaft, followed by a drifting underneath in the Calico Hills, what sort of diameter are you thinking of for that drift, and what's the scientific and cost basis for that?

MR. CLINE: Is this for the early access to the Calico Hills, that option, or the--

DR. DI BELLA: It's Option 4A, I believe.

MR. CLINE: Can you--is it this option that you're talking about?

DR. DI BELLA: Yes.

MR. CLINE: Okay. I can't answer that myself. I don't know, is there anyone here that can respond to that?

MR. MCKENZIE: I could do a Dennis Williams and say I don't know. I'd have to speculate. I know that the drift is going to be driven with--like an AM-100 roadheader. So it's not going to be a very large drift. You're talking a horseshoe shaped, two or three, four meters in width and probably four meters high. The shaft is relatively small, too. I believe it's in the four to five meter diameter range, but we'd have to get you some exact number.

MR. CLINE: The idea is to get--

DR. CORDING: And that cross drift that you have there is providing you with a picture of the conditions all the way across the east-west, across the repository. Part of that concept of that, is that to do some of the sorts of investigations of major structures that might otherwise be carried out at the level of the repository?

MR. CLINE: I believe that excludes the north ramp extension, yes.

DR. CORDING: I think one of the points in that is it's pulling it in the section perhaps where your geology is--some of the structure seems to be more typical of the central and southern portion and even further to the north where you're--I know there's been some discussion about a lot of things going on in the area of the north ramp extension in terms of structure that might be somewhat different than the central part of the repository.

MR. WILLIAMS: Dennis Williams, DOE.

I think what we were looking at as a possible attractive option here would be to go across the center part of the block. And I think if you recall some of the Scott & Bonk mapping, you do see more fractures towards the southern part of the block, and likewise, we have some preliminary geophysical evidence that indicates that we don't have a whole lot of structure on the north end of the block. So if we want a possibly more of a worst case look at what we could be dealing with on that west side block, then we would like to have a crosscut further to the south, more towards the center of the block.

Of course, drifting down in the Calico Hills is a more--again, more attractive because it's less expensive than going through the hard rock at the Topopah level, and likewise, we wouldn't have the concerns of how that potential drift would interface with a potential repository.

So it's attractive to go down there, if we, in fact, go to Calico Hills.

MR. CLINE: Yeah, in the exercise for the north ramp extension, the Option 3A was very attractive. It went across the central portion of the block as well at the Topopah Springs level. The drawback on that, of course, was the impact on the repository design.

DR. CORDING: In what respect?

MR. CLINE: Layout.

DR. CORDING: Just because you've got a drift there that you have to work around--

MR. CLINE: Relatively speaking, that was used negative compared to the other options.

DR. CORDING: Yeah.

MR. BROCOUM: I just want to say a couple words to put these studies in perspective. The Systems Study that Rick led, that was planned last summer. Last summer we were just, you know, working on our Program Plan. At the time in the Program Plan, the Calico Hills access would have been 98 or 99, as I recall. It would have been after the suitability decision based on the funding and the activity as we laid them out in the Program Plan and the funding profile that's allowed for the Program Plan.

So that study--and we knew we'd have to make that decision on Calico Hills, so we decided to do a Systems Study to help us make that decision. The Systems Study doesn't make the decision for us, but it does give us some information how to go into that decision-making process.

We were also, in our baseline, had the north ramp extension, so we decided to look at some options for the north ramp extension.

The big thing that I--several things have now evolved since then. The first is that the engineers have come up and figured out a way to get down to Calico Hills a lot sooner, and that's a shaft, a drift option where we can construct the shaft in '96 and drift over in '97, so we could actually get completely across the block at the Calico Hills level before a suitability decision. So that gives a lot more flexibility than we had when we planned these studies, at least in our own minds.

And we feel with the increasing efficiency that Rick's been able to demonstrate in the TBM and in--we would be able to accommodate that onto the Program Plan funding scenario. But the other new twist now, of course, is it doesn't look like we're going to get the Program Plan funding scenario, and so we have to worry about what our funding is. Is it going to be level for the next few years, or is it going to be declining if interim storage becomes a big--becomes, you know, on the front burner, if you'd like, for the program.

So there's a lot of issues here. So all of these studies are just information that are going to help us make these decisions as we go down the road. But the thing I want to really emphasize is that we now have the possibility to get to the Calico Hills and across the block much sooner than we ever visioned before.

DR. CORDING: Thank you.

DR. DOMENICO: Could we see Slide--Domenico--15 again, Page 15, the expected dose?

Yeah, I don't really know what an acceptable dose is. I don't know if anybody knows yet, but if--and that's, again, with 90 per cent fracture flow, and apparently the doses are high.

If you could identify an acceptable dose, there's another question that says what percentage of the fracture flow would you need in the Calico Hills to exceed that, and, obviously, it's something less than 90, but if it's something substantial, 20 maybe, it seems like that's motivation for getting down to the Calico Hills because you're never going to ascertain that from vertical boreholes.

MR. CLINE: This supports that, I think. We didn't do the sensitivity.

DR. DOMENICO: Certainly that's--you're quite safe-sided, I quite agree, in terms of the--you're not going to get 90 per cent, but you're going to get maybe some percentage, and what percentage will it take to give doses that might be considered unacceptable? And if that's significant, I think it's sufficient motivation to get down there.

MR. MEMORY: There is an indication on this chart that gives the sensitivity. It's not the exact parameter of dose. It's cumulative release. But this is zero fracture flow, and that's 10 per cent fracture flow, 50 per cent, 90 per cent. So there is a significant jump.

DR. DOMENICO: Yeah, but we've seen enough from these studies to know that cumulative release has never given you any problems, doses have given you a lot of problems.

MR. MEMORY: Yeah, I understand. My point was just the sensitivity of the fracture flow.

DR. DOMENICO: Yeah.

MR. CLINE: Why don't you put that one back up, 15.

That, also, assumes, I believe, no dilution in the saturated zone.

DR. DOMENICO: It assumes no retardation, I presume, as well for those--

MR. CLINE: No retardation. Yeah, no retardation.

MR. DOMENICO: They're not retarded. That's why there's been no retardation. That's a good reason.

MR. MEMORY: No dilution, also, in the saturated zones.

MR. DOMENICO: No dispersion in the saturated zone?

MR. MEMORY: Right.

DR. LANGMUIR: Langmuir, Board. Doesn't retardation simply shift the curves? I mean, you're just slowing things down a little bit on the retardation. You're still going to have the doses for the down as long as the half life--

MR. MEMORY: Yeah.

DR. CORDING: Well, we're a little beyond our time. We're going to reconvene here at 1:30. We would certainly look forward to discussing the basis and the results and how you're--as you proceed, how you're considering this in the management. But we'll look forward to some discussions on some of the assumptions and backup for the way you've approached this. Thank you very much.

(Whereupon, a luncheon break was taken.)

AFTERNOON SESSION

DR. CORDING: Dennis Williams will be making that presentation. Dennis is Deputy Assistant Manager, Scientific Programs, Yucca Mountain.

MR. WILLIAMS: I think I was introduced, Dennis Williams, Department of Energy, talking about the geologic conditions at the Exploratory Studies Facility. And basically what I'm going to be talking about is some of the as-predicted conditions that we anticipated that we would encounter and then what we've actually encountered so far.

For a little bit of background on it, this geologic data was gathered for basically ESF design, design and construction, controlled by the Study Plan 8.3.1.14.2, soil and rock properties of potential locations of surface and subsurface facilities; Sandia National Laboratories. I guess our folks that were here this morning have left, but this is a lot of Sandia National Laboratory work, and I think you'll find that a lot of it is quite good. So we probably got our money's worth out of them with regard to this one.

North Ramp Geotechnical Report, that was submitted. That was the information that was used for design by the design construction folks. There was a lot of input from the USGS and the M & O into that particular report. That report was based on explorations of 11 boreholes, one deep trench, I think almost 2,000 meters of borehole, 1,400 meters of core.

We had about 100 field tests, over 600 rock property tests, and a couple hundred soil property tests that went into that report, as well as three surface geophysical surveys, core logging, RQD determinations, a whole raft of things.

We will have a Main Drift Geotechnical Report that will be submitted in July of this year based on the explorations that we've done along the north-south main, basically four boreholes, NRG-7A on the north end, SD-9, SD-12 and SD-7 on the south end.

The South Ramp Geotechnical Report, we're planning that for '96, depending on how our planning goes. If we're going to do a south ramp, we'll do a report.

What kind of data do we get out of the ESF to basically the geologic studies and design and construction? One of our big activities is ESF mapping. We've got detailed tunnel maps in right now from the beginning to station 4+00 a pair. This is basically being completed in June. We were supposed to have it deliverable yesterday. It hadn't quite made it into our office.

This is a final--the final maps. We map actively behind the TBM, and we stay up with the progress of the excavation. The folks that are doing the mapping for us are actively reviewing the section from 4+00 a pair to 8+00 a pair, and they are working, of course, on 8+00 a pair up to 10+50, and I think the cutter head's at 11+38. So we're staying right behind the TBM as we move through the tunnel.

Construction monitoring, we do scan line surveys right behind the cutter head to give rock mass quality data that we hand off to the designers and construction as the--or constructors, as the tunnel is excavated.

We refer to a Q system, rock quality designation system. Probably on this job it would be more appropriate to call it by the parent organization indicator, which is Norwegian Geotechnical Institute, because we get so involved in Q support systems, et cetera, with the NQA-1 approach.

This information is handed off on a daily basis. Totally reviewed information is handed off to the designer and constructor on a weekly basis.

I'm going to jump into what we have learned. Rock mass quality will be the end thing that we'll talk about, but basically what we've learned from the faults, from the stratigraphy, from fractures, and then in the end, rock mass quality that we hand off to design and construction.

With regard to faults, basically as predicted, especially in the section up to station 5+00, between station 5+00 and station 6+00, we're getting into smaller faults. They've been more difficult to predict from the surface and from the geotechnical investigations. So we weren't quite as good on those predictions as we were on the big ones, like the Bow Ridge Fault.

This particular diagram, which doesn't come out very clear, and it's kind of small, there is a copy in your package, and there's a full-scale drawing at the back of the room that you could look at if you were interested in the details of it. But this is basically our predicted section from 0+00 plus a pair out to 6+00 a pair, and this is the as-encountered or as-built condition from 0+00 a pair out to 6+00 a pair. So you can basically see what we have predicted as far as the geology and the major structure and then what we have encountered.

Yes?

DR. LANGMUIR: Langmuir, Board. What does 2+00 a pair mean, to those of us who aren't in the business?

MR. WILLIAMS: Two hundred meters. That's survey station. You're 200 meters in.

DR. LANGMUIR: Plus a pair of what?

MR. WILLIAMS: 2+00.

Bow Ridge Fault, the largest structure that we have encountered so far was predicted by Sandia to be at 1+96. That was a crown's--or roof section projection. What we did when we did the actual excavation, we have encountered it as 1+99.5. at the right spring line. So novelly, that was pretty close for projections.

I'll talk about some of the other--where we encountered stratigraphic units later on in the presentation.

Faulting is quite interesting. Here's a few points that we put together based on our observations up to 600 meters.

Faults with small offsets, nominally those less than five meters, between 500 meters and 600 meters, have wide zones of disruption that may be as much as 20 meters in densely welded tuff. Remember that when I get down to the last one on the Bow Ridge Fault.

The fault at 5+50 in the ESF mapping is based on very limited exposure due to lagging. Lagging has given us a little bit of difficulty. I'll show you where we've had lagging and how we're handling that with regard to the mapping.

We didn't have a fault at 5+00 a pair, as we showed on our predicted section.

7+00 a pair is a high-angle normal fault.

Additional surface mapping indicates there may be a northwest-trending fault near 5+00 a pair, which is consistent with observations in the ESF.

Again, we're seeing the big ones. Those are projected to depth. Some of the smaller ones we're having a little bit of difficulty with.

With regard to the Bow Ridge Fault, offset in excess of 100 meters, has a limited zone of disruption, less than five meters.

Small faults where we juxtaposed welded rock against welded rock, we're seeing quite a wide zone of disruption. In big faults where we juxtaposed welded rock against non-welded rock, we don't seem to have as much disruption.

I think this may be an indicator of what we're going to be dealing with as we move further along in the tunneling at Yucca Mountain. These are not easily recognized from surface exposures, so you're basically going into them blind. They give you more of a blocky condition, where that may be as much as 20 meters along the alignment of the tunnel. The big faults that we have predicted, like the Bow Ridge Fault, the Drill Hole Wash Fault, the Ghost Dance Fault, those types of faults, may not be as disruptive as what we had anticipated.

This goes back a little bit to Russ McFarland's question, I believe, this morning on whether or not we're having difficulties with blocky ground or faulted ground. The small offset faults are more like blocky ground. I believe those are the things that are giving this TBM progress the most difficulty. And likewise, we'll see on the joint patterns that just the basic joint patterns along this alignment are giving us trouble with TBM advance.

One of the questions that's been raised has to do with the imbricate fault zone. The definition of the imbricate fault zone, of course, comes from Scott, GSA Memoir 176. And basically what we're dealing with is the western edge of the--or the imbricate fault zone, the western edge of that zone defines the eastern margin of the repository lower block.

If we look at a diagram here, we see the imbricate fault zone out here on the east side. Projections north on that, of course, cuts across the north ramp alignment, and we believe that these are the faults that we are seeing in the north ramp.

Dan McKenzie tells me that this old drawing does not represent the pork chop of the repository, and, of course, Rick would say, "We're not doing this ESF now." So take the green and take the pink out of your mind, but the geology stays the same. ESF changes, repository changes, but we still have faults that have been there for a long time and will continue to be.

DR. ALLEN: Excuse me. On that diagram, where are you now?

MR. WILLIAMS: Put the diagram back up, Dennis. Okay. If you look real close, you will see NRG-4, and we have just passed the NRG-4 location. I think that was at 10+80, 10+60, 10+80 area, and we're out to 11+38, I believe.

DR. DOMENICO: Excuse me. Domenico. Just for my reference here, you're going to make the bend as you go along and complete the loop? Is that the game plan on this tunneling procedure?

MR. CRAUN: Yes.

DR. DOMENICO: That's it.

MR. CRAUN: DOE, Craun. Yes, we're going to make the bend complete, going down the main drift.

DR. DOMENICO: And then come out on, again, on the--

MR. CRAUN: As Dennis said, depending on the funding profile, if it's the south portal versus further EBS design, versus scientific tests, I mean that will have to be weighed as a result of the funding profile. But the Program Plan does show that we would come down the north ramp, make the corner, do the main drift, and then back out the south portal, that's correct.

MR. WILLIAMS: Yeah, this deviates a little bit from what we've been talking about recently because it does have a north ramp extension, south ramp extension coming across to the imbricate fault zone. I think coming across to the imbricate fault zone, we can see that we're getting a lot of information on the imbricate out of the north ramp itself.

Stratigraphic contacts, nearly as predicted. I'll put a couple of diagrams up to demonstrate that. It would be nice to have two machines.

Over here we have the predictions from the Sandia report, basically going through some of the key geologic units and where we would encounter them along the tunnel alignment. Over on my left, your right, we have the actual ESF tunnel stratigraphy as we have mapped it in the tunnel. With the geologic terminology over here, we've got the thermal mechanical unit over here on the left side, and, of course, the stationing.

A couple things that I'd like to point out, there is the Bow Ridge fault zone at 1+99.5. Over here, the Bow Ridge isn't specifically identified, but it is the contact between the Tiva Canyon Tuff and the Ranier Mesa, 1+96.

With regard to coming back into the Tiva Canyon Tuff after we go through the Pre-Tuff unit, actual we have 3+49.5. Over here, it was predicted--the earliest prediction would have been 3+54.

As we get down to some of the other key units, down here at the Pah Canyon Tuffs, and we come over here to the Pah Canyon Tuffs, we see a 10+20, compared to a 10+28.

So some of these are coming out quite well from a predictive sense.

DR. MCKETTA: 10+28 is 38 to me. Tell me again what 10+28 means.

MR. WILLIAMS: One thousand and twenty-eight meters.

DR. MCKETTA: Then why don't you say that? It's easier to say 1,028 than it is 10+28.

MR. WILLIAMS: I'm sorry, I was a surveyor before I was a geologist. I'll try to clean up my terminology.

We're mapped up here to about 1,075 meters, which is breaking into the TSw1. We've subdivided this. We've probably got a vitric zone in here that we don't have on this particular visual yet that likely will define the bottom of the PTn and the top of the TSw1. Information still to come.

With regard to fractures, basically our borehole and pavement data indicates that the majority of the fractures are steeply dipping. We have confirmed this by mapping in the ESF.

What we have here is a great circle diagram on a lower hemisphere stereographic projection. We have the tunnel alignment represented running through like this, and these are three major joint sets. And you can see on your--in your package, you have the strike of those joint sets and the dip of those joint sets, 85 degrees north, 75 degrees west, 75 degrees west, basically steeply dipping joint sets.

If we would basically complete this diagram for the structures on the mountain, like the faulted structures, we would basically have them setting in in a north-south configuration, also dipping to the west. And I think you'll be able to see on a slice of the mapping that we have that the contacts in the stratigraphic package between the various units of the volcanic--they're dipping to the east down at a low angle, and they would be coming up in a presentation similar to that. So we can see that on a slice of the--

DR. CORDING: And the tunnel's about north 60 west or--

MR. WILLIAMS: About 300 degrees, yes.

DR. CORDING: About 300?

MR. WILLIAMS: Yeah, sitting right here.

DR. CORDING: Okay.

MR. WILLIAMS: This is a slice of our tunneling mapping that's being performed by the Geological Survey and the Bureau of Reclamation. There's a 10 meter section through here, another 10 meter section. This is a full periphery map. If you take a drawing like this, as Susan always tells me, you've got to turn it like that, you can actually look at the geology down the tunnel. So I remembered what she told me.

Basically, this is the crown, left spring line, left invert, right spring line--I'm sorry, right spring line, right invert, left spring line, left invert.

We have, as I mentioned, the contacts between the volcanic units represented here; again, dipping back to the southeast. Major fracture structures running perpendicular to the tunnel alignment. We have represented on this where the actual steel sets are located, and then lightly shaded is the location of the lagging that was in the tunnel at the time this mapping was performed.

I think you can see--well, one of the things that we want to demonstrate is that we can see these actual locations here for various structures. We can draw projections on that through the lag area, which you can go back and then actually see what surfaces of the tunnel were available to us when we made this particular drawing.

Down here at the bottom, you have the corresponding wall map that goes with it. Again, right spring line up towards the crown area, the dip of your lithologic units, your major fracture zones running through the tunnel.

DR. ALLEN: This is a vertical projection?

MR. WILLIAMS: Yes, it's a vertical projection on the right wall. Same scale as the upper portion of it.

The final maps for the first 400 meters are what I mentioned earlier, are shortly available, and, of course, they'll be available for distribution.

Rock quality. Rock mass quality from the north ramp boreholes compares well with rock mass quality data from scan line observations in the tunnel.

We do two rounds of determinations of rock quality. One is done up very close to the heading before the walls are actually cleaned off, and then one is done--a second round is done in conjunction with the mapping on the mapping platform after the entire circumference has been cleaned off.

We use two systems, the Q system, which, again, is the NGI system of Martin 74, and then RMR system, geomechanical system. And probably the Q values come out the better of the two with regard to representativeness of actual conditions. So most of the discussion will be based on the Q.

