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NUCLEAR WASTE TECHNICAL REVIEW BOARD

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P R O C E E D I N G S

COHON: Could I ask you to take your seats, please. Thank you very much. It is my pleasure to welcome you to this second day of our meeting. Yesterday was very interesting and engaging. We look forward to another good day today. We will be turning to some other topics, all very important to where the program is right now and where it's headed in the future.

I want to announce a change in the order of speakers for the last session planned for today. This is the session that will start at 1:15, the session focused on performance confirmation. The major change is that Steve Brocoum, who was going to speak at 1:20, will now be the last speaker in that order. Everything else stays the same in terms of order; however, Nancy Williams--do I have that wrong? Okay. However, an additional change is that Nancy Williams who was scheduled to be part of the originally scheduled 3:05 talk is not able to be with us. But her colleagues, Peter Swift and Larry Trautner will cover together what she would have covered. So the major change here in order is Steve Brocoum goes at the end of that session.

With that then, we start our day with a session on Staged Repository Development, and Debra Knopman, Board Member, will chair the session. Debra?

KNOPMAN: Good morning. We're going to pick up in this session the same pattern we established in a couple of our sessions yesterday, which is to first introduce an international perspective on, in this case, the notion of Staged Repository Development, move from there to the DOE view, and then conclude with some comments by Steve Frishman on the Nevada perspective.

Our first presenter is Charles McCombie, who some of you met yesterday. Let me just properly introduce him. Dr. McCombie is currently an independent international consultant in radioactive waste management and since in this year he's become Executive Director of something called ARIUS, which is the Association for Regional and International Underground Storage. For almost 20 years, up to 1998, he was Director of Science and Technology at National Cooperative for the Disposal of Radioactive Waste in Switzerland. And subsequently, he has spent most of his time working on projects toward international or regional repositories. Let's see, he was also a member of the National Academies Science, Chair of Committee that looked at long-term waste options. And he's a member of the Nuclear Research Advisory Committee of the Swiss National Paul Share Research Institute. He's got a Ph.D in physics from the University of Bristol.

MCCOMBIE: Thank you, Debra.

First of all, I'd like to thank the TRB for the invitation to talk on this pretty topical issue here. It is nice to be in D.C. again. I happen to be here a lot right now. In fact, when I look out at the audience I see so many familiar faces, I think I can probably forego my usual stuff where I talk when I explain why a Swiss citizen like myself has such a peculiar accent. Those who probably looks like Andrew Carnegie.

The talk I'm going to give today is split into two parts. The first part is based on the work which I'm doing with the National Research Council now on a committee and set up at the request of DOE, and our report on that committee work in the first part of the presentation.

The second part is my own personal opinions about how different programs around the world are actually using the concept of staging. And the reason I appear under my own title is that I don't want to stress any of my committee colleagues with some of my own opinions which might come at the end.

So the first on the committee, and this is a committee on the principals and operational--important word--strategies for staged repository system still to come by the time of the final report, which is scheduled for--

around like November of this year. Well, the study itself on the staging, we were asked to address--this is the statement of task, which you are familiar with the NRC and the original NRC and method of doing these things. So we're supposed to look at the objectives and risks associated with staging, and in a very wide spectrum from technical to societal. We're supposed to look at the impacts of staging on these issues mentioned here like safety and security, costs and so on. We're supposed to look at how staged strategies might actually be in the operational phase, was the original statement of task. We were also asked to identify knowledge gaps. What do we have to know to do staging better, to do staging correctly, do staging at all. And then very importantly, we were asked, and we'll come to this I'm sure, to look at the potential incompatibilities of staging with licensing procedures.

There's some very important caveats in addition to this statement of tasks which have got to come on. First, as the title was, the emphasis is on operational aspects. And at the beginning we agreed with Lake and his colleagues that we couldn't just do that staging. It's for a whole process. So we really have to take some position on things like siting and so on. But the report is focused on operational phase.

Also important is it's meant to be generic report first of all. It's for a waste repository somewhere. Not for