This is scan line data from the Tiva Canyon portion. This is the--the bold line is the borehole data predicted values. I'll move it up a little bit so you can see.

Your rock mass quality indicator is down here, and then the scan line information that's coming in on five meter intervals from the work that's done closely behind the heading.

Ground support categories are shown up here based on the design, and that's the design reference right there.

A little different way of looking at the same data is to lay it out along the geology from the Tiva Canyon through the bedded tuffs, to the Tuff "X", again back into the Tiva Canyon, into the Pah Canyon, and then into Topopah Springs. Stationing, zero to 1,200 meters, the data how it plots out with regard to the Q system and the ground class category shown over here on the right side.

DR. DOMENICO: Domenico. Dennis, what does that mean? I know it's a Q value, but I don't know what Q values are. That means the Tpc is the worst quality you have here?

MR. WILLIAMS: The values down in the lower end of the scale are the worst values. Those will correspond to more--to a heavier support system, like steel sets. When you get higher on the scale, then you're talking about Category 1, or in a lot of cases if you were on a government job, you might even be considering a bald-headed tunnel.

So values up in here indicate good rock. Values down in here indicate the poor rock.

DR. DOMENICO: How does that correlate with the ease of tunneling? Where are you finding it easy, where are you finding it difficult?

MR. WILLIAMS: This isn't an indicator of ease of tunneling.

DR. DOMENICO: Okay.

MR. WILLIAMS: This is an indicator of ground class with regard to the type of support that you may want to put in that tunnel.

DR. LANGMUIR: Excuse me. Aren't they related? Didn't you--excuse me, Langmuir, Board. Isn't the blocky stuff that's tough to drill and the stuff that's loosest and least supporting? Aren't they--Richard?

MR. CRAUN: This is Richard Craun. Yes. I think also what we're experiencing with the machine is a process as we're tunneling and we're actually dragging some of the blocky material around the head. So as we're in an area that is more in a fault zone and extremely blocky, at that point we'll actually over-excavate, where we actually have in three separate different locations--I believe it's three separate locations--have actually created voids above the machine, and that's where, in fact, we'll lose the vertical--or the upper gripper.

So it's a combination of both of these, and it's actually, I think, an effect of actually removing more material than we've actually mined, is where we're really having the most trouble.

MR. WILLIAMS: The numbers that you would--or values that you would arrive at down in this area would indicate that you might want to support your rock mass as quickly as possible with the appropriate support. Of course, over here, the support guideline gives quite a bit of flexibility, especially in the 3 category. It runs from some quite good rock down to some poor rock. And I think as was mentioned earlier this morning, the Category 3, possibly because of its broad range, is one of the more difficult support categories to deal with right now based on what we're doing in the tunnel.

DR. LANGMUIR: Langmuir, Board. Can I interrupt you one more time while we're looking at this figure? You mentioned that the disruptive zones were largest for the small fractures sometimes, and the Bow Ridge had a very small disruptive zone. Are the very disruptive zone rocks with the large fault effects disruptive zones in the Tpc, are they these worst rock kinds of horizons?

MR. WILLIAMS: You see a lot of that. The minor faults would be through this zone through here, and we would probably be encountering them, then, in these areas where we had the real blocky nature of the rock and we were getting fracture densities that were--or fractures that were closely spaced. That would be giving you higher fractured densities. That, along with other parameters, goes into your Q system determination. That would tell you that you've got to either put in heavier support or you've got to get your support in real early in order to control that rock.

DR. DOMENICO: Conversely, the Tpp would be the better quality, less-fractured, less-bulky rock that you encountered?

MR. WILLIAMS: Right.

DR. DOMENICO: And you could move faster in that; is that correct?

MR. WILLIAMS: And I think that was--

DR. DOMENICO: Could you move faster?

MR. WILLIAMS: --the position that we encountered. I think Rick moved quite rapidly through that section with minimal difficulty.

DR. DOMENICO: How much more Tpc do you anticipate?

MR. WILLIAMS: None.

DR. DOMENICO: No more--not enough formation with that kind of rock.

MR. WILLIAMS: No, you said Tpc?

DR. DOMENICO: Yeah. I know you're through the formation, but I'm sure some of the other rocks are--

MR. WILLIAMS: Topopah Springs, of course, is a welded tuff, similar to the Tiva Canyon welded tuff. We're in welded tuff for the duration until we make the turn onto the south ramp, come back up and encounter the Pah Canyon again.

DR. DOMENICO: Okay. So on this whole loop that you're going for, you make the bend, you might anticipate quality of the Tpc, more or less.

MR. WILLIAMS: Look at how the numbers are--the numbers are immediately falling down into the range that we encountered in the Tiva Canyon.

DR. DOMENICO: Okay, rough sledding, in other words? Rough sledding for a little bit?

MR. WILLIAMS: It could be rough sledding.

MR. CRAUN: This is DOE, Craun. More opportunity for success.

DR. CORDING: It's a challenge. The openness of the joints, is that--I'm trying to recall how much that's being weighted in the Q. The Q is just a weighting system for a lot of different factors. It's also, you know, counted together into a number. But is the--the openness of the fractures, is that weighted very heavily in the system? I can't recall what that was.

MR. WILLIAMS: Openness of the fractures, it's difficult to see where we're seeing the majority of the work. The openness of the fractures is affecting the ground condition largely in the areas where it's immediately supported behind the shield.

As far as remembering the six factors in the Q system, operation, water, openness I don't think is a very--is one of the dominant factors.

DR. CORDING: It comes in under joint properties--joint aperture, whatever, but it may not be that heavily weighted. But what we're--what I've seen, and the tunnel people described to me, is some very open features at the shallow depths, and as to how that's going to look deeper. The degree of interlock on those joints is another key part of the stability, and if the blocks are all by like a bunch of loose teeth and they come rolling off on you, like behind the cutter--right behind the grippers, the shield, then you have to deal with that in a different way, and it's tougher to deal with it, and it's going to get broken up at the front and all that.

So to what extent the behavior will be better in the Topopah Springs, it's going to depend to some extent on that type of parameter as well.

MR. WILLIAMS: I think one of the things that we're not seeing here that you see in a lot of tunnels, you always consider how bad the water situation is affecting you. However, the water does give you some alteration of joint face and sometimes can even enhance some of the joint faces as far as holding things together. You don't have that in this mountain. It's basically a fairly loose matrix of rock blocks, and the longer we deal with a tunneling system that basically manipulates that, even for 40 feet, without some initial support, we're losing a lot of stand-up time, and we are having difficulty then over here on the support column.

DR. CORDING: Yeah, and I assume it becomes more important that your support go in underneath the shield, so that you're taking care of what's gotten loosened as you come out. That becomes more important to that type of machine.

MR. WILLIAMS: I think that this is indicating to us that the blocky condition of just the joints themselves, and possibly the minor faults, is probably going to be a more difficult condition than the large faults, in part because we don't have very many large faults that we're going to cross, and the fact that at the Bow Ridge, we seemed to, you know, with a minor amount of initial difficulty, went through that quite nicely.

Of course, one of the best parts of the tunneling had to do in a case where you can't really classify the rock according to the Q system, but in the bedded tuffs, they were of considerable concern in the exploration. That was one of the better parts of the tunneling exercise.

Probably running real close here. I'll run through these here real quickly. These are just basically some histograms that show some of the distribution of ground class categories as predicted for the subdivision on 1A, 1B, 3A and 3B because of the influence of spot bolting and some other supplemental systems. Scan line predictions for the Tiva Canyon welded unit.

Basically what we've installed as far as support, largely support in the 1B category and a Class 4 type support, which is steel sets.

This is an example of the sheets that our Sandia folks used for making the ground class determination. As you can see, all your Q factors here, your RQD, joint set, roughness, alteration, water reduction, stress reduction, and then the RMR factors are noted in here as well, to come up with a rock quality from both the Q standpoint and the RMR index standpoint, and then the typical support recommendations down here based on the design keyed into who did the work station, 1,060, 1,065 meters, the date, category, et cetera, all part of a Q records package.

Conclusions with regard to the geology faults, stratigraphy, factors, rock quality substantially as predicted.

The very last thing in your package is a diagram of the predicted geology along the north-south main, north end, south end, two of our major borings on that, SD-9 and SD-12.

We will be getting rock quality data that comes in with the geotechnical package that will be coming in in July.

DR. CORDING: Okay, thanks. We're just about out of time here. We are out of time. But you're also doing--this is--you're focusing on relationships with the tunnel support here, but there's also--you've got other mapping data besides just classifying as a Q system. You're describing character of joints. You're describing materials in the joints, things that relate more to the overall geologic--things that might relate, for example, to hydrogeologic concerns; what sort of materials is moving through the fracture system, how open are they, what's the history of that?

MR. WILLIAMS: Yes, and I think you will see--if you go into the tunnel, you will find that when we get to one of these interesting areas of joints that look like they've had a lot of movement on them, or actual fluid movement on them in the past, that's where all the sampling is concentrated. You'll actually see what block samples have been carved out of the wall, and, of course, all the measurements, all the alteration on the joints, everything associated with those joints, with the geology of the tunnel is being captured from the mapping platform.

DR. CORDING: Okay, thank you.

DR. LANGMUIR: Langmuir, Board. Related question, a short one.

You had blocky rock, and then, of course, you had the Bow Ridge with a small disruptive zone, and you just talked about--and I looked at your form here, and I was hoping to find a category for the folks who look at the fractures and faults where they identify not just alteration, but secondary minerals. And, obviously, from a water point of view, you want to know--I'd be interested to know whether the blocky versus the well-defined fracture zones seem to show the most alteration effects that you can see have occurred, absent of any water right now. But have you--is there evidence of past flow water in these systems, and have you run across zones where fractures and faults--you've identified alteration and mineral precipitates as evidence of past flow fluids?

MR. WILLIAMS: I cannot give you the specific details on those kinds of--or answers to those kinds of questions. However, those are things that our folks are supposed to be capturing, and I'll be reviewing the records packages as they come in to make sure that we are capturing that kind of data.

As far as exactly what the criteria for the sampling, the sampling criteria for why we take a sample, where we take it, I would defer that to Ned because I think he's got a closer hands-on handle on that, and perhaps he could bring that up in the next presentation.

DR. LANGMUIR: I wonder if John Stuckless, who I just happened to notice was back there, has thought about or heard about what's been identified in terms of secondary mineral effects in the fractures and faults so far encountered?

DR. CORDING: Could we bring that in at the end? Let's bring that in after Ned's--

DR. LANGMUIR: Make sure he stays around, though, so--

DR. CORDING: Sure. Let's go to the next presentation, and thank you, Dennis. We do need to move on.

ESF testing by Ned Elkins. Ned's been coordinating a lot of the testing activities in the tunnel, interfacing with the construction activities, and he's the one that has been gracious enough to take us into the tunnel after he spent a night on the graveyard shift, and then he goes out in the morning and brings the short term tourists, or the tunnelers, or whatever. Thank you, Ned.

MR. ELKINS: Thank you, Ed.

I want to ask that the lights hopefully will be bright enough. I'm going to do a little presentation. When I was following Rick and Dennis, I decided to try to do the entertainment portion of this program and show you a few of the photographs of things that are in the tunnel, things that we've discussed this morning, and along that travel log, at least try to give you a good status and update of the scientific program in the ESF, and then entertain any specific questions you may have. But I noticed that they're kind of washed down. Your hard copies, even though they're black and white, may be sharper. But we'll go through these and see how well they do.

Just before I get into the component, a review for most of you certainly of the overall site program as defined for the Exploratory Studies Facility, and I'm using these next few pages as the table because they give an interesting breakdown, a more functional breakdown of those test facilities.

Basically there are 42 sites, activities that come right out of the SCP program as activities under a suite of study plans. What you're seeing--and this is not a unique assemblage, you'll see the same test activity appear in more than one of these groupings. But basically, these groupings and the dates on the right-hand side correspond to physical locations of the test activities themselves and when they either historically have been put into motion underground, or when we at least, against the project plan, felt that we would.

On this first page, most of these test activities, and certainly in the first two groups, are in the field. The first group are those that we do actually within the TBM envelope, most of those off of the TBM itself. The second group are construction phase, are non-deferrable tests that we do in alcoves, and we've talked some about alcoves this morning, and I'll give you status in a little more detail on our alcove test program.

DR. LANGMUIR: Ned, do we just add two years to these numbers on the right? You've got '93s and '94s over there for the ESF.

MR. ELKINS: No, the TBM envelope test, the reason we put '93 in, and we did it very purposefully, is because we actually started the suite of these programs in the slot cut. So before we even went underground, we established an initial suite of these test activities. They went to the field when we were cutting the slot, before we ever even went into the starter tunnel, which is the drill and blast component. So just to give these in terms of when we put them in the field, and I know that's a little misleading, but these are the tests in that grouping that we have carried on into the TBM program, but they were initially fielded as stand-alone outside in the sunlight.

Then the '94 and '95 activities, all of those correspond with underground in the tunnel, and the '96, '97 are those that a lot of them you're going to have to take with somewhat an understanding that the program is being evaluated now, as it is every year, a prioritization program, and we keep this program flexible enough to respond to what the critical data needs are and the realities, if you will, of the budget. And we'll make those adjustments as necessary, but they're our best shot.

So the second group, as I said, were the alcove non-deferrable tests. They're primarily related to unsaturated zone percolation. They're primarily a USGS study plan, which have eight different ESF activities. The construction monitoring and the mapping, though, are certainly a part of that program, as is consolidated sampling, and then deferred tests in the mains and ramps. And just to give you some idea of test programs, we do not have fully fielded consolidated sampling. We don't have all of those activities--some components are deferred.

And then the second grouping of those are in situ alcove tests in the core test area and ramp extension. This is primarily the mechanical and thermal program. We'll talk a little more about that later.

And then I just go ahead and always show the suite of activities that scientific organizations have always maintained would be the candidate test for a Calico Hills program, and I wasn't even bold enough to put a date up on those, just show them as TBD.

So, again, very quickly, what I'd like to do is just give you a high view look at those programs that we have currently ongoing in the field. I want to spend a few minutes as we go through on geologic mapping and our sampling program, which involves 14 different study plans active at this time.

Our geohydrology program, as I mentioned, was a single unsaturated zone permeability program.

The construction monitoring program has two studies active right now, in situ design verification and excavation investigations.

And then our consolidated thermal testing program, two study plans involved. We have the Fran Ridge large block program. In the field we're getting to implementation of that or the beginning of the actual heating phase of that, and I'll talk a little more about that later.

And we have begun the formal planning and design process just kicking off, and I'll show you some conceptual layouts and some places we're going with the underground in situ part of the thermal mechanical coupled process test.

With these, we give these pictures that will show--some of them will show well, some of them not so well. The only reason I threw this out, and I think you've been hit on this two or three times, that is just where we are right now, is 1,138 meters--I'll do it that time, and from now on, I'll probably say 11+38 because I'm just too used to that.

But these pictures are just, again, for those of you who haven't seen good pictures of it, the cutter head itself before we went underground, and a look from the launch chamber, down the large picture, down the tunnel, and then from right off the back end of the TBM in an area where we were not having to use full scale support back towards daylight with the conveyor system components in. Rick showed you those this morning.

To look at this test program, as I just mentioned it, out in the field, and I don't know if the laser will show you much, but just to update very quickly where we are. As I indicated, we came in here in the north ramp. The question was asked, and Dennis responded, we were right here in the cutter head, right in the Alcove 4 location. We have this suite of tests, the TBM tests up in the upper left-hand corner are active. We have field and the full suite of test in Alcove 1. We are close on Alcove 2. We are in the final location and design modification process for Alcove 3, and that activity will start before the end of the summer.

And within the week, we will have the initial party for location of Alcove 4 because the TBM cutter head is just now engaging the top of the Topopah Springs welded unit No. 1, and it is at that location, in the transition from bedded tuffs back over, but that alcove--real quickly to point out, Alcove 5 is another major fault property test that is the next of these critical, non-deferrable tests. Alcoves 6 and 7, likewise, are non-deferrable tests. And you have the Ghost Dance, Sundance complex. These non-deferrable alcove tests all follow that common theme that primarily are permeability geohydrology program. They're primarily being done during the excavation phase because of great uncertainty of the impact and deferral of those test activities, and we heard a little about that this morning.

So we push these tests, not that they have to go in two weeks behind the TBM, but we're uncomfortable with them sitting there a year or two behind that TBM.

The general thermal address area is right here at the bottom of the--again, I'll talk about that more. But maybe one thing that came from the discussion this morning with the first group, the consultants that were in, that I feel just obliged to point out--and, Rick, I appreciate you pointing out part of it today two or three times. First of all, this test program is not being fielded as the SCP said field an underground test program. This program has been evaluated almost to nausea for years. We have evaluated this thing for deferability, for ability to fit with the construction program and meet our high level data needs.

For instance, in the north ramp, there are nine alcoves. We are constructing five along that ramp. There were nine that we were to construct, and we deferred those out of the program at this point. Along the main drift, we were going to put in two stubs. There were four additional alcoves. We have said we will defer those. They're not on that critical path--we believe we can retrieve that data if it's critical later.

And if you notice, after this alcove, from here all the way to daylight drive in the south, the test program has not identified the critical data need, which would require stand-alone alcove. There are, however, 13 deferred alcoves in that area. And that's point one, and the second point that Rick was very good about making, and I appreciate, and I'll re-emphasize, the scientific program hasn't cost this TBM operation a day yet--a day. And I think that it's something that on behalf of that whole program, we're extremely proud of. And that's not just the scientific program. Without the effort of the construction and design group, if we weren't working together on that, we just wouldn't be there. And I couldn't be prouder than I am of that effort.

Real quickly, just now to brief you on the tests themselves. Geologic mapping, this is the picture geologic mapping in progress, a line survey going down the right rib. At a minimum, we always try to keep that right rib open, regardless of geologic conditions, so that we can get in and do a detailed line survey.

At this time, there are four components of a mapping program, and I've just referenced where they're at. Full peripheral mapping sets at 10+50. Tunnel photogrammetry is at 10+60. RQD classification, which is a rock quality component, at 10+40, and detailed line surveys at 10+41.

We are currently in the process of evaluating this photogrammetry, which is stereo regularly overlapping photographs. We're taking a section of this tunnel, where we're able to put in channel and bolts, and we're evaluating the data from stereo photography in a smooth bore opening. We considerably are moving towards the concept that maybe we don't need to use stereo photography in a smooth bore opening. You're not really getting the relief that's necessary. Some of you guys have been with this issue for years. But I think we needed the technical database. I think we're close to getting that, and we do believe a photographic record is important, but it certainly doesn't need to be stereo.

Impact of ground conditions on just our end of the business, on geologic characterization. And you've already heard a lot about it, but, again, just some pictures to reinforce words.

This picture in the upper left is actually above. This white structure you see is the top shield of the TBM, and yours truly was jammed up in there, and that was a tight fit for me to get this picture in here.

This area extends up, and it's almost six feet in places, and this isn't, you know, the worst condition that we've naturally seen. But it does give you a good idea of what's going on in interaction of this machine and that rock mass as we come through these blocky areas, and these are kinds of challenges that we work with.

We do, however, even in the worst conditions, were we were to take this picture, we do have the geologic mapping group come up here and take a look, and we have the geotechnical people come up here and take a look, as necessary. We're very concerned about safety. This is not a condition we want to put scientific or construction personnel in on a regular basis. But at least a quick look before we do anything like fibercreting, flashing, covering this up. It's critical that we not cover something until we've taken a look at and make that original evaluation.

These other two pictures, in the lower left just shows you what the transition from partial lagging, where we can at least get some look at the geology to an area that the constructor felt was warranted to type or full lagging. And in that situation, certainly, there is not much in the way of the geologic look, but we are up front with the constructor before that's put up there, and he nor us get a great look at the rock, but we get the best we can. And I don't believe at this time that if the Bureau of Rec or the USGS were here, they would say that any critical characterization or information has been lost due to this, but certainly there is opportunity to efficiently optimize that program.

This here is just the transition from partial lagging to six-inch wire, and this wire and channel is that transition that you've seen a lot about. Again, even though this isn't the best picture for that perhaps, hopefully you can even tell on this photograph how much better the crown observation is for geologic mapping activities in that situation.

You heard this morning Rick talk about the innovation, and we certainly consider it that in the science program, of moving away from lagging wherever possible and going to a two-by-six very rigid interlocking mesh. We've only been able to do it over about eight meters so far, so it's not a valid test, even though we like what we see. And this is--in these upper two sections, this is that interlocking mesh, two-by-eight section, transitioning back there with the lagging. The technical community is delighted with this. The ability to see through this, as you can see in this kind of a photograph, is extremely good compared to certainly solid steel lagging.

You've seen this picture, and I won't spend much time on the geologic section. We do ours differently. We've revolved it because a lot of people don't like looking right at the left. So this one, the portal is on the left and moves under.

The thing that I'm going to spend a little bit of time talking about is this TBM has just engaged this area right here, that even without knowing much about geology, you say that's a pretty active area. Those are the bedded tuffs that we just traversed through with the tunnel boring machine. We sat right at the bottom of those, just entering the upper Topopah Springs, and so I'll give you a little bit of information about what we've seen there primarily.

And the photograph--I wanted to show you a couple of conditions. This one is not--it's not a good picture, but there's really not much to see there. But if you look closely, you can see a lit bit of gray hatching in here.

At about Station 750, we have full saturation in the matrix in the ESF. People talk about water, we hit water. It was never water in a perched sense or free sense. We never had a fracture run, but we hit absolute matrix saturation. Yes, the material was cold to the touch, clammy. You break it, the full matrix was wet. We saw that exact phenomena on every borehole we drilled out there. It was fully expected and anticipated, but I just wanted to show you not only the fact that we were there, but more importantly, and again, it comes to a point of hedonics today. If you see, that only very select areas now are showing this moisture. This is three weeks after excavation. If you don't get in and sample that water very quickly, the make on that, the capillary pull, is far overwhelmed by the ventilation in this system, and that water is lost extremely quickly. So the ability to get in here and get those samples and get out is important to us.

This is the best example, or the most visibly exciting example, if you will, of the bedded tuffs. This is the pre-Pah or the very bottom unit of that bedded tuff area. This is an altered tuff. This feature right here where this picture was taken has now got the distinction of being the second most sampled feature in the ESF to date. Only the Bow Ridge Fault that we collected more samples than this altered tuff. It's a great interest to people. DOE is writing a report on this structure right now. They believe that there's a lot of significance there. We have extensively sampled it, and the results of those analyses may lead us to even do further characterization on that type of feature.

Consolidated sampling. We have an extensive sampling program underway. I'm not going to spend time with it, but there are 14 studies that are supported by consolidated sampling.

The Test Coordination Office, with support from the USBR, take these samples, keeping the PIs, the numerous investigators, behind these 14 programs generally do not have to come underground to get their sample. They let us know what they need. They provide those criteria, and we train to their procedures as necessary. We use the mapping geologist to every extent we can when we take these samples. We have a program, a sample management facility there to store those samples for the PIs, and it works very efficient.

We have a very active construction monitoring program going on right now. As of the 10th of July, we've instrumented 26 steel sets. We're vibrating wire strain gauges in the ESF. We started out with a very dense program, and did pre-jacking loads to really understand the installation of that steel. We're slacking that back now, as we have a good database that we're--for instance, in the entire Topopah, we're only looking to put in five additional instrumentation sets. We've mirrored those with six-point convergence pins.

So we put in, to this point, a tremendous amount of instrumentation on steel. We're also putting in MPBXs and single point borehole extensometers. That's this operation here on the left. This is the welding of strain gauges onto a steel set outside. Here you can see the actual installation as it sets in the tunnel that are looking at that load.

Geohydrology program. The next two or three slides focus on the alcoves themselves. Many of you have seen Alcove 1. This is from a little deeper in the tunnel, looking back at Alcove 1. It's about 40 meters in.

This is the actual test area as it looks today. We still have an active cross-hole testing program a year and a half in. That should complete within the month.

This alcove then goes to a long term monitoring component. We are already, even though rudimentary in the process of staging a visitor area, if you will, but is full of information about the TBM or excavation and science programs, things like cutter head disks, and over on this table, we're putting examples of all the different types of rockbolts and materials that we use. Being just 40 meters in, we believe that the project will get great advantage out of having a place, without going deep underground, where visitors can come and get a flavor and at least have a little rock over their head. This alcove will become more and more of that staging area.

Alcove 2 Rick mentioned this morning. Actually, this morning we shotblast around for the design depth. We'll be taking the PI for acceptance, and hopefully we're there.

You can see the back end, see that line going in. You can see that we put a lot of support, a lot of bolts in this area. We did a tremendous amount of instrumentation. Every blast has been monitored. That data has been collected under a Q program, provided on a shift-by-shift basis to the AE in the field so that he has the information from an accelerometer down hole study, observational study as well, and as well as just motion sensors that we're doing peak particle blasting measurements on as we go even deeper into this tunnel.

We should be starting drilling certainly within the next month, once we get everything--equipment in and instrumented.

Alcove 3, we're finally locating. Alcove 3 probably represents the best example of rapid transition of a steady idea that we've had so far. This has always been assumed to be a single alcove along the contact and running a series of boreholes on both sides of the contact. When the exposure was actually opened to us and we got the geologists and hydrologists down there, we actually found two contacts of equal interest to the PIs. One of them at 7+50 is the one I showed you in the earlier picture where we transition in the Tiva from densely-welded, moderately-welded tuff. That triggers the actual initiation of the Paintbrush Tuff non-welded. And this is this area still under saturation. That saturation fades out within 100 meters of this location, and it gets dry again in the bedded tuffs.

If you go down the tunnel about 20 meters, and if you look from lower right up to upper left, there is a transition through here. That is the moderate to lightly-welded Tiva, the transition right here to what's called the Shardy base, which is vitric non-welded component at the very bottom of the Tiva. That is a very clear transition. The USGS has interest in sampling both, and instead of putting in two alcoves, again with design and construction working together, we've been able to come up with a compromise idea. We're right in between them. At 7+60, we're going to drive a single alcove, drill both ways, and test this contact from either side. And I think, again, it's another achievement of the cooperation between those, and that final design is now underway.

We ran a diesel test, and I wanted to throw a quick slide up to just show you that not all of the test activities we do are tightly tied to study plans. If design engineering or any component or program has a critical data need, we have, we believe, the capability to quickly plan and get a test in the field. Diesel emissions is one that has been very important to us to look at the impact of any diesel locomotives and diesel support.

We initially constrained ourselves extensively against that. We used the primary electrics and were asked to run the tests to provide information to say whether or not we should relieve or fail to relieve those restrictions on diesel.

We came in and did three consecutive tests over one day when the tunnel was in a little less than 600 meters. We ran a locomotive continuously hooked up, an inner analyzer directly to this locomotive about 500 meters down to the end of the tunnel. Came into the vent line, put a series of peto tubes and sampling tubes. We also did a lot of organic gas samplings in VOC bottles.

Just a little bit of data, I couldn't resist, on some information we gained here, things that I think are important because this was a valid test of the ventilation that was done under very extremely controlled conditions from a ventilation standpoint. We saw an average of 1,166 cubic yards--or cubic meters per minute coming down the tunnel. That's a dilution rate of 93.39 to 1, or about 100 to 1. It takes about 26 minutes to totally change the air out at the ESF at that point in time we ran this test.

The statistical band on this kind of data is extremely high, but I wanted to just give you some general information that we took out of that. The most conservative assumption we had going in was that all of the NOX and SOX produced in this tunnel would be retained, nothing would come out. That was the basis of our design evaluation, and just the fact that we were seeing return in this with the dilution that we had, it was extremely significant, given the fact that we know we're exhausting a lot of these gases.

At this point in time, the DIE is being re-evaluated. We are looking now to relieve the controls on diesel, apply controls in two areas. One is on the diesel itself, have scrubbers and catalytic systems applied to them and a regular maintenance system on them, and also use a very clean fuel, low sulfur fuel, and given that, we believe we ought to relieve those kinds of constraints. The sampling and testing program will continue to take swipes and look at any long term degradation.

But again, I think that that's--it was a quick test, but one that got off a dime on a design issue.

I'm cranking through these pretty fast. I don't have a sense of time.

I think, Dennis, you showed this slide.

This, I wanted to give you as I finished this talk up and talked a little about thermal. I wanted to show you the section along the main. This is no longer looking down the north ramp. This is section along the main. That hard black line is the tunnel. As you can see, it comes in just below the litho-stratigraphic contact between the upper lithophysal and middle non-lithophysal. It's in that general area, or just above. The repository planning design people are looking at the upper bound of the potential repository.

This drive is going to be remarkably consistent in what it sees, and it's going to stay high in that upper non-lithophysal material, very little in the way of observed faulting. One thing I noticed in this, well, it's just not shown real clear because it's green, but we do have the Sundance structure that we believe may be there. We're going to get a chance to encounter that. You can see the abandoned Wash structure here, but generally, that's a pretty clean drive, and we're going to find out a lot about what kind of block and fracturing systems we really have that aren't tied to significant faults as we go through this drive.

It's right here in this upper left side that we looked, as the thermal testing addressed, and with that introduction, I would be remiss, as always, to not at least show something on Fran Ridge. The Fran Ridge test continues to be developed. We are drilling this block now. We completely slabbed it. The cable ways are in. We'll finish drilling this test out. The cables will be installed this fiscal year, very early next fiscal year, funding and motivation from the part of management provided. We'll go ahead and instrument and turn the heaters on this test.

This kicks off truly the field phase of the thermal program, and it's often overlooked and forgotten as people look at the ESF and talk about the in situ thermal. But that field program really begins there at the large block.

And what I wanted to finish with, then, real quickly--and I don't know that I can get all of this quite in, is where we're at in terms of the thermal planning.

A team of both scientific, as well as management people, have been put together to finally get down to brass tacks and pull this thermal program together. We have spent about six months already evaluating the very needs of performance assessment, repository design, site program. What you see here represents for the first time a general concept, or a general location address and concept of the thermal test program, that from the scientific program standpoint has universal acceptance. In other words, all test organizations all agree that this is generally what they're looking for and what they want. And that's a step forward. We are going to be moving very aggressively on design and beginning to support the design effort of our design team here with this kind of concept.

This by no means is set, but the things that I wanted to show you here, again, is the general address. As we come swinging out of the turn on the north ramp at about Construction Station 2800 meters, that's the general area where we think we've got our closest and most quickly available access to go after this thermal test.

In terms of what numbers are important in terms of constraint, this test has been looked at now by the testing community as essentially about a 50 meter offset from the main. We don't want this thermal test program crowding the main ramp any closer than 50 meters. So we've got to get 50 meters off the main, and right here, that little number is the number that has been argued and debated until, I think, we finally come to a consensus at about 10 meters below the 10 per cent lithophysal to middle non-lithophysal. In other words, that litho-stratigraphic contact between lithophysal and non-lithophysal, 10 meters below that contact will be the address for the thermal test.

To get there, if we were to go to the east--could go to the west, but that causes some severe restrictions on the repository and the repository design. To get there from the east, you can see we would have to run an access drift of a little over 100 meters.

We've shared this information preliminarily already with the AE. The design organizations are looking at this with us, and we'll proceed with probably more interest to most in terms of a test.

Now, the real key to this test is that it is a single test composed of various activities perhaps. Dennis Williams mentioned today the desire to really focus on or jump to the thermal--or what I could call the coupled process component, the big heated room. And as you can see, there's very little else in this program.

However, two other things that we believe are important--we believe repository design people feel they're important, are some of the mechanical attributes, both properties information, very difficult to tease out on the coupled process test to do in ERT types of measurements and thermal response alone.

Here we're looking at the possibility very early in the drive as we're moving down here to get this set up to do a uniaxial wing heater type configuration to look at some very, very clearly mechanical attributes of thermal perturbation, and not really look too much at coupled processes, but really focus on those parameters necessary for the mechanical concept of thermal. And right over here, this little niche, is for a--is a plate loading test, the test where we had actually used jacking to look at closure in a small opening, associated with in-drift, and this heated test would have in-drift heaters, and these little dark black lines are wing heaters that would accelerate the thermal build-up in that rock mass.

This is a short duration, three-year, hard-hitting, heat-it-up, cool-it-down test. It's an LA type test. In other words, we would like the results out of this test to be available for license application. It is not to say that there is not some continuing thermal program of this type, either performance confirmation or long term heating and cooling cycles that may need to be looked at.

But getting off the board and getting moving forward with the design of this test, we hope to have the access underway by spring of next year. We hope to actually field an initial component of thermal if we make the commitment to do this mechanical phase before the end of the next fiscal year. We're looking to have this component of the program in perhaps by the spring of '97.

So that kind of gives you the feel for where I think we're at right now with thermal planning.

Construction, as we're beginning to look at that, with this access drift, it does give us some challenges. At a 10 per cent downgrade, it's certainly a rubber tire program. We would like for it to have been flat, but as you remember in the previous--and I didn't point it out--geology isn't flat in this area. And if you're looking right down the main, and that's the main, you see you've got a 4.2 degree dip in that bed. To stay at a given geologic point, you've got to chase at 4.2 degrees. To get any deeper than that, you have to even go steeper, and that's why this little drift right here, to gain that little additional head, requires coming down at about a 10 per cent downgrade. And that's certainly not a rail haul.

I've whipped through a lot of this stuff. I don't even know how my time frame was, but I think that's generally it. If there are any questions, I'll try to answer them.

DR. CORDING: Let's take a moment or two for questions. Your time frame is all right. I think we didn't start you as soon as we would have liked. But, any questions? Russ McFarland?

MR. MCFARLAND: Ned, one quick question. On your thermal test facility, is there a strong consensus that there are important thermal mechanical issues that must be addressed early in the test program, more important in the coupled process testing?

MR. ELKINS: Yeah, there are certainly different schools of thought, Russ, on that, as you talk in the program. As I just kind of bumblebee around pollinating all of those groups of interest around the project, I feel that the probable from a site standpoint or licensing standpoint, I think what's emerging as the primary or driver is the coupled process test.

However, that's not to say that there isn't criticality in the mechanical component of it, I think if you go in and speak specifically to repository design. But there is some of the information that they most critically need as they look at early design component retrievability. If they don't have some good mechanical properties thermal response, we have really no basis for that design.

And so even though that may not be the highlight or quality of coupled processes, I don't know that we can afford to just completely ignore those either.

MR. MCFARLAND: But you're going to draw conclusions from a drill and blast opening--

MR. ELKINS: Yes.

MR. MCFARLAND: --and extrapolate it to a machine board opening, even though there is--in terms of natural analog, there must be immense data available worldwide on the response of openings in geology through different types.

MR. ELKINS: I agree, that's true.

MR. MCFARLAND: Not much data on coupled responses.

MR. ELKINS: That's true. That's true. That's why I say, I believe coupled responses is emerging as a critical path activity for us. If, however, similar to the interface between testing and construction, if we can get some good mechanical data at no cost in either time or schedule to the other activity, I think it's probably something we really owe it to ourselves to look at, and that's what we're trying to do here.

DR. CORDING: Yeah. In visiting the project and looking at the way the alcove was being constructed and all, I mentioned this before I think earlier today, but it did appear very clearly to me that you and the contractor in the science side, the engineering side, had worked together in a way that allowed that to be placed without affecting the machine progress. And you said there had been not one day of delay. I mean, the construction of that alcove was basically drill and blast. It was being done principally, at least getting started, at the time the TBM was being maintained, and so, in looking at that, are you saying there was no delay at all for putting that alcove in, or you had some, perhaps, delay on that?

MR. ELKINS: I'm glad you asked the question, simply because I think even less than a year ago, nine months to a year ago, we were looking as we were doing our advanced planning and scheduling for construction activity, we were putting four weeks, every time we wanted to put an alcove, shut the TBM down, lock her up, four weeks, that kind of impact was not getting anyone anywhere.

And yet, when we really sat down and began to focus, and Peter Kiewit was coming up to speed, and the M&O was up and we were able to engage construction management design, the innovations that we thought were there even before we addressed them, we thought they were out there, we began to see.

The utilization of blast mats and some very careful planning for this type of activity allowed us to essentially shoot this first shot. I was there when we fired the first shot. Blast matted ventilation line was running. We could have been--technically, could have been running the TBM at the same time we fired even the first shot right off of that main. We never lost a single shift. We didn't ding up that vent line on the first one, because we learned how to close blast mats properly, but it's been a learning process.

We never lost a shift. What we've tried to evolve to is one shot per day, and then we try to do that right at the tail end of graveyard, where you've almost got a shift coming out. We load quickly, we shoot. With the blast mats, the trains can run right on in. We can start as soon as ventilation clear and environmental health gives us the go. We can go right to the TBM and get fired up for day shift maintenance and operation period. We begin to muck out the alcove.

We go through a sequence of muck, pre-drill, load that night. It's worked beautifully. It has caused us now to not be so phobic about how many alcoves we've got to do concurrently. I think we can look at these things truly in a sequence of activities. That interplay is, to me, just fabulous and, you know, Rick, I think, feels the same way.

DR. CORDING: And I saw tests going on that are interesting, and, particularly, some even in the area that I'm most interested in, but one of the areas of the rock mechanics. But, some of those tests, I saw that they were going in, perhaps, in a way that wasn't--they weren't the most critical issues for the thermal issues or hydrologic, let's say, but they were going in in a way that was not interfering with other activities.

MR. ELKINS: Exactly.

DR. CORDING: So it was a target of opportunity sort of approach that I think was what you've been looking for. I think that's been very good.

And the heater test is going to be done with a heater that goes out in--those heaters are going into the rock; is that right?

MR. ELKINS: Correct, both. We'll have in-drift heating and we'll do guard heaters in boreholes.

DR. CORDING: So you're trying to set up something that will model a large loaded area?

MR. ELKINS: Yes, try to expand that modeling area and accelerate the rate with which we can get a more--a larger area looked at.

DR. CORDING: What groups are working with you on that from the science side?

MR. ELKINS: Well, the key groups on the scientific side from the modeling standpoint, primarily looking at hydrology, Lawrence Berkeley; from a near-field standpoint is Livermore, and from the mechanical standpoint, the primary driver is Sandia. The M&O is heavily involved in that. Federal Services is actively kind of involved in that process. Los Alamos is looking at some diffusion or some couple kinds of things, and GS is also looking at the possibility of at least being able to use some of the data from it.

We're going to try to keep the group down to a dull roar in terms of the actual activities that are going on in there, but the value of that data, we think, should be pretty general across the technical board.

DR. CORDING: I think that's one of the things we've been asking and advocating over the past several years, is to make sure that groups work together and utilize a test setup in a way that they could all obtain the information from a thermal test, and I'm pleased to see that.

MR. ELKINS: Absolutely.

DR. CORDING: In looking at the fracture characteristics around the drill and blast opening, or in the way you--I should, perhaps, start over. In the way you're going to advance through that section where you're putting in the drift scale test, have you set up a plan for minimizing the overbreak and all? You'd love to be able to do it with a TBM if you had the druthers, but--I assume, but are you going to be able to deal with the fracture and the overbreak?

MR. ELKINS: We have to absolutely control the overbreak and fracture impact of this. We need to be able to simulate as best we can mechanical excavation, or we're not going to be able to do it.

In terms of where I believe we're at--and I think the technical community pretty much share this--we're just now beginning to formally involve the designer, and we will let the AE, with input from construction, help us, because they have a better feel for it. But my assumption is, going in, that for that component that's actually heated, from the bulkhead in on that thermal component, we're liable to have to line drill this. In other words, it's something that that's going to be important enough on it, we're not going to allow that overbreak. If it needs to be line drilled, we'll do that. If we can come up with creative solutions that are not that onerous, that's fine.

However, for most of the instrumentation drift and the drillholes that'll go off in there, we don't believe that the impact of a controlled drill and blast should be that critical to us, but as we get in close to that thermally-heated drift, we believe we have to be able to say with some confidence that we didn't have a major impact due to drill and blast.

DR. CORDING: The line drilling would be drilling on the perimeter, to make, essentially, a close to continuous--

MR. ELKINS: Yes, and try to half cast it; absolutely.

DR. CORDING: --half casts around the perimeter, with no blasting on the perimeter?

MR. ELKINS: Yes, sir.

DR. CORDING: And the start of the alcove construction and the start of the testing, what's your schedule, again, on that?

MR. ELKINS: The current schedule for the TBM is to have the trailing gear by Station 2800 about February. Once that machine can get by that location, we want to have the design in place, at least for the access. We still will likely be fussing with fine tuning the test design, but in terms of the access that'll get us there at the beginning in the Sandia component, our plan is to be able to get excavation started, just like these alcoves, very expeditiously, and at a suitable place, break out two or three rounds, and allow a single element test, which provides two things.

One is that mechanical data we're talking about. Second, it's a shakedown for that test that's about to come, because I would not want to put every egg I had in the basket that says I can do that thermal drift and all of the drilling that's required, and instrumentation, without seeing a scaled down version of that, at least in an underground environment, so as a shakedown, as well as as a mechanical component, we think we can do that before, have that test underway before the end of fiscal '96.

DR. CORDING: And when would you turn the heaters on in the drift scale experiment?

MR. ELKINS: Right now, best plan we can come up with, with the best, most aggressive schedule--and we think it's doable--is the spring of '97.

DR. CORDING: Okay, thank you.

Any other questions? Don Langmuir.

DR. LANGMUIR: Ned, I've always been curious, and I probably could have introduced myself to some GS people and some--I'm sorry--Livermore people who would have answered this, but it's unclear to me how you're going to test for the effect of coupled processes at some distance away from a heater in the ESF, and I doubt that you're going to even see it in the large block tests in a way you can assess and extrapolate to the mountain.

What are the plans right now for instrumenting to do coupled process determinations in the ESF; in other words, looking at mineral precipitates and fractures, the movement of minerals in fractures. I can't imagine how you'd do it.

MR. ELKINS: I certainly am not going to want to be the champion to answer that question completely. I'll tell you what the general concept is to get to that, is to essentially have not just hammer drill, but drill out a coring as this test is being set up, so that you've got a lot of geologic, you've got a lot of infilling information, fracture information, so you've got a basis on the geochemistry end.

The primary instrumentation, if we set mechanical aside, now, I've talked a little about mechanical. We'll do multi-point extensometer work to look at closure and expansion. We'll certainly do, I think, some plate work to look in the actual opening, but on the other components of coupled processes, the primary instrumentation that I am having given to me that produces this kind of a layout is twofold:

The primary components of it are an ERT, electrical resistivity, where they're going to look at changes in a very hostile environment, which gives you some challenge in and of itself, but look away from that, from a ground zero, through a heating cycle, and back to see what's happening in terms of moisture content in that rock mass.

Couple that, or right beside that, side-by-side, is a thermal front, so they'll be looking at changes in thermal, changes in water, and between the two of those and the geochemistry, and then one those things cool back down, they're going to go right back in there and re-drill this area back out, get new core side-by-side with what they had seen before, and try to assess any geochemistry alteration, any changing to--

DR. LANGMUIR: But the bottom line is have fluids moved through the block, and has that fluid movement been affected? If you can look at locations and see moisture changes, you can certainly look at the local effects.

MR. ELKINS: Right.

DR. LANGMUIR: But do you have any evidence, or can you identify actual transport through the system, and changes in that as a function of the heating? That's really the critical question.

MR. ELKINS: It's certainly a scale issue, and I know that the primary group that debates that with the project and others on site is Lawrence Livermore, and to the extent I've understood the argument of Tom Buscheck and others, they're going and that's very scale-related. If we run too small a test, the answer to the question, I think, that you just asked is absolutely not. As the size of that test increases, I think the chances of doing that are better.

This test of the scale we're talking about here--and I very carefully kept numbers off from this. It's just a concept, but in an area where you may do 50 to 100 feet of heated drift in a tunnel, at that level, those people believe that you'll have enough geologic information because it'll be detail mapped, it'll be detail sampled and tested. They think they can get some of that scale effect, and so this is the size with which they think they can answer that question, Don.

Beyond that, I would say you really need to challenge them with that type of question, but we did not want to run a test that we didn't think was representative. As we've got them to come to consensus, this is about the scale that they believe they can come to consensus understanding.

DR. CORDING: Okay, thank you very much.

We're going to move on and cover the repository operational concepts. Kal Bhattacharyya, the M&O, is going to be discussing that, and we're moving now towards repository, away from ESF, as such.

By the way, just for your information, Kal is the Department Manager of Repository Design for the M&O.

DR. BHATTACHARYYA: Thank you, Ed.

My topic is to talk about repository operational concepts. I've been asked to address the concepts for these different phases, construction, emplacement, retrieval, and closure, and then discuss the alternatives considered within these phases, and bring up some specific design issues as we go along.

Just to put things in perspective a bit, just to remind that we are in kind of a halfway to the conceptual design phase. According to the Program Plan, our ECD is supposed to be complete by March, '97, and license application to be completed by September, 2000 to meet our license application date of 2001. So, it's my estimation that we are about halfway through the conceptual design. That's why we are not exactly in the selection mode yet. We are in the mode of proving feasibility of the whole process here, so you will not see very many selections yet at this moment.

As I said, we have been asked to look at certain given phases. Just to put that in an overall framework, we are looking at operating the MGDS in ten different phases. The site characterization is in one of them. I have put little stars on the ones that the Board has asked me to discuss; construction, development, emplacement. There's a caretaker period, retrieval, closure. Off-normal, obviously, can happen at any given time, PA and the post-closure, so I will simply discuss the four or five phases that have an asterisk beside it.

Construction phase typically expected to start after NRC has given us the construction authorization. It is expected that we will get that in 2004, if everything goes well, and basically ends when we have sufficiently constructed facilities, both surface and subsurface, to permit steady emplacement, so this is really the construction of pre-emplacement construction, and it's expected that if we did get that 2004 construction authorization, then we will complete this construction phase at 2010.

Just to give you an idea of what the repository conceptually is expected to look like at 2010 or so, for the surface facilities, we would have finished primarily these systems, the site prep system would be, for example, the grading, flood control, muck handling system, and so forth.

Site transportation system will include the roads and ground movers and whatever is within the site. Site utilities system, power, and so forth; waste handling facilities; support facilities; utilities; and transportation.

Let me just point out, this is a conceptual design. This is, just to orient yourself, that's just the north portal, that little notch here, and this overall area is the nuclear handling facilities, and this is the balance of the plant, the non-nuclear facilities, as a matter of fact, separated by a fence and a gate, and it's expected that everything you see here would have been completed by 2010.

The primary things to point out are the waste handling operations, cask maintenance facility, waste treatment operations, as well as all the railroads and roads that are necessary.

Getting back to our subsurface area, this is a picture of what, again, the repository may look like in the year 2010. What we have, really, is you would have, at that time, constructed the secondary service main. This is a part of the ESF. We would have constructed the perimeter drifts, the two shafts, the emplacement exhaust shaft and development shaft, and connected them to the main perimeter drift, and would have constructed this set of drifts. We, right now, are thinking somewhere around 10 to 15 drifts that will be constructed just to get you going at that time. We have not started emplacing yet.

We would have then established the separation of the emplacement operation from the development operation at that time, and I'll show you a picture in a minute how we do that, as a matter of fact, and, at this time, we should be ready to accept waste.

This simply kind of narrates what's on that picture. We will have all the excavated openings, shafts, ramps, drifts, limited drifts, all the support facilities to this, ventilation, and so on; waste package handling system. We will have established the railroad system, and so forth.

So, that would end the construction phase, as a matter of fact, and then we enter to the development phase, which is really a mining term where construction is often called development. We could have just as well called the whole thing as a construction phase.

We say repository development is a continuation of the construction phase, and continues from the time we have started emplacing, to the time we will finish emplacing, about 2034, and this proceeds concurrently with waste package emplacement. That's something that people have asked often, how are we going to do that, and I'll address it in a minute.

This shows that, just like in construction, we will develop a set of drifts at a time, 10 to 25 again. What we are going to do is, as we said, is develop 10 to 25 drifts at a time. This is the emplacement area, and this is the development area. They are physically separated. If you look at it, we have a separate ventilation system here through this emplacement intake shaft. Then it goes out through there, and exhausts out that way. We have a set of shafts and a ramp here to ventilate the development side, as a matter of fact.

This is, of course, in a cartoon fashion, showing what's going on. We have emplaced, for example, several drifts. Some active emplacement is going on in this area, maybe in the second drift, as a matter of fact, and a set of them are standing by, as a matter of fact, so these are all constructed, supported for the final support system, as a matter of fact, ventilated, instrumented, and then emplacement operations going on.

Then, what we do is a set of development drifts are being constructed at various stages. These are virtually finished, these two are. A TBM is working here. A second TBM could be working here, and these little notches, which would be like starter tunnels, would have been constructed by some secondary system, such as a load header, and so forth.

As this set of drifts are completed, then we will create this separation, what we call a substantial stopping. We'll construct a set of these stoppings here, which could be something like an air lock, and then we'll bridge these, and this whole ventilation system, then, will become on the emplacement side ventilation. Construction on the development side will go on.

Some of the issues that we are asked to discuss, the development issues, of course, the big word is, of course, maintain the flexibilities, because we are still in conceptual design phase. We are expected to meet what is coming down the pike. Thermal loading has been often mentioned as an issue that really certainly affects our development, how quickly you develop, and the pattern you develop; extent of area needed, what's the extent that you develop, directly proportional to the thermal loading.

Emplacement strategy. You could be achieving the same thermal loading using all kinds of different ways and all variation of drifts and waste package spacing, as a matter of fact.

Rate of emplacement could become an issue. If you are emplacing it at a high thermal load, then the current rate of emplacement or waste acceptance is all right, but if the initial emplacement is at a very low thermal load, then you could not probably keep up with the rate of receipt. I discussed that a little bit in Las Vegas in April.

Spacing of waste packages and drifts. Again, there are various school of thoughts, if you will. You could place the drifts far apart and waste package close by, achieve the same thermal load. You will have a kind of a localized, very high temperature situation, or you could put the drifts and the waste packages in a square pattern and maintain a lower temperature profile.

How to interface between the development and emplacement needs to be worked further out, and limitations of excavation equipment used. We are primarily looking at mechanical excavation and TBM, for example, under mining condition certainly has some amount of limitation for what you can do with them.

This kind of illustrates the various ways you could develop this thing. As you saw, at 2010, at the beginning of emplacement, you probably would have constructed these emplacement drifts, and you probably want to keep them at a very low, like 22.5 meters centerline position, which would allow you to go to 100 MTU/AC, and then you may want to continue and close this space drifting while a decision regarding thermal loading is being made. If you maintain this, you could certainly go to 100 MTU.

Somewhere around 2010, ten years after emplacement begins, you may want to go to a lower spacing, because if you want to go to a thermal loading of, say, 50 MTU/AC, it could change the spacing of that thing and complete the repository, so that'll give you--what it really tries to illustrate is that your flexibility is time dependent. You cannot keep it flexible all the time; otherwise, you would have constructed all these tunnels and would have probably used only second, or every fourth one of them, and you would have wasted a lot of construction money.

I'll talk a little bit about the emplacement phase. It begins when, obviously, when the first shipment of waste is received, and ends when we put the last shipment in, and, as I discussed a little bit there, development and emplacement are concurrent, and that's how--the picture listed how we do it.

Some very specific questions were asked to discuss. The question was how do you transfer the waste package from the surface facilities to the underground? Well, let me put a picture up here.

This is a conceptual picture of the surface facilities. This slide simply describes the steps at the surface waste handling facilities. We'd load waste package into a transport cask, and what we're looking at, really, is the last operation, the underground transport. This is the waste handling facility in the surface. That's the north ramp right now, the north ramp portal, and what you're looking at is this operation.

Basically, the surface facility is handing the subsurface facilities the waste package in a transport cask, so that this remains within the waste handling facility in the surface. The waste package never comes out of the surface facility, and what we do is we attach a waste package prime mover. That would be done on the other side of that room, as a matter of fact, and will move the transport cask out of the building, and it will be going down the transport to a ramp portal, and would take that ramp into the designated emplacement drift.

One of the alternatives we consider, as a matter of fact, let me show you a picture. You may have seen this in the initial summary report that we had. We are talking about a waste package transport cask and carrier. Initially, we were thinking about putting the waste package inside a transport cask with its own wheel.

It would have been a fixed transfer wheel, and then put this whole thing on a rail carrier and take that underground. You can easily see that this kind of gets rather tall and unwieldy, so, currently, we have removed this part of it. We have put the waste package inside its transport cask with its own wheels, so that it can attach a prime mover, like a locomotive to it, and directly pull that out.

The advantages of this one was that this fixed transfer wheel made chances of derailment less, as a matter of fact, because we would just run them in a straight rail inside an emplacement drift.

When we started that on our north ramp and south ramp area, in a five to six per cent gradient range, we obviously could not use an integrated rail system, so we primarily, at that time, looked at wheeled and tracked vehicles, and I showed some of these pictures two or three years ago. We looked at monorail system, but once the new configuration of the north and the south ramp were developed, integrated rail system obviously became the preferred method, so we had looked at some alternatives.

The next thing we were asked to discuss was how we handled the waste package at the emplacement drift entrance. This is an illustration of the operation at designated emplacement drift entrance. What you are looking at is the transport cask now had been brought by a electric-powered locomotive. This is the north/south drift, which we call the TBM launch main. These are the emplacement drifts. One thing to notice is the emplacement drifts are somewhere around 5 meters to 6½ meters, depending on what kind of emplacement mode you are using.

This launch main is actually nine meters, because this is where we launch our TBM from. It creates an inherent problem because there is a tremendous amount of difference in the diameter and the size, so we have to get from this elevation to that elevation through it.

What it is doing is this written thing describes what we are doing. We bring the waste package transport cask here by this locomotive. We used to have a concept of a turntable. We are basically abandoning them. I don't have a quick picture to show, but what we are doing is we are simply, like the way you park a car, you are coming along a drift, and then just backing it up into the emplacement drift, as a matter of fact, so we are getting rid of a turntable.

The operations involved would be you have to open this door, and then push this waste package out inside this emplacement drift sufficiently, and then remove this transport cask and bring another locomotive and this one, position an emplacement equipment, which would be, you know, again to your locomotive, off-load that emplacement equipment from this one, and then you push that inside and then close the door, and that part of operation at the emplacement drift entrance is done.

Talking about a couple of alternatives that we looked at, this is the same operation, except the operation is being done inside the shielded door here.

You saw before this whole configuration was out here. One could put them inside a shielded door. What it does is then once you take the waste package out of it, you are still doing this behind this closed door, as a matter of fact, which added an extra safety. Only problem with that is also that you have to cut out this extra excavation from each of the emplacement drifts, as a matter of fact. This emplacement drift is only five meters.

This whole question of handling waste package at emplacement drift entrances, as I described a minute ago, we had initially looked at a turntable versus direct transfer. This doesn't have a turntable. In our earlier concept, we used to have a turntable here. We are looking at a concept of air bearing, which doesn't have a lot of promises for moving very heavy loads, for moving waste packages around from inside of this into there.

The rail cart concept was one of the earliest concepts that we looked at. This is the one. The waste package sits directly on the rail cart, and we are looking at roller conveyor for moving this waste package a short distance from inside the transport cask out into the drift.

The last operation we do in this emplacement phase is emplace the waste package. That's pretty straightforward. You can see that a locomotive--and not in this picture. We had to bring a different locomotive at a different level--attaches this to the transport cask and just takes it into a location where the final resting place of this waste package is, and then return the emplacement equipment to drift entrance.

As alternatives, we are looking at locomotives and gantry as a prime mover, and waste package base, we are using a rail cart or a pedestal. This one shows a rail cart, but we are also looking at a pedestal where the package directly sits on a pedestal. You will, of course, have to use a gantry to put that on a pedestal.

Retrieval phase, I'm just going to touch upon it, because Dan McKenzie is going to discuss that at a greater depth. This waste package retrieval phase is one of the ten phases that the MGDS operation includes. It includes all actions to retrieve the waste, if necessary, and retrieval can happen any time. The 10 CFR 60 says any time after emplacement, up to 50 years. Our program plan then increased that retrieval period from 50 years to 100 years.

We primarily have four functions to do retrieval operation--underground, that is; provide access to the emplacement drift. Some way or other you have to get into the drift, remove the waste package, transfer waste package to surface handling facilities, and then further handle and process the retrieved waste at the surface facilities, which is being developed, the idea. Again, the issues, and so forth, are going to be described by Dan McKenzie, coming right after me.

Closure phase begins when NRC amends the license and allows us to close it, includes backfilling and sealing, decontamination, and then we establish a barrier, protective barrier around the repository.

The particular operations are fairly straightforward: decontaminate and remove all the underground equipment and fixtures. If you are going to backfill, then prepare the drifts for backfill, and, if it's necessary to do, backfill the drifts. Then you seal the repository, and then establish the protective systems.

The issues, the primary issues, backfill, again. Dan McKenzie's going to discuss questions about backfill. The primary issues are: Do we need a backfill? And if you do need, what performance we need to attribute to the backfill, and if we do decide that we need a backfill, what type of backfill. Many have been proposed, and we have a system study right now going on to address this thing, and once you do find what kind of backfill you need, the question is, can you construct a backfill to meet the specification, can you engineer and construct it, and, again, Dan will go through this engineering process a little bit more.

So, I believe that I have discussed the things that I was asked to discuss, primarily, about four or five different phases of repository operations. We looked at some of the examples of alternatives being discussed for performing each stage of this operation, and brought out some of the issues related to the various repository operations.

That's all I have. If you have any questions, I'll answer them.

DR. CORDING: All right. Thank you.

Do we have questions? Russ McFarland.

MR. McFARLAND: Yes, Kal. Thank you. That was an interesting presentation.

One question. You're showing on page 15, emplacement drifts, something of the order of 2,000 meters long.

DR. BHATTACHARYYA: I don't think so, Russ, unless there's something wrong with the--let me find that.

MR. McFARLAND: Page 15.

DR. BHATTACHARYYA: The average length of these drifts are about 1,000 meters.

MR. McFARLAND: I had a hard time reading your scale. I thought that was a full thousand. Assuming they're 1,000 meters long, you're going to go in and push from one direction 1,000 meter long train of packages in order to fill an emplacement drift, one after the other?

DR. BHATTACHARYYA: We will do one at a time. We are emplacing at the highest--at the peak rate, we are getting about 600 packages a year. That we need to emplace only two packages a day, one package a shift, so what we expect is that we'll take that single package, and we'll have a locomotive and just push that one single package with the locomotive, and we'll start emplacing it at the end, and emplace it at a given spacing, one at a time.

MR. McFARLAND: Right, and in the extreme, it will pushing something on the order of 1,000 meter long train?

DR. BHATTACHARYYA: That's correct; no train, just one at a time.

MR. McFARLAND: One at a time?

DR. BHATTACHARYYA: Yeah. There won't be any train.

MR. McFARLAND: The locomotive will go into the drift and push it all the way in?

DR. BHATTACHARYYA: That's correct.

MR. McFARLAND: So that you are training them. The locomotive will go in the full thousand meters, then back out, bring another, and one at a time?

DR. BHATTACHARYYA: That's correct.

MR. McFARLAND: I see. Now, how would that happen in that drawing you have up on the left, for example?

DR. BHATTACHARYYA: I don't have that picture, as a matter of fact. What you're seeing is that this is the prime mover. This is the big locomotive that brings the waste package down from the surface facilities. It comes down this way, goes up that way, backs it up. You know, there is enough in there you can't quite see, and then it goes down and comes right at the beginning of the emplacement drift.

Then, this locomotive goes away. Then another locomotive has to come and an internal mechanism of this, since this is in that emplacement drift, an internal mechanism, such as a roller bearing or something or other, or whatever, pushes this out, and then this locomotive takes its empty transport cask and goes back all the way up to the surface.

MR. McFARLAND: Then you're left with your waste package at the opening of the drift.

DR. BHATTACHARYYA: Waste package at the opening of the drift, and another locomotive, which could be parked right here, a smaller locomotive, that is just going down flat, and this bigger locomotive is going up and down, so this is going to be probably a 30-ton locomotive, and the smaller one that's just--we call it an emplacement locomotive, will have to be brought on a kind of a carrier or a low-boy, and so that it is in the same level as this emplacement drift, and that locomotive, the small emplacement locomotive will couple at this thing, and push it out.

MR. McFARLAND: So that there are really two locomotives, not one?

DR. BHATTACHARYYA: Well, there are three.

MR. McFARLAND: Three.

DR. BHATTACHARYYA: There are three.

MR. McFARLAND: Three locomotives?

DR. BHATTACHARYYA: We are looking into that. Right now, the biggest problem, Russ, is, of course, we have this big step.

MR. McFARLAND: Indeed.

DR. BHATTACHARYYA: And we don't want to make 100 miles of nine meter tunnels to avoid this step. One of the things we are looking at is a secondary excavation where we could take the bottom out of this thing and we'll have a nice horseshoe shape, you know, on bottom.

But, unfortunately, when you have two circles and one is a nine meter diameter and the other is a five meter diameter, you have to go through these steps, but we do have three locomotives. That locomotive will be riding on a carrier, and the third locomotive help push it.

DR. CORDING: Dennis Price.

DR. PRICE: Actually, Russ was asking the very question that I had on both the options, and I assume that the locomotive we're looking at now is shielded, because it's inside the radiation door; is that right?

DR. BHATTACHARYYA: That's correct. First of all, the transport cask, of course, is shielded, and this locomotive could be actually a remotely operated locomotive, also.

DR. PRICE: Remotely operated?

DR. BHATTACHARYYA: Yeah. There's no reason not to, you know, but any locomotive that's going in and out of this thing, I assume to be remotely operated.

DR. PRICE: And you very quickly said for retrieval, you just go in and get the thing you want and bring it out. As with this, there was a lot of details which aren't there, and how do you go in and get that thing and bring it out?

DR. BHATTACHARYYA: I'll defer that question to Dan McKenzie's presentation.

DR. PRICE: Oh, that's coming up. Oh, I'm sorry.

DR. BHATTACHARYYA: I'll give him the hard task, and then if you still have questions, then I will answer.

DR. PRICE: Do you have two parallel--you've got the launch main waste and the handling main waste. Where is this interface? It says, "TBM launch main drift."

DR. BHATTACHARYYA: Okay. Maybe it's confusing. TBM launch main/waste handling main, so this is only one of them, and this is the service main, which is the current use of north/south drift.

We need this TBM launch main because we need to start the TBM a number of times, and that's the nine meter tunnel that you are looking at right here.

DR. PRICE: So you bring it down the smaller line. Okay, there it is there.

DR. BHATTACHARYYA: And then you back it up. There is a curvature in there that you can back up this and just come right at the face of the emplacement drift.

DR. PRICE: Okay, and are the trucks articulated as you see them on the shielded transport?

DR. BHATTACHARYYA: Yes, that's correct. These are articulated. You remember the picture I showed, one didn't have articulation, but right now we are considering these as articulated, which will negotiate--these short cross-cuts have a 25 meter turning radius.

DR. PRICE: Is it only one that's articulated, or are they both articulated?

DR. BHATTACHARYYA: They both are.

DR. PRICE: No. I mean, you've got two sets.

DR. BHATTACHARYYA: Oh, two sets? Yes.

DR. PRICE: And they're both articulated on that?

DR. BHATTACHARYYA: That's correct.

DR. PRICE: Are they power drive, is that the idea?

DR. BHATTACHARYYA: No. They are being just pushed by this prime mover.

DR. PRICE: That can be tricky sometimes with double articulation in a coupled thing. You know, someone's going to have to gain quite a bit of skill to do that.

DR. BHATTACHARYYA: Okay. Now, I probably am not the right person to answer that. I don't have much literal experience, but I believe that, for safety's sake, we could actually use two locomotives in tandem so that there will be no runaway, and so forth.

DR. PRICE: And maybe I'm not following something. With the use of the term locomotive, I assume rail driven?

DR. BHATTACHARYYA: That's correct.

DR. PRICE: Okay. So the articulation, then, double articulation--you've got to lay down rails for each access to each drift at the time you're working that drift. Then I presume you take the rails up; is that right?

DR. BHATTACHARYYA: Let me show. Maybe I have a backup picture that'll help you.

This kind of shows the activity on the development side. This side is the emplacement side, and this is the development side, and you can see that there is--this is the TBM launch main. We have a curvature on it, and then as we finish each of these drifts, we provide a rail so that it could bring a waste package in a locomotive and back it up here and bring them down all the way.

DR. DI BELLA: Kal, Carl Di Bella. Could you explain--I know you mentioned this last April--when there are human beings on the emplacement side of the repository, I understand they're not supposed to be, normally, anyway, in the emplacement drifts. May they be, and does your plan count on them being in other parts? Are they in the north ramp, for example?

DR. BHATTACHARYYA: Yeah. We are assuming now--and we really are, of course, far from getting there yet, but we are assuming that when we do open this door, that we do not want to completely relinquish control of this operation, so we may have people farther down in this ramp, this drift, this drift that runs north/south, you know, at a 90 degree angle from the emplacement drift, and we could create a mobile shield system from which people can observe it through television or some remote device, and so forth, and it's not inconceivable that some people would be there behind a shielded, on this drift, as a matter of fact, but we don't expect that anybody will be there in there at all, at any time.

DR. REILLY: John Reilly. Just a question. Is it possible to motorize the transport cask and do away with the locomotive?

DR. BHATTACHARYYA: Transport cask?

DR. REILLY: It seems to me there's an opportunity to automate the whole system of operations and simplify it.

DR. BHATTACHARYYA: That's true. We have not thought about it, because just really think that this is a pretty huge locomotive, looking at it. We are looking at like a 35-ton locomotive. This cask assembly could go as high as 185 to 200 tons, as a matter of fact, so to motorize that, I am not sure. I'm not sure that that'll work.

We are thinking about using even two locomotives in tandem, because you have to go up as small amount of grade when you are running the mains, as a matter of fact, but, you know, it's certainly something we need to consider.

DR. REILLY: I think you'll find that the power to drive it, you've got two things. One is the weight for friction, and the other is the power, and the power is independent of the locomotive. It doesn't matter whether it's on the locomotive or on the cask.

The second part is the power distribution to power it, how is it powered, and the third is that the turning radiuses seem very short for what you're trying to do, plus, you've also got to set up those turning radii to start the tunnel drive, the drift drives, and it looks like the physical layout needs to be worked out in some more detail.

And the third question that goes with that, have you thought of angling the drifts at 45 degrees rather than 90 degrees to the main tunnel?

DR. BHATTACHARYYA: No, they are not 90 degrees, actually. They are about 70 degrees. They just look like 90 degrees. This is for illustration purpose only. When you do look at the overall view here, you can see that they're not 90 degrees, actually. They are at about 70 degrees, so there is an angle to that that's about 70 degrees, and we do have a curvature on each of them. The impression that I have is that a 25 meter curvature is sufficient for bringing this locomotive in, as a matter of fact.

DR. PRICE: Isn't it true that if they were angled in the other direction, you wouldn't have to back it up? You could just push them in.

DR. BHATTACHARYYA: That way?

DR. PRICE: Yes.

DR. BHATTACHARYYA: Yeah. Okay, that brings Russ's question back.

MR. McFARLAND: If I may, Kal, if we look back--I don't mean to be questioning this layout, but if you look back, maybe Mike Voegele could verify it, but the layout has changed little since 1985. We go back to the SCP and we see the same which, again, is there because of launching.

Now, a 2,000-foot long drift oriented in that manner should be very efficient from a construction standpoint. From an operations standpoint, it could offer you a great number of headaches, and I hope Dan will be talking about recovery from rock fall in the next meeting, or the next presentation.

But, from an operational standpoint, I would think that you would like short drifts. The question I have is, why don't we see alternative layout configurations so that the merits of other layout configurations can be examined and compared against what we have seen here for almost ten years?

DR. BHATTACHARYYA: Let me try to answer a couple of things. You will see it in about five minutes. You'll see about six or seven of them, and, unfortunately, I never get enough chance to show you all this good stuff.

And I will take a slight exception to the fact that this has remained the same as ten years. It really hasn't. If you look at the SCP--and Mike Voegele is sitting right there--SCP days, our emplacement drifts is to run north and south, as a matter of fact. It is the access drift is to run that way, so we did have, you know, this configuration, actually. We have completely changed the configuration from when we addressed the Ghost Dance Fault about 60 per cent of the time to avoid it completely.

When you are running TBMs, the reason that you try to make them long is it takes so much to launch it once, we want to get the full benefit out of it, so there is a clear advantage of running as long a drift as you can from a construction point of view.

It may not be very good from recovery point of view, and when we got the initial ESF interface drawings, we had a main going right through there just to cut it down into a thousand meters. It would have been kind of a pain to go through all this thing, and then would have difficult ventilating them, would have lost a certain amount of emplacement locations, and so forth, so we have been looking at it, and maybe in another few minutes you'll take a look at it and bring up the question again.

MR. McFARLAND: One last question. You mentioned ventilating the emplacement drifts. What would be the purpose of ventilating the emplacement drifts?

DR. BHATTACHARYYA: We are really not. Let me get a picture here. I want to put that to rest right now.

If you see this picture here, these are the shown drifts that has been emplaced, and you see this big blocks across it. That's emplacement bulkheads. We are cutting off ventilation as we finish each of these drifts. You see the arrow now going only during the active emplacement. While active emplacement is going on, you need ventilation, but as soon as you finish it, you shut them off and you forget about them unless the thermal management or some other reason you need to ventilate to manage the heat, but that's the only reason we'll even think about ventilating. Otherwise, you certainly don't.

DR. CORDING: All right. Thank you very much, Kal.

Our schedule says were going to sit here until 4:25 or something, and I think that's a little long. We're going to take our break now.

Before we got out, I just want to say that Dan McKenzie will be speaking afterwards on repository engineering studies. We have a time for discussion and comments following those presentations, and at 5:25 p.m.-- we're running a little late, I mean, the schedule runs late towards six o'clock tonight, but at 5:25, we'll also have opportunity for public comment. If anyone does wish to make a public comment, then they should sign up with the people at the desk, so, thank you very much.

We'll reconvene in 15 minutes, five minutes until 4:00.

(Whereupon, a break was taken.)

DR. CORDING: We're ready to convene now.

The next presentation is by Dan McKenzie. Dan McKenzie is originally M&O, lead mining engineer. In July of '94, the board approved design assumptions to be used to develop a repository conceptual design, and as I recall, we were looking at 17 key assumptions, but I'm looking forward to the presentation Dan has. He's going to make two presentations. The first one is repository advanced conceptual design. We'll have time for some comments after that, and then proceed with the second on repository engineering studies.

So, Dan, at least we've got people in the room to listen.

MR. MC KENZIE: Okay, good afternoon. It's been a long day, but I'm the last one that you've got to listen to. The bad news is I've got a big pile of stuff to go through here, so we'll step right ahead.

The title of this first one is Repository Advanced Conceptual Design. It's a very broad title. This briefing is not that broad. We have three specific points that we were asked to discuss in this briefing and that's what we'll go over. They are the controlled design assumptions, some changes that we made to the CDA this past April. Then we have one on segment on repository layout. We'll talk about some of the requirements for layout, some of the major features, some of the driving assumptions that cause the layouts to be the way they are. We'll look at about a half a dozen or seven alternatives that we've been looking over. And then the last point in the first briefing is on retrievability, and we'll talk about the requirements that drive retrievability and some of the issues related to retrievability.

Now, if you tuned in expecting to see the design solution for how to retrieve under all conditions, you're going to be sorely disappointed. But we'll talk about what those conditions might be, and maybe we can get some discussion going about it.

Okay, this is the same chart that Kal showed just to let you know where we're at in the design schedule for repository ACD. We're a little less than halfway, so that's why there aren't a tremendous number of design solutions available.

Okay, the CDA, the controlled design assumptions is a tool that's being used by the repository and the waste package designers to collect the design assumptions. It's a common sense thing to do. It's a fairly large design and fairly complex with a lot of different facets and the CDA is our tool for putting all the key assumptions and underlying assumptions in one area so that somebody can pick up a single document and look and see what it is we're thinking about.

There are other things in there besides assumptions. There's a concept of operations, a functional description of an MGDS and there are listings of the key assumptions and there are also lower tier assumptions that affect essentially a single design group. Key assumptions sort of by definition are those which cut across more than one design area for waste package and subsurface design.

As I said, we revised the document effective this past April. Some of the changes were brought about by the program approach. The top level functional analysis and sequence of operation that supports the function, and then there was already a concept of operations description in the document, and they went through and restructured that so that it flows along with the functional analysis. And we simplified and integrated the process and the format for putting in and taking out design assumptions. It used to be there were signatures required on every page and it was a very, sort of forbidding task to try to do anything with it, so now the document is approved as a whole so that it's reviewed just like a normal control document. And some assumptions were revised, some were added, some were deleted.

Some examples--this is the only chart I have on the CDA, so I'll stay on it for a minute. The first revision of the CDA, thermal loading assumption was the primary high thermal load, and we had to keep our options open to go to a low thermal load if we needed to. In REV one, we just stay inflexible and we have a range, a fairly wide range, between 20 MGs per acre and 100 MG per acre, so we have a very wide range and no specific target picked within that range.

Waste receipt schedule reflects an oldest fuel first receipt. Backfill in the first revision, there was no backfill assumed. In this revision, the assumption, we'll look at it later, is that backfill will be evaluated for its effects on long-term performance and we'll evaluate whether or not we need to do it.

One other emplacement area. Before, we were only assuming that we would use the primary area. That's the area we've been looking at with all these layouts to show a primary large block and a small block to the east of it. Now we're saying, yeah, we'll use the primary area first, but we also have to keep our options open. If we're going to go to some low thermal load, we're going to have to look at expansion areas, so we have to be aware of the fact that we may have to expand beyond the primary area.

The next area we're going to get into, and I have a little more information in this area, is repository layout.

You've always pretty much seen the same layout since, I don't know, the last year or so anyhow. That's the one that Kal was showing. First we'll talk about some of the requirements that drive the layout and some of the assumptions that we've made that control the layout, and then we've got some alternatives that we can kind of look at.

These are some of the requirements. The underground facility must be at least 200 meters below the ground surface. That sounds simple enough. The underground facility is everything but the shafts and the rims. So all the underground area and the placement drifts have to have at least 200 meters of cover directly overhead.

Another big one, and we'll talk a little bit about this later, is you must preserve the option to retrieve. I think it's actually stated as you shall not preclude the ability to retrieve the waste, any or all the waste from the repository.

This is an interesting one here. Assist in keeping liquid water from contacting the waste packages. The layout, this is a requirement on the layout. We do this by maintaining positive drainage. The layouts are all set up so that there are no places where water pools anywhere around waste packages. The emplacement drifts will drain to the mains, and the mains all drain to the north into a single area. So it's not really so much that we're keeping water, you can't keep a drop of water from falling on a package, but you can keep the packages from sitting in water. That's our approach to the requirements of that.

The orientation, geometry, layout and depth must contribute to containment. We do that by trying to orient the layout in the most inherently stable configuration, keeping it as high above the water table as we can while still maintaining the 200 meter cover requirement.

Some more requirements. Certainly we must consider the thermal and thermomechanical response of the host rock. That's sort of job one. Excavation methods should limit potential for creating preferential pathways. That just means we shouldn't go around and indiscriminately excavate by whatever means we want. We should take care to not open any more fractures than we have to in the course of excavating the repository so that we don't increase the permeability of the unit and promote radionuclides escaping at an earlier time.

This is an important one at this site or any site; must maintain the flexibility to allow for adjustments. All we know is that we don't know, and that when we get down there, we'll be surprised by something that we see. So the layout has to be able to skip over an area, for example, without losing huge amounts of space. The layout has to be flexible. A lot of that has to do with radiological safety design, ALARAs, and it is a design approach to minimize radiation exposure to personnel to the maximum extent possible, or is reasonably achievable. And that's the process that we'll use.

This is another one that tends to--that you at least have to consider every time you look at a layout, is can you separate the ventilation of the emplacement and the development areas. That's a requirement of 10 CFR 60.

These are assumptions and goals that we look at. This is a big one; implement the MPC-based waste packages. Of course, the MPC is big and heavy and puts out a lot of heat, so that drives us to a certain degree. We look at almost exclusively at in drift emplacement. We don't look at any kind of emplacement concepts that involve putting the package in a bore hole, for example. It gets too hot. The package puts out heat at a great rate.

We have some thermal goals that are sort of surrogates for performance of the site. We don't know exactly what's important as far as the heat, so we set thermal goals to keep us from over driving the system. 200 degrees C is the maximum rock temperature that we'd like to see in an emplacement drift. The hottest point in a drift shouldn't exceed 200 C. Within the package, the cladding, the temperature of the fuel cladding should not exceed 350 degrees C.

This is the flexibility thing I talked about. The thermal loading strategy has to be to remain flexible, and we have to meet our licensing strategy.

The waste receipt rate Kal talked about that results in all placement of 70,000 metric tons in about 24 years. It starts off kind of slow, 300 MTU the first year, then 600, then 900. It kind of steps up, and in four or five years, you're up to 3,000 to 3,400 MTU a year.

Avoid faults to the extent practicable. When we get to looking at the layouts, you'll see that the layouts are generally bounded by faults just about all the way around.

Here's some of the features of the layouts. When we look at them, you'll see that on every one of them, you'll see that ESF loop that we've been looking at all along, north ramp, main drift, south ramp. Those are in the north ramp extension, or it's incorporated into all these layouts, so we maintain ESF/GROA, which stands for geologic repository operations area in case you're more familiar with that. That's a 10 CFR 60 acronym.

They all allow us to varying degrees to maintain flexibility regarding thermal loading. They all, as I said earlier, use an in-drift emplacement method. They all use integrated rail transportation. That was made possible when we lowered the slope of the ramps in the main drifts so that they were less than 3 per cent, and less than 2 per cent in most areas.

We maximize use of tunnel boring machines because they're efficient for making long round holes, and that's what we need a lot of, and they don't result in a lot of blast damage like you might get drill & blast, although you can make a good case of drill & blast done properly is not going to cause a tremendous amount of damage.

We minimize, and this is differing among the layouts, the number of main and secondary access drifts, particularly in the area of secondary access. Some of these layouts require a tremendous number of secondary access drifts, but we try to minimize them wherever we can. As I talked about earlier, they all drain to the north. We try to provide a common point of drain.

This is the first one. You've seen this one. I tried to make these--the drawing that these exist on is really kind of busy and I had them take a bunch of the stuff off and they got kind of carried away. They took all the faults off, too, so we have to use our imagination. The Ghost Dance fault runs through there, and that's why that blank spot is there in the middle. We balance it on the east--north is that way. Drill hole structure comes down along there, the Solitario Canyon over here. So that's what bounds the block in all these layouts. With some very subtle differences in the shape of the block maybe down in this area, all of them are bound to have the same sort of boundaries. That's not something that varies from one to the other.

Okay, ESF drifting, north ramp, main drift, south ramp. That's part of the ESF, 7.62 meter diameter tunnel, fairly flat grades, 2.2, about 1.5, a little steeper here, 2.4 starting at a grade break just right along in there somewhere. That's actually the beginning of the south ramp right in there.

The emplacement drifts, we talked about this earlier, these are all along there, the emplacement drifts. Now, some of these other ones, some of these layouts are only different in the way they would be developed.

Okay, this one's kind of interesting looking. This is--there are 156 drifts just in the upper block. So that means you have to have 156 tunnel boring machine launches if you want to drive it like this. So this was an effort to cut down on the number of launches. This results in sort of nine drift blocks that are driven with only--I believe there are actually two launches that drive a center drift down through and then start here, around and around and around till you finish right there. And when you finish that one, you go to the next one.

It cuts dramatically down on the TBM launches. It does cost you some real estate, depending on I guess if you got real creative, you could emplace right up in these curved drifts. It would be a little difficult with the rail based emplacement concept that we've been talking about with the simple rail cars because we'd have to go around these curves, so you might lose a little bit of flexibility. This one cuts down on the number of TBM launches.

The next one is an attempt to do the same thing slightly differently, and this one is important to look at the little inset right there, because this one looks much-- you know, very similar to some of the other ones. But here you can see what we're doing, the launch and the TBM, this is a special machine that has a reasonably small turning radius. As it approaches the main drift, it actually curves and then turns back around and goes over and goes to the other end and then it curves and comes back.

Okay, actually you launch the machine, when it comes around, instead of just breaking into the drift, it turns sharply and then picks up another emplacement drift and goes on. It just kind of makes it sort of like weaving a sweater, sort of just makes an interlocking set of drifts that minimizes the number of TBM launches. The problem here is this is a specialized machine and this intersection, if you really saw a blow-up of that intersection, it's kind of ugly. You've got some weird looking pillars and sharp corners, and it would be somewhat tough to deal with from a geotechnical standpoint. I suppose you could support the hell out of it, but it doesn't look real good when you look closely at it.

My personal favorite here. Whenever I look at this one, it always looks like the bottom of a basketball shoe. This is one that has a great deal of secondary excavation. The emplacement drifts, this is if you're a fan of very short emplacement drifts, this is what you get out of this one. These are the emplacement drifts. They're also oriented north-south. If you noticed on the other ones, the orientations were primarily east-west, or a little bit north-west.

On this one, the emplacement drifts are actually oriented north-south. So if geotechnical conditions conspire to drive us to want to orient our drifts north-south, this is one that would buy you that.

This is normal TBMs that drive this thing, but these little short guys are driven by like a micro tunneller or something like that. The technology for this one may not quite be there because these are several hundred meters long and they need to be at least four and a half meters in diameter in order to not have any thermal problems with the big packages. And right now, you can't go out and buy a machine like a micro tunneller that will set up easily to drive that many short drifts. This is a concept, but it needs some, if we really wanted to push this one, we would need some more mechanical development.

This is one that has, again, north south oriented emplacement drifts. Again, if the geotechnical conditions indicate that north south is the most inherently stable orientation for long-term stability, we could orient the drifts this way. These are significantly longer. These are 500 meters or so. I didn't give you before when we were looking at the main layout, the idea of the scales, about 3,000 meters from there over to there. You could tell it from the scale, but it's not easily read.

These are sort of panels. You have parallel secondary access drifts that are connected by emplacement drifts. Waste would be emplaced in these, but not in those. Those are for ventilation and access. This is just another concept that gives you sort of a panel segment, the block in the panels, and it gives you north south emplacement drifts.

DR. ALLEN: Excuse me. Why do you say the north south drifts are somehow more stable?

MR. MC KENZIE: I don't know that they would be. Actually right now, the reason you see on these are just referenced layout, for lack of a better term, has them oriented this direction and they're that way for a very good reason, because the data that we have right now tells us that's a good orientation from the standpoint of joint orientation. You don't want your drifts running parallel to the major joints. You want to run across them to the extent you can, but there's always--not always, but there's generally more than one set of joints, so you end up having the joint patterns will cross in an "X" and you've got to try to split that "X" one way or the other to try to get your drifts oriented so that they cross the best they can, cross the joint pattern.

Right now, we think that's the best orientation. But it's all based on drill hole data and TBM hasn't gotten into the Topapah yet. So this is just sort of to show that we're not--we haven't crossed the river yet. We don't have to go this route, but right now, we think that's the best way to go. If we need to, we can do this.

I'm going to stop and breathe here for a minute. We've got one more we're looking at. This next chart is not in your package, but I know you all have seen it. Most of you have seen it several times. The next concept is actually a multi-level concept, and it's a little harder to visualize. We've been looking at plan views. This is looking down, of course, from the sky down into the mountain. Now we're looking at cross sections. This is a cross section east west. The section would be right at about there, and you're looking that way. You're looking north. This is showing for a single level repository, like all these are that we're looking at, the upper block, the big block, that one there is this elevation. The lower block on the other side of the Ghost Dance is flat also at that elevation.

We been looking at the concept of having a multi-level repository. The TSw2 is actually a fairly thick unit, a couple hundred meters, and we could put actually three levels. We're looking at essentially that same section, just kind of a different scale, but again we're looking at, here's the crest of Yucca Mountain. This is the line 200 meters below the surface. Actually this like should look exactly like that one. But that just shows you that it's all under 200 meters of cover.

That line there would be the single level layout. That would be that block. And this line over here, this upper one, would be the lower block, and the single block. And if you separate these levels by 50 meters, you can put another layer below and another layer above, and you can put another one over here. It's not the answer to all our problems or anything; it doesn't buy you low thermal loading, or high thermal loading at low thermal loading temperatures, but it does tend to keep the maximum temperature lower for the same amount of waste emplacement of primary area.

You end up with a thicker block. You end up with three very near fields, essentially, so you could emplace three layers of 25 MG per acre and end up with the same mass of waste emplaced as one layer at 75 MG per acre.

We've done a little bit of thermal modelling on that, but it's not something that we're going to abandon everything else and go in favor of that. It's just another option we're looking at.

Just to summarize on the repository layouts, that's about the end of that one. The big issue is the thermal loading. The area of the repository is indirectly proportional to the thermal loading. If you have a high thermal load, you have a small repository. If you have a very low thermal load, you have to have a very large repository if you want to put 70,000 metric tons in it.

The faults and the joint orientation are the things that physically drive the layout, that shape it the way it's shaped, and put the entries the way they're oriented. There are a lot of other issues that have to be looked at; construction and operability, retrievability, backfill are very important issues that have to be addressed.

Okay, this is where we have all the answers. This is retrievability. The first views here are just the requirements on retrievability; why do we think that we even have to do it, or might have to do it. These are black and clear because if you try to shade them like that with blue and clear, they sort of disappear.

10 CFR 60, the GROA or the geologic repository operations area shall be designed to preserve the option of retrieval. That's straight out of the law, and it may be because of a loss of confidence in the site, all the wastes are emplaced and all of a sudden, your long-term performance confirmation program shows you that the site is not going to perform, so you have to withdraw the entire inventory.

Then there's another statement that says it has to be designed to be retrievable in accordance with 60.111, which is the one above there. And there's another area. It also says that it has to be retrievable on a reasonable schedule. They're nice enough to define a reasonable schedule as one that would permit retrieval in about the same time as it took to build the repository and to emplace the wastes, which in our case would be somewhere in the 30 to 35 year range.

The NRC has come back later, this was just a little after the release of 10 CFR 60, and they clarified their issue or their position on retrievability. Retrievability does not imply ready or easy access. It means that it doesn't have to be cheap, easy or quick. It just has to be possible. The idea is that it should not be made impossible or impractical, if necessary to protect the public health and safety.

We've got a couple of schedules here. All we're trying to show here really is when you say 50 year retrievable, it implies a longer time period than that that your facilities have to work. Kal was talking about six years to develop the minimal amount of the repository that's needed to begin simultaneous development and emplacement operations.

You excavate drifts for about 24 years after that. You emplace packages for 24 years after that. Under a 50 year retrievability schedule, you have 26 years of what you call caretaker. That's when you're not emplacing any more; you're just keeping an eye on things. You have a performance confirmation program going on that's assessing the performance of the site and watching the waste packages.

The retrievable period starts the day you put the first package in, and it ends, as far as 10 CFR 60 and the NRC is concerned, it ends 50 years later at the end of caretaker. Then what the bad news is is that on the last day of the 50 years, they can walk in and say it's not working, you've got to take it all out.

So we show ten years to prepare for that operation, 24 years to do it, the same amount that it took to put it in, then ten years to close the repository. So you actually end up with an 84 year operational period and 100 years overall, even though it's a 50 year retrievability schedule.

Then the program approach, DOE says we'll extend that retrievability option to 100 years. So all the 50 years that got added, got added right there in that time bar, the caretaker period. It still takes 24 years to build it and 24 years to emplace it, and now we're going to watch it for 76 years. Still, on the last day, they could say take it all out, so we've got our 34 years and ten years to close.

So now we say it's 134 years of repository lifetime, and from the start of construction through closure, it could be 150 years. So later on when you see it, it says--one of the subjects on the next briefing is 100 year ground support, you can kind of put that in quotes, because it's really 100 plus years.

Okay, now this is going to kind of drop back into the SCP days, Voegele will probably get a kick out of this. I'm sure you all have memorized the SCP and you know that there were four key issues. They had an issues hierarchy and they had four key issues that were identified, and there were a bunch of sub-issues underneath that. Retrievability was identified even back in the SCP days as a necessary issue, one that had to be addressed during the design of the repository.

The first key issue was postclosure performance; how is the repository going to perform after you close it up. Two had to do with the safety during the preclosure. Three was environmental and socioeconomic impacts. And four was ease and cost of repository construction. So two, essentially can you do it, can you build it and operate it safely, and four is is it going to cost more than the GNP of the country. How much does it cost.

So really all of this is kind of a history lesson. We're just saying that retrievability was an issue that was recognized back in the SCP which was published in December of '88, and it's something we're still actively pursuing.

This is still, again, out of the SCP, approach to resolving the waste retrievability issue, was to evaluate regulatory requirements, determine functions and processes that must be performed, and establish performance measures. These two you need to remember for a minute because we're going to talk about those in the next two charts. Establish performance measures, identify normal and credible abnormal conditions. We'll look a little bit at those. Develop a reference design, operating plans, analyses and demonstrations, and then do a compliance analysis to see if your design complies with the law.

Okay, one of those bullets had to do with figuring out what the functions are. This is a real simple minded description of the functions for retrieval. If you want to retrieve a package, you've got to provide access to the emplacement drift. It's pretty hot in there, so you have to do something to provide yourself access to the drift. You have to extricate the package from the drift. That may be as easy as running a locomotive in there and coupling it up and pulling it back out. Then again maybe not.

You have to transfer waste package to the surface handling facilities from underground, and then there is some, from my standpoint, unspecified further handling, which you've got it outside, you've got to do something with it. So that's another thing that the DOE would have to consider before embarking on a retrieval of the inventory.

Another one of those bullets had to do with performance measures and goals. The provide access function in the last bullet, there were several functions that had to be done, and the first one was provide access. So your activity might be design and construct drifts so that they're usable throughout the period when they may be needed. And the way you measure the performance of that is by the time that the drifts would stay open, and our tentative goal, as you say in that schedule, would be 134 years under the extended one.

Another activity would be to develop a rock support concept that will allow that these drifts are maintainable, and the performance on that might be the amount of rock that's allowed to spall before you do something about it, or the frequency of maintenance that you might be expected to incur. And the goals on that one are to be determined.

That's what TBD is.

Another activity, monitor drifts and access. What you'd be looking for is localized rock and rock support displacements, and again that would be TBD, the tentative goal for performance.

Okay, in retrieval, you go to retrieve, you're either going to have normal conditions or you're going to have abnormal conditions. Normal conditions are ones that we would project as being present, the rock temperatures in the drift. For a high thermal load, 100 MTU per acre, the rock temperature might be 180 C. That's probably a good middle number for the model we've been looking at.

The condition of the openings, we would sincerely expect it to stay open for that period of time because we're going to try to orient them in as inherently stable configuration and we're going to support them in as robust a manner as is required to keep them open. We'll talk more about that in a minute.

And we can project pretty well based on experience of the radiological people what the radiation environment would be in the drift at the time the machinery had re-entered.

The SCP, they had some off-normal conditions. We had some work--the next chart is more off-normal conditions that are more specific to that sort of a layout. In the SCP, these were the things identified, the processes and events that might cause off-normal conditions; tectonics, variability in the rock, we know we're going to see that. Human error, and this one, that could be anything from improper ground support, insulation, to putting the wrong fuel assemblies in the wrong packages so that package didn't have the characteristics that you thought it might. Then of course aging and corrosion of the equipment and facilities and radiolysis.

In the SCP, we're looking at very small light waste packages, and they had a very thin walled package and you had a bore hole liner and they were concerned about I guess neutron interaction causing radiolysis with the bore hole liners. As we discussed, this is probably not an issue now. It was a different concept.

These off-normal conditions are more geared toward an in-drift emplacement on a rail car. Things that you might have happen is it might have gotten hotter in some places in the drift than you maybe thought. You could have a rockfall, have a waste package buried or at least hung up in the drift by rock that's fallen on it.

You could have flooding in the unsaturated zones; it's not likely, but it could be caused by a man made event, maybe you had a big fire or something down there and you had to use a lot of water to put it out, or you had an accident or something. You could easily have an emplacement car derailment if you had a broken rail or something like that.

Retrieval equipment could go into the drift and then fail and that gives you another problem. You've got to get the one out that's broken, plus still retrieve the packages. Radiation level may be higher than expected or the drift may be blocked off by a fall. So those are sort of just the hypothetical horribles that you've got to look at when you design the repository so that you can design your retrievability plan to account for them.

I might note that not all of those would end up possibly being design basis events is something we're going to talk about here in a little while. All those may not be determined to be credible events. If they're not credible, then we won't consider them.

Design approaches for trying to maintain the option for retrievability are, as I said several times, locate and orient emplacement drifts so that they are optimum with respect to the joint patterns. We want to do stability analysis and hearing and cooling phases. If you've got to retrieve, you're going to take a drift that's very warm, 180 C, and you want to cool it down so that the rock temperature is probably around 50 C. You could do that in as short a time as a week, and that may, depending on how much area, that may cause stresses that would cause you problems with the ground support. So it's something we have to evaluate.

You have to provide access for inspection. That's not somebody walking down the drift. That's remote telemetry of some type to ascertain what's going on at the drifts, the roof looks good, are the packages looking okay. You need to develop equipment concepts so that we can remotely recover from these kinds of events we talked about in the last slide, equipment failure, rockfalls in the drift, that sort of thing. And the layouts need to promote, to the extent they can, consistent with the 9 million other things that they have to comply with, they need to try to promote ease of maintenance and recovery from accidents.

Okay, so I'm just going to summarize real quickly, this is the first half of the show. The CDA has been updated and some items have been added to it. Regulatory and programmatic issues govern layouts, and they're required to maintain flexibility. We still have many layout options being evaluated. It's sort of many are called, but few are chosen. We have few are rejected and none selected.

And retrievability is a requirement, is an integral part of the layout. The design has to take retrievability into account right up front. I know whenever I look at a layout, a plan for a layout, the first or second thing I think about is how can we get stuff back out of it. Retrievability has to be built into the system. That's the end of the first one.

DR. CORDING: Okay, let's take a few minutes for questions. Don Langmuir?

DR. LANGMUIR: I haven't heard a word about defense wastes versus spent fuel by either you or Kal. Is that part of your approach to locating the waste and getting it into the site?

MR. MC KENZIE: We tend to, rightly or wrongly, we tend to do all our designs around the large 21 element MPC because it has the highest heat output. It's the heaviest package. 10 per cent of the inventory at least is going to be defense high level waste, and we tend to--we don't ignore it, it's part of the 70,000 metric tons, but it doesn't drive us on just about any issue I can think of, but it's not the most radioactive, it's not the hottest, it's not the heaviest.

DR. LANGMUIR: But what about the fact that it maybe has equal volume? What about if its volume is equivalent to that of the spent fuel?

MR. MC KENZIE: Right now, it's about--it makes up about 25 per cent of the packages, and the packages are--you can put four glass canisters in a single MPC, and that results in something like 3,200 packages out of a total inventory of 12,060 or something. So it's certainly not insignificant, but it's not--if they decided to bring all the Hanford waste, for example, it might become significant, the number of packages of defense high level might start to rival the number of spent fuel packages. But that's not the plan now.

DR. DI BELLA: The EPS panel visited Idaho last--I guess it was a month ago, talking about defense wastes, and we were told at that time that DOE was considering changing the plan. Indeed, I talked to someone just last week who said the plan is going to be changed basically to allow the defense waste people, or EM, to suggest on their own priority system any particular waste that they feel they need to dispose of. So this volume issue could become significant.

MR. MC KENZIE: It could be. I guess we've got enough rules for this game right now. You know, I hate to try to design by the headlines. But right now, the plan is 10 per cent high level waste. If they tell us different, you know, it certainly is not something we can't cope with. Depending on our thermal load, you know, there's a limited amount of area in the primary area. So if there became a very large burden of defense high level waste, it might start to be an issue.

DR. ALLEN: It seems to me there are some things you can rule out right off the bat, and I hate to sound like a broken record because this comes up about every year, but you've got to anchor these canisters in there so they're not going to be rolling around during an earthquake, which is likely to happen in 100 years, and is surely to happen in 10,000 years many times. So the idea of just rolling them in and rolling them out is totally absurd, it seems to me.

MR. MC KENZIE: Well, we don't want to just leave them sitting there, but there's a lot of ways to keep a rail car from going anywhere, put brakes on it. I don't see that as a real big problem, but is certainly you have to look into. You're right; we're not just going to take them apart in there and just let them sit.

DR. ALLEN: Well, there are many cases of rail cars being thrown off their rails during earthquakes.

MR. MC KENZIE: If we had that kind of an event, we'd be into this off-normal derailment sort of thing. That may be the least of our problems, quite honestly, if we had that kind of an event. But that's, you know, certainly something to be considered. We can't just park them in there and hope they're going to stay. We've got to have some assurance they're going to stay where we leave them.

DR. CORDING: Dennis Price?

DR. PRICE: I take from your presentation, you've got an emplacement drift with a very small diameter, and we're rolling these things in in a horizontal mode, and putting one in and then putting another one in and so forth. Imagine one in an emplacement drift that is in the most difficult place to get to, and it needs to be removed. Does that mean that your plan is right now either you don't know how you're going to remove it or else you've got to remove all of those in the line before you can get to that one?

MR. MC KENZIE: That's exactly right; it's the second one. You take all the ones out that are in front of it. That means that you have to have a blank drift somewhere, an empty one that you could take all the others. Say there's 60 packages in a drift and 57 was the one you want. You've got to take the 56 out in front of it and put them in another drift and take the 57th one out.

DR. PRICE: With 100 years emplacement and maybe monitoring equipment failures, how do you get at the monitoring equipment failures? Do you have any specific plan for that? You know, first of all, let me just comment. What you just said sounds to me like a very awkward way to have to get one, but maybe that's all there is right now.

With regard to monitoring equipment or other things, I think it's reasonable to expect you're going to have failures in there. How do you retrieve those parts of things?

MR. MC KENZIE: Well, again, any time you wanted to send somebody into a drift, you know, an awkward as it sounds, you'd have to empty that drift out. You're not going to send anybody in a drift with an unshielded waste package. So I guess there's just a lot of things that go into it. You could build the drifts, you know, 12 meters in diameter so that you had plenty of room and you could put them over on one side or you could have shielded waste packages that cost a God awful amount of money. There wouldn't be very much waste in them.

We feel like retrieval of an individual single package, if it ever happens, has got to be a very, very remote event. We don't want to build this thing like a it's a Seven-Eleven or something where you could walk in and get whatever you want. I think that would cost an awful lot of money. And the design of the repository is that the emplacement situation, the system that we pick, should be robust, simple, it should have as few moving parts as possible, and it should be very, very stout.

DR. PRICE: But in terms of the monitoring equipment, if there are things yet to be monitored, things yet to be done in the emplacement drift, that is, it's not clean of all equipment, but you have things in there for reasons of tests and otherwise during this retrieval period, do you conceive that as being the case? Because if that's so, then it would not be such a rare event that you would have to empty out the emplacement.

MR. MC KENZIE: It's possible, and that's something that we probably need to look at a little harder. The idea of monitoring every drift continuously, or do you have a remote telemetry package that you can send in and out of a drift to kind of check on it and then go on to the next drift, you know, there are a couple ways of looking at how you might want to monitor the repository. Quite honestly, in my mind's eye, I'm not looking at something where every one of 200 drifts has a bunch of monitoring arrays in it, because if it did, you're right, we will be parking waste packages every day. That's all you're going to be doing, is fixing the monitors.

So I don't see that as a way to go. I think we're going to be looking at some sort of a mobile telemetry package. I'll get into something that I was going to talk about later. We hired a fellow from Jet Propulsion Laboratory, kind of stole him away from there to be our remote robotics guy. When we showed him our plans and said do you think you could do these, he said is that all you've got. He was not, you know, intimidated in the least by the remote type operations that we were envisioning. He feels like it's certainly within the realm of feasibility.

MR. SATERLIE: One of the things we plan to look at next here is developing a performance confirmation program, should funding allow us to do that. That's clearly something that we have to look at. And how we're going to monitor those things, the kinds of instrumentation and the longevity and what those instruments have to be qualified is something that we have to take a real hard look at.

We've done some very preliminary look at this. Like Dan says, some of the sub-surface folks have looked at it a little bit. We did some of that in a system study last year and some of those instrumentation concepts, just a preliminary nature, were published in a '94 thermal loading study, which I believe you have a copy of. So there's some of that information that we were thinking about maybe sending a robotic instrument down the tunnel for those things that we could do maybe on a routine basis like every month or so.

DR. PRICE: Supposing your remote locomotive attached to a car goes down there and the gears freeze up. Now, you've got 185 tons or so of a load, plus you've got a locomotive. How do you get it out?

MR. MC KENZIE: Well, I'll start out by saying real carefully. Certainly if the locomotive that's pushing the package into the drift, for example, that could be probably something in the 20 ton range, you've got to have something else available that can move that load, even with the wheels not moving. They'll skid, the four or eight wheels that aren't rolling. You've got to have a bigger, a big locomotive with 35 ton, or maybe one of the ones that pulls a transport, maybe even a 50 ton, that could go in there and pull it back out.

Certainly when we look at off-normal operations, there's going to have to be some limits on the credibility of certain things, but we're going to have to be able to recover from things like that, from a broken down locomotive, from a package that's, you know, a 66 ton package on a rail car that's off track. Those are not trivial undertakings. But with every concept that you adopt, whether it's small packages in vertical bore holes, or packages in horizontal bore holes, you adopt a certain problem set when you pick that emplacement mode, that methodology. The problem set we're talking about comes with this one, but other ones have equally onerous problems.

So I don't think we're setting ourselves up for failure or anything by going this route. We really don't. We kind of have the faith that we'll be able to develop the technology we need. That's the reason we're going this way. We don't see a whole lot of real technology development. We're not having to re-invent anything. The locomotives are pretty standard. As far as the remotely operating one, you don't see it done very often right now, but it's certainly not something that's a big stretch of the imagination. That's one of the reasons we're going this way, is it's prudent technology. But you're right, there are certain fairly daunting problems that we're going to have to deal with.

MR. MC FARLAND: One question, Dan. I'm looking at your alternative layouts. None of them are feasible with today's technology.

MR. MC KENZIE: Thanks, Russ.

MR. MC FARLAND: In terms of tunnel boring machine technology. Last January or February at the technical program review, the project was very blase about the question of the higher level funding on reasonable available technology, that there were no issues of technology that would in any way raise question to that finding. And yet many of the configurations here are not--you know, there's no way, there is no tunnel boring machine in which you can do right angle turns.

MR. MC KENZIE: Well, if you think we're going to turn 90 degree with a tunnel boring machine, you're right.

MR. MC FARLAND: Look at Page 14 and 15.

MR. MC KENZIE: I didn't say we're going to be doing it with tunnel boring machines. Some of these layouts would be very difficult to develop.

MR. MC FARLAND: Then they're not real layouts.

MR. MC KENZIE: They would be developed by either secondary excavation, and in the kind of hardness we're talking about, that's not easy to do. It's tough to mechanically excavate stuff that's 22 or 23,000 psi. That's not easy to do. We're going to have to do a certain amount of that anyway because the tunnel boring machines, if you need a flat floor, you're not going to get it with a TBM.

MR. MC FARLAND: In good faith, you feel that the reasonable available technology requirement can be met, that there are no issues that would cause any trouble?

MR. MC KENZIE: I certainly think it can be met with this type of layout. In some of those other ones, when you're talking tens of thousands of tons of secondary excavation, that's a different story. But I think one that has, you know, 99.9 per cent of the tonnage, I think we're in pretty good shape.

MR. MC FARLAND: Then in reality, we have one layout? The others are not real layouts?

MR. MC KENZIE: The others would require varying degrees of secondary excavation, which we would have to work more on on the machinery to produce it.

MR. MC FARLAND: That presently doesn't exist?

MR. MC KENZIE: I'd say that's true.

DR. REITER: Yes, Leon Reiter, staff. I wonder if you could put up the slide that Rick Craun has on there. And this also is a layout of the repository and the faults. However, it includes one of the faults that has not been mentioned before, the Sun Dance. And the Sun Dance cuts across the middle of the repository.

Now, a lot is not known about that. There are really a lot of questions about it, but it's certainly not been wrapped up yet. What kind of an impact would it place on the repository if you had to leave say a zone as wide as the Ghost Dance around the Sun Dance?

MR. MC KENZIE: We wouldn't leave that big--on this kind of a layout, we wouldn't leave a gap that big unless we got down there and found that it was something really, really major that was going to cause a lot of trouble.

DR. REITER: Fault avoidance, is the concern making the repository, worrying about fault movement or worrying about increased permeability?

MR. MC KENZIE: Yes.

DR. REITER: All three of them?

MR. MC KENZIE: The faults that we know or that we suspect or for dominant features we've avoided just straight up. But we know we're going to find, you know, things like the Sun Dance, we don't know how major it is. Our approach to this would be to drive these drifts--you don't see it on here, of course--but it would be right through there. In the worst case assumption that we have right now on the design assumptions, we would drive the tunnel through the fault. We wouldn't leave a big window there, but we would not emplace packages within 15 meters of the fault on either side. So worst case right now is a 30 meter wide that went through there.

DR. REITER: The present indications at least, they've told us that there is no single trace they have of the Sun

Dance. It looks to be like a zone; it could be 100 meters wide or something like that.

MR. MC KENZIE: That is possible.

DR. REITER: Would that create a big problem for you?

MR. MC KENZIE: You'd have to identify--really, without being there, it's hard to say, but somebody is going to have to during the construction of the repository, they're going to have to make a judgment call. Every time you drive a drift, they're going to have to walk down and say this is good, this is bad, this is good, this is bad. They're going to have to decide where the problem areas are so they know where to not put packages.

DR. ALLEN: It's certainly ridiculous to have a set back of 15 meters when a fault has been proved inactive.

MR. MC KENZIE: You know, we get pulled both ways. If I was to stand up here and say I'm going to put packages everywhere regardless of whether there are faults or not, I'd have other people beating me over the head just as hard saying you can't put a package on a fault, what's the matter with you. It's a tough issue. From a conservative standpoint, you would stay out of those areas. They're liable to be worse ground support anyway. It may be a tough place to keep the roof up. So there may be other reasons besides just the fact there's a fault there not to put a package there. But certainly if you could make a determination that absolutely this fault is not going to move, then there's just not a fault there. There's an NRC guy sitting right behind you that might take a big issue with me putting packages in faults.

DR. ALLEN: Well, a fault is a fault, let's face it. But whether or not it's likely to move during the life of the repository is quite a different question.

MR. MC KENZIE: I agree. I'm making a complex issue a very simple one, and that's not the right thing to do. But that's something that we're not--you know, we're not to the point yet of declaring what's a usable area and what's not. But I think the fact remains that somebody is going to have to make a determination of what's usable and what's not, and the whole idea of faulting has a lot of horsepower being applied to it.

DR. ALLEN: Particularly when the smaller faults have the larger--

MR. MC KENZIE: Yeah, that was an interesting proclamation this morning, that the small ones break up the ground a lot worse for a bigger area than the big ones do.

DR. CORDING: There's some decisions and the conclusions regarding that would certainly have to be developed during the exploratory programs, so that's going to be part of the review of how widely spaced these are, how wide the zone is and whether or not we have water on those surfaces or potential for water on those surfaces. But I think if one tries to go in and take care of every--every time you see that there has been a six inch or two foot, three foot offset, we don't have a repository.

MR. MC KENZIE: We don't have much space left.

DR. CORDING: You won't have space left. So assuming that all those are active, it would be a very major problem.

DR. CANTLON: Cantlon; board. Let me take you back to the retrievability period. It would seem to me that you'd have to have your design so that you'd have some empty drifts.

MR. MC KENZIE: Indeed you would. If we're going to be in the position of having to, especially if there's a--if the performance confirmation people decide they want to take out ten packages a year and they want to be able to pick whichever ones they want, yeah, we're going to have to have several.

DR. CANTLON: Empty drifts.

MR. MC KENZIE: In order to juxtapose packages so you can get out the one you want.

DR. CORDING: How do you see the exploratory program to decisions regarding what sort of support requirements should be, what sort of support you use in the emplacement drifts? At this present time, are you thinking you're going to have a lot of concrete lining for the drifts, and how would one investigate the thermal cooling effects on the concrete lining, or whatever lining you decide that you're putting in there? But what sort of support concepts are you looking at right now?

MR. MC KENZIE: I may cover this again here. One of the things in the next briefing is 100 year ground support. We don't know--we know that we're going to be looking at something fairly robust. It may be continuous concrete liner or it may be steel similar to what we have now or something. We don't know what we're going to have. We presume it will be fairly robust. We're going to try to maintain drifts for very long periods of time.

DR. CORDING: And are you looking at steel ribs as a permanent support?

MR. MC KENZIE: Unknown. I really wouldn't want to speculate.

DR. CORDING: Because I know in mining, one maintains steel rib support over projects. But there's almost no projects where steel ribs are permanent supports.

MR. MC KENZIE: Well, this one's got reasonably interesting characteristics. But, you know, as far as the drifts are going to be fairly stable temperature wise for a long time, they're hot, but there's not going to be a lot of--there's no diurnal changes, you know, day to night or anything. The conditions in the drifts will stay reasonably constant once the packages are in and the drifts are closed, assuming we don't ventilate them.

DR. CORDING: By the time you close off, they're already heated. They're already up to the temperature--

MR. MC KENZIE: They're staring to heat. Within a year, the temperature goes up 50 or 60 degrees. Heat temperatures don't happen for 30 to 40 years, but it heats rapidly and then--

DR. CORDING: But in terms of testing that sort of condition with the support and thermal testing and all, it's not the same sort of issue that the hydrologic features are, but certainly understanding what's reflective of heating, particularly for high thermal loading, would be certainly part of that ultimately.

MR. MC KENZIE: If you had your druthers and all the time and money you wanted, you might do a heater test that then resulted in letting you do a rapid cooling of the drift, of course put the roof support in, watch it while it heats, and then cool it rapidly and see what happens. That would be nice, but I've got a feeling we're not going to see it.

DR. CORDING: Well, let's go on to the last presentation on the repository engineering studies.

MR. MC KENZIE: Okay, this is on repository engineering studies. And, again, we're talking there were three specific points that were asked for by the board, and the title may not really indicate--it's not that we've got engineering studies going on in these areas, it's just that in some cases, we're just going to--the result is going to be that it's either going on or it needs to go on.

These are the three subjects; 100 year ground support, and again we're talking in quotes, long-term ground support, minimal maintenance, recovery from rockfalls, and the presumption here is that we're talking about rockfall into the emplacement drift that has an unshielded waste package, and backfill. The whole subject of backfill, whether you need it, what's it good for

Right now, if you look at Revision 1 of the CDA, the controlled design assumption document we talked about earlier, you see these words, and they say that drifts will be designed to be stable throughout the period and will not rely on planned maintenance, and other non-emplacement areas will, of course, be designed to be stable, but they may rely on periodic maintenance.

And you read this and you don't have to work very hard to come to the conclusion that we're guaranteeing that we're going to drive the drift, put a roof support in it and leave it sit there for 120 years without every having to go back, and that's not the case and that's not what we're trying to indicate. So that when the CDA is written again, we're going to change the wording a little bit in that document.

I haven't developed a new wording yet, but essentially it's just going to acknowledge the fact that there's some degree of post-emplacement drift maintenance may be needed, that it's not reasonable to expect 150 miles of tunnel to stand up for 100 years without doing anything to them.

The goal of course is to minimize the number of times that you have to do this, because if you did have to send people in, there would be a safety concern. But it's going to be a big problem operationally; even if you do it remotely, it's going to be a problem operationally to be going in and maintaining drifts all the time, for whatever reason. Maybe it's for bad monitoring units or maybe it's for emplacement that looks like it's ready to fall in or something. There would be a high cost associated with it and we want to minimize having to do that. For that reason, we're going to tend toward a very stout, very robust ground support system.

While we don't have any--you know, a report coming out that's titled 100 year ground support or anything, we have quite a few of the studies that we've been doing this year have implications in this area of long-term ground support. So I'll just run through some of the--this is not a whole list of all the studies we're doing, but these are the ones that have some application toward long-term stability of the drifts.

There's one that's completed and it's called definition of the potential repository block. It's essentially a report on a 3-D geologic model that we use in the repository program to model the emplacement area to guide us on the best places to locate emplacement drifts that comply with the 200 meter cover criteria, and to stay below the 10 per cent lithophysal contact that Ned talked about, in other words, to be in the TSw2 primarily, stay above the TSw3.

So this is essentially a 3-D model that shows us where the area is that is best for the repository to be located so that we can locate the drifts in the area that's going to give us the best stability.

Another one we did was an emplacement mode evaluation. Again, when you're talking about MPC, the emplacement modes are fairly limited. You can look at in drift modes or you can look at alcove based modes where you excavate a little room for each package off in an emplacement drift and you put it in there and close the door, and that alleviates some of the problems we're talking about earlier about having to take out 56 packages to get another one out.

That brings us to another thing worth talking about; you accept another set of problems with another emplacement mode. There's just a raft of problems that are associated with trying to excavate these alcoves and trying to keep them stable for long periods of time. The result of that analysis was that in drift emplacement was the preferred option.

We didn't differentiate between, for example, pedestal emplacement or emplacement on a rail car, and we didn't differentiate between setting the packages in the middle of the drift or basically setting them off to the side of the drift, and it may have some attractive features that may allow you, or would allow you remote access past the line of packages. You could actually have a drift with 60 packages or so in it, and have two sets of parallel rails and you could run your remote telemetry on a parallel track to the emplaced packages that are off center, where there's a slightly larger emplacement drift, maybe on the order of 5 1/2 meters.

The point of that was that one of the big advantages of the in drift emplacement modes is that you end up with an array of drifts that look like this. They're a circular cross-section and they're at a reasonably low extraction ratio, down around 22 per cent, and they're oriented in the best possible direction for joint interaction, and that's your most inherently stable layout. Anything with alcoves is going to have a lot of intersections which are more difficult to control.

The recommended layout concepts report; this one's currently in review and it has an evaluation of several layout options and it really deals heavily with the discussion of that area that Kal was showing you where the packages are transferred. The area he was showing you where the locomotives were backing in and all that is right in that area. There's a dozen different ways to do that, and there was a lot of that report that deals with the best way to handle that option, whether to have two drifts here--you probably can't see it on here, but if you look on your handouts, there are actually two drifts here. There's the one that's ESF created, and then there's another nine meter diameter launch drift. We have some concepts that only just have the single ESF drift. So there's several possibilities, several ways of doing that.

The thermomechanical analysis is one that was completed. It just looked at the effects of heating on emplacement drifts on the PSW2, and it's not going to give us any--it didn't give us any conclusions except that it says that there were not any general instabilities in the emplacement drifts when we heated them up in the 180, 190, 200 degree C area. It didn't create any areas that were inherently unstable. And the inference from that, and this inference has been drawn for design effects, is that with ground support, the drifts should remain stable. You shouldn't have any trouble keeping the drifts open.

The repository design data needs; this is one that's just recently been finished. The big deal here, and it's not a big news flash, but one of the data needs that we put in there was geochemical effects of man-made materials. And of course that's been known since the beginning of the repository program that you needed to evaluate the geochemical effects of man-made materials in the emplacement environment.

The big deal here is that the ground support if we go to some sort of a continuous liner or something like that is going to be probably the single largest source of man-made materials in the emplacement environment, so we need to take a real hard look at what we might do, good or bad, to the emplacement environment by having large amounts of man-made materials that would be permanently emplaced in the emplacement drifts along with the packages.

Then the ground support analysis is one for later in the year, and it's going to look at the common ground support type materials, and it starts to address their applicability as far as emplacement environment. That's going to be working with and meeting with Livermore here pretty soon. Annmarie Meike is the man-made materials expert and we're going to be having a meeting with her here pretty quick to kick this one off.

Remote handling/robotics is something we're just starting on. As I said earlier, we've got things pretty sharp in this area. And for this year, what he's doing is--well, he's filling out a lot of forms actually, but what he's supposed to be doing once he gets all his training done is evaluating the--doing three things for the repository program as far as remote handling robotics. One is looking at what the environment is that he might have to deal with, what's the environment that you're looking at for remote handling, what's the temperature, what's the radiation field, that sort of thing, and what's the state of technology, what's available out there right now to be able to do these kinds of things. And then what the applications of that technology are for the repository work, which things do we need to have remote handling for.

Okay, heating and cooling scoping analysis was an evaluation where we looked at either continuously cooling the ventilation of the drifts throughout the preclosure period, or our current concept, which is closing the drifts off as soon as they're emplaced and let them heat up. If you don't have to retrieve, then you never have to go back in, and you close them up that way. But if you have to retrieve, you have to do rapid or blast cooling, which is you open the drift up and put a fairly large quantity of air flow through there and drive the temperature of the drift back down for access. This looked at the thermal conditions. There wasn't a mechanical report at all; it was only a temperature of the air and rock.

But a natural extension of this would be to take these cooling conditions, the rate of cool down that you can project from these calculations to see what that does to the different kinds of ground support and emplacement drifts, something that hasn't been done yet, but it's obviously something we need to do.

Just a summary on this. Again, while it's our goal to have long-term stable emplacement drifts, we know we can't guarantee that they'll never require maintenance. So we'd have to be able to handle that kind of maintenance on a regular basis within the repository program.

Evaluation of ground control systems is in the early stages. By the end of ACD, I don't expect to see at the end of ACD to have category one, two, three, four and five ground support, and we're not going to be trying to detail--design the ground support system, but we're going to be looking to be able to sort of prove out our theory that long-term low maintenance stability is possible. That's going to be sort of our goal.

Okay, the next one is the idea of recovery from rockfall. And I've got exactly one chart on that. It's not something we've done a whole lot of work on. We have one of many potential events that we may have to deal with, but we have a list of other ones, water and all sorts of things. We haven't yet developed our design basis events. Those are the things that once they're developed, we'll have to show within the repository program that we can recover from these things, whether it's an earthquake or a flood or a fall of ground or a derailment of a 66 ton waste package or whatever it is. Those events we'll have to be able to show in reasonable detail how we deal with them, how we're going to be able to recover from them.

And this is kind of a stupid example, but in general this is what you'd have to do if you wanted to recover from an in drift, an emplacement drift with a rockfall. You'd have to cool the drift to less than 50 C, assuming that it's been allowed to heat up, so the equipment could go in. Remember, no people can go in there; just equipment. You'd have to pull the packages out, as we talked about before. If the fall was on the 40th package, you've got to pull 39 of them out in the normal fashion.

Then you're going to have to get equipment in there, I would visualize something like a backhoe but with a brake and hammer and something on it that can work on the fall, not necessarily knock it along and get it out of the way, but reduce it to the point where you can get ahold of that package, and we're going to have to have a recovery of a vehicle. What I would sort of envision in my mind is a larger than standard transport cask, a type of shielded transport cask that we use to emplace the packages originally, but much lower slung and with sort of a ramp down. You're going to have to be able to get ahold of the package and pull it up into this recovery cask, close the door and take it out.

Then the rest of it is withdrawing the rest of the packages and then either remediating the drift or deciding that the drift is not worth saving and putting the packages someplace else. So that's kind of the state where we're at. We don't have any pictures to show you as far as the design solution in that area.

The last subject of the day is emplacement drift backfill. There's a couple definitions. Backfill, if we use backfill, it will part of the underground facility, and then by extension, of course, it would be part of the engineered barrier system, the EBS. And then the EBS has to be designed to assist the geologic setting in meeting the performance goals of the repository.

We have not established requirements for backfilling yet. Indeed, we haven't decided whether or not backfill is a good thing or not. We don't know whether we really need to do it or not.

If we're going to use backfill, it would probably be for one or more of these reasons. You would use it because it may enhance the waste package longevity by changing the interaction between water and the package. Maybe it keeps water away from the packages, or maybe the backfill has something in it that enhances the package life.

After the packages are gone, backfill may retard the release of radionuclides from the very near-field right around the package and keep it from getting out into the rock. Of course, backfill that's emplaced to the point where it completely covers the packages to a certain extent would provide some mechanical protection when the roof begins to fall on the packages years down the road. And if you backfill the drifts with a significant amount of fill, you could reduce the potential for subsidence of the rock mass, although with the kind of extraction ratios we're talking about, we're going to be probably--not very much subsidence danger anyway because the amount of rock you're taking out is small compared to the rock mass.

These are sort of factors that you might think about when we think about whether we need to use backfill. The waste package is pretty robust and it's designed to perform in a wet, damp environment. So the backfill is not going to help it very much. The waste package is structurally very robust, so it may be that it doesn't need mechanical protection from ground fall.

It may be that pre-emplacement measures, such as before you put the packages in, when you have unlimited human access to the drifts, you might decide there's something you can build in that drift, such as a diffusion barrier on the floor, some kind of a fancy invert or something, might give you a lot better performance than backfill would. It has to be emplaced--you know, post-emplacement, after the packages are already in there, it would have to be done remotely and in these long drifts, it's going to be a trick to do it. So this may be something that we'll want to look at as a pre-emplacement measure that we could put in there before the packages go in.

The assumption that's in the CDA, this is one I noted way back earlier that said that we would evaluate back to early on, the first CDA just said backfill was assumed not to be used. Now we're saying that we will evaluate it. All those words mean that we're going to look into it and decide if it's a good idea, and if it is, then we'll have to design it into the waste package and the underground design.

We have a study going on, a systems study, right now on the backfill areas that's just now getting started. I think it started right around 1 July, I believe. And these are some of the expected outputs of this study, some sensitivity cases for the next TSPA. A list of potential backfill alternatives; here we're talking about different materials. We'll happen to have about 15 million tons of crushed rock sitting out there that might be a real prime candidate, but it's not necessarily the only candidate material.

An evaluation of the near-field and TSPA effects on the alternatives, the different alternatives that you see above, and then this is--from my standpoint, that's a very interesting one. How are you going to get it in there? It's not easily done to emplace backfill of any real standard spec remotely like that. That's going to be an engineering job right there. And then there will be some cost estimates to try to get some comparability to the different options.

That study is expected to be done in early 1996 time frame, I believe.

Okay, just summarizing now a little the last three bullets. Our goal is to design and develop emplacement drifts that will be usable for the next several hundred years with minimal required maintenance. We'll try to keep it down to the least amount we can.

Recovery from emplacement drift rockfalls is going to have to be taken into consideration, as will many other design basis events. And the need to employ backfill in the emplacement drifts is being evaluated and we should have some preliminary answers on that early next year.

I ran out of viewgraphs, so I must be done.

DR. CORDING: Okay, thank you. Thank you very much, Dan. Don Langmuir?

DR. LANGMUIR: I heard for the first time, I hadn't even thought about the obvious, which comes out of what you've just been suggesting. A common sense way to go if the goal--obviously, there are several things that backfill could accomplish. Those of us in the hydrology and geochemisty area are particularly interested in it as a barrier, diffusion barrier to releases of radionuclides, and as long as it's an unsaturated zone, the changes are likely that the flows will be vertical from the waste packages downward.

A very common sense thing to do, which probably is part of what's being looked at right now by your study group is to make a road bed out of crushed tuff and leave the tracks on it, and that becomes the barrier, and it's not in the way of anything that you're going to do in terms of emplacement. But it's there, and depending on the dimensions of your tunnel, you have some flexibility as to how deeply you make this road bed. Obviously to the scale of how big your packages might be and how much space you need to have between the packages and the tunnel walls, that obviously is a constraint you've got. But has that been discussed so far? Is that an issue or an approach that's been considered?

MR. MC KENZIE: Well, it was discussed on that viewgraph there.

DR. LANGMUIR: Other than what you've just been telling us?

MR. MC KENZIE: Yeah, I--

DR. LANGMUIR: It seems like a very reasonable thing to do.

MR. MC KENZIE: I won't take credit for coming up with that idea. I mean, a fellow from performance assessment made a note and was reviewing one of my reports, and one of his comments was that just the concrete invert segments that we were talking about are a significant diffusion barrier, that they may have an effect in his PA analyses.

DR. LANGMUIR: But I made a comment at a meeting in Beatty on that, that my driveway lasted ten years. A concrete invert is not going to last very well. It's going to crack and it's going to give you fracture routes through it. Crushed tuff isn't going to be affected at all for millennia, any more than the rock around is.

MR. MC KENZIE: Then isn't it sort of--

DR. LANGMUIR: Well, but if you crush it, it's fine grain material, and you pack it down into the road bed, it's going to stay forever.

DR. CORDING: Okay, Dennis Price?

DR. PRICE: The difficulty of emplacement is not only the remote and that, but I think where whatever you use for backfill, particularly if it's tuff, might impinge upon the waste package, scratch, nick, create corrosion enhancement situations. It's going to be very, very difficult to have anything like a tuff and really put it all around that package.

MR. MC KENZIE: Yes, it will. It's something that if you want to evaluate the added performance effect, though, you're going to have to also take into account the fact that there's going to be these scratches on the packages that result from whatever emplacement mode you use.

DR. CORDING: John Arendt?

MR. ARENDT: To help me better understand what's been presented in the last three papers, I'd like to take you back to viewgraph Number 5 of your first presentation, which is titled controlled design assumptions. And I'm interested in who has the controlled design assumption document that you're talking about there dated April, 1995. Who's document is that?

MR. MC KENZIE: It belongs to the systems engineer.

MR. ARENDT: Is that a DOE document or is that an--

MR. MC KENZIE: It's an M&O document.

MR. ARENDT: It's an M&O document, okay. So I think what I've been hearing here in the last three papers, I've heard some design assumptions, I've heard some ideas, I've heard some concepts and a lot of things all mixed together and I'm kind of confused, and I'm wondering, and maybe what I need to do is to read the controlled design assumptions so I know what's in that particular document, which would help me better understand what's been presented. But it does trouble me to some extent that there's been a lot of exchange and there's some wild ideas, concepts, and yet we talk about a controlled design assumption, and that troubles me a great deal because that's rather important. And so I don't know what was presented here this afternoon, how that fits into the controlled design assumption document.

MR. MC KENZIE: It's a good point. We probably didn't do a very good job of explaining that, or explaining it at all.

The design assumptions are not things like the layout is going to look like this. The design assumptions are things like you're going to get waste packages at a certain rate, and you're going to get--but they're sort of the rules that the game is played by, but they don't necessarily make the layout look like it will. One of the big assumptions is avoidance of faults. That obviously makes the layout shaped the way it is. So that tells you where the playing field is, but it doesn't tell you which way your tunnels have to be driven and it doesn't tell you you have to use locomotives and waste packages. Those are design solutions. So the assumptions are only assumptions that operate for the rules of the game. That's not a very good explanation, but it's not--they don't tell us design solutions; they just give us guidance.

MR. ARENDT: Then maybe to help me better understand then, what have you been talking about in the last two papers? Have you been--

MR. MC KENZIE: A mixture of both. We talked about design concepts. These are ways which we could comply with the design assumptions. There shouldn't be anything in these layouts that runs counter to the design assumptions, to the controlled design assumptions. They should all comply with that.

Now, some of them do to lesser degrees. Remember the one about secondary excavation being minimized. some of these layouts have a lot of secondary excavation. So to that extent, they're not hard and fast rules.

MR. REILLY: A followup to that. You have levels that control the design policy, design criteria and design guidelines, and the differentiation between those three is fairly critical in terms of the application of the baseline, development of the conceptual design.

Now, the controlled design assumptions, how would you describe them in relationship to a policy, a criteria or guideline? Let me just say the criteria is what must be done. The guideline is a suggested way in which it could be done.

MR. MC KENZIE: These are certainly going to be at the lowest level of what you're talking about. This is just a document where we collect the assumptions that we have to make in order to proceed. If we didn't have some set of guidelines to go by--and I used the "G" word there--but we'd have 10,000 layouts. We wouldn't have any guidance at all. So we have to have, in order to sort of focus the advanced conceptual design, we made these assumptions, the key assumptions.

MR. BROCOUM: Let me say something, this is Steve Brocoum, about the controlled design assumptions document. It does have what might be considered to be your policy. It has what we call key assumptions, which are things like 70,000 metric tons which are--you know, how many waste packages. You know, it goes from very high level things that are problematic, all the way down to very detailed level assumptions about ventilation, and it's all in one document, but it's broken up within the document into different sections. I just want to make sure we have an accurate answer about that document.

MR. CRAUN: This is Richard Craun. I believe also the key assumptions are approved by DOE, if I recall. I think Dean Stucker may be in the audience and can confirm that.

MR. MEMORY: Let me barge in here. This is Rick Memory.

We do have a set of controlled requirements documents that go from the system level down to the project level, and the CDA is one set below that project level document.

MR. STUCKER: I might add to help clarify, Dean Stucker with the Department of Energy, the controlled design assumption document is really developed to help clarify our technical baseline. We have a technical baseline that has numerous to be determined or to be verified requirements, and in controlled design assumption was developed to help clarify those to be determined or to be verified requirements. And the document is set up into three areas; the requirements area where we make our best technical judgment as to what that to be determined or to be verified requirement really means.

It has a section on the concept of operations, for instance rail. Right now, we are pretty sure we're going with rail, so you may nail down the current assumption is rail for concept of operations area. And we have another area that is the data assumption area. If there's some data that we may not have verified or substantiated yet, we will list that assumption in this document.

So really you've got those three areas; requirements, concept of operations and data. And our approach was to make our best judgment on what the assumptions are in those areas. Once we have substantiated or validated that assumption, it would go back into the technical baseline.

If we can't substantiate it, you go back and you look at what the impacts are to the concepts and adjust your assumption until you can substantiate that assumption. So maybe that clarifies it a little bit.

The key assumptions originally were set out to be DOE controlled. Recently, we transferred that back to the M&O and asked them to keep us informed when they changed anything, but specifically when they did change a key assumption, to let us know. So we did change that recently to where it is a complete M&O document or AE document that they control at their level. And it was done to assure that we could have quick changes. If an assumption changes, we wanted to be able to assure that the designer could change it, look at the impacts, look at the different concepts that might be impacted and have that latitude to change it very rapidly.

MR. REILLY: Is there an overall document that describes those relationships as you've laid them out?

MR. MC KENZIE: Not with the CDA. The CDA is--

MR. REILLY: I understand that, because the CDA is a lower level document.

MR. MC KENZIE: There are--there's a document hierarchy that comes down in those parts of the repository design requirements, which is the lowest design requirement document for the repository program for the repository design.

MR. STUCKER: I think the systems engineering management plan of the project is being revised to clearly identify what the CDA function is. I don't believe it's gone through a whole change yet.

MR. MC FARLAND: A year ago this month, you made a presentation on ACD to the board, and in that presentation, you presented just about everything we've heard here today, except you had 17 key design assumptions, if my memory is correct. Now, I have a document in my office on the read list right on top is today's controlled design assumption document. And there are 40-some design assumptions in it, again, if I'm correct.

MR. STUCKER: I think there's 42 key assumptions. There's thousands of other assumptions.

MR. MC FARLAND: I'm curious. A year ago, a key assumption was that none of the drifts would be backfilled. Today, that key assumption isn't there. Today, we heard from Dan that there's sort of a chicken and egg situation. We don't know that we want to backfill until somebody does a systems study, but nobody is going to do a systems study until we know we can backfill.

What was the logic that led you to drop that key design assumption and has that logic been documented any place?

MR. STUCKER: Let me back up. For that particular key assumption, we struggled with, for instance, backfill. We got the technical people, the licensing people, the lab people and especially the PA people, and at that particular time, PA was--the answer on the PA aspect was saying it looks like we meet all our performance goals without backfill.

Now, since that time, they're looking at keeping the flexibility open. As the PA, as the models develop, you may want some flexibility to do some more EBS and may want to backfill. So we came back and adjusted that key assumption to say let's be flexible, let's not close that option out at this point, let's be flexible so that we're sure that if we need the backfill, that we have that capability.

So a lot of the key assumptions were adjusted thinking from the licensing strategy with the new program plan, and with PA. So I think there has been a lot of adjustments. The thermal strategy that we had, there's been some adjustments to that.

MR. CRAUN: This is Richard Craun. Let me add also that the controlled design assumption document is really to allow us to document our assumptions so that we can proceed with the design, recognize that the design is at the beginning stages, and proceed. And as data comes to the surface, Russ, some of those assumptions may change. You're pointing out one.

For example, as a result of some of the TSPA calculations, it was determined that backfill may be necessary, a diffusion barrier. I believe at that time also discussions were initiated on whether or not the inverts could function as a diffusion barrier.

So please recognize that you're at the beginning stages of the design. The design is at a conceptual level. That's why responding to an earlier comment as what have I been looking at this afternoon, a lot of it is very, very in process concepts, not flushed out, not with the detailed backup design. And so as such, these issues will change with time, and I would expect some of the other assumptions to change. As we get more data from ESF, we may find that, as indicated in some of the presentations, that the joint structure is at a different orientation than what we currently know. Could that have an effect on the repository and the in drift emplacement layout? Absolutely. But I think what you're seeing is the evolution of the design process, and also the document here is intended to help us capture and control and distribute so that all can be using the same assumption so that we can keep continuity in our designs.

MR. MC FARLAND: True, Rick, but conceptual design, preliminary design, however you want to call it, is an evaluation of options. It's not a design per se. It's trying to understand what options you have and what are your alternative designs, so that you can narrow that down. I really don't see any narrowing that's occurred over the last year. In fact, if there's a funnelling, it's going wider, and I'm puzzled. You know, would we expect next year, for example, to see 80 key design assumptions rather than 40?

MR. CRAUN: I don't know if I can respond to the number of assumptions that we would see, but I see from my standpoint, an increased focus on the waste characterization, the engineered barrier systems, the material analysis to allow us to then define more accurately the performance assessment--the performance of the engineered barrier system so that we can go ahead and do a TSPA calculation that would allow us to get a larger handle on it. Then as those studies come to closure and come into focus, then some of the other related issues I think will also come into focus. But I still see that we're at the beginning of the cycle. Whether we like that or not, that's where we are.

MR. MEMORY: This is Rick Memory. For the record, Russ, the 17 key assumptions really haven't--there's not that many more. It's just a matter of the way we broke them out when we put them into the document. I think if you look back at the August document from last year, there were about 40 of them at that time.

What we did was there were three sub-sets of the shielding assumption, and we just broke that into three assumptions. So they're not really expanding.

DR. CORDING: All right, we're near the end of our session and we have an opportunity and time for public comment that people would like to make. And if you have comments that you wish to make, you can do that now. We do have one individual, Mr. Hal Rogers from the Study Committee, Carson City, Nevada, who had wished to make some comments. And if you would do that now, we'd look forward to that.

(Mr. Rogers not present.)

DR. CORDING: He's not--I know we've run late here--well, we haven't run late, but it's been a long day. Does anyone else wish to add to comments as we close up or make a comment?

DR. BARNARD: Just to remind people we have another comment period tomorrow afternoon.

DR. CORDING: Yes, we will have public comment tomorrow for this part of the session, so that's another opportunity. We will then adjourn until tomorrow, and I think we want to spend a few minutes here in the room across the hall,

(Whereupon, at 5:35 p.m., the meeting was adjourned.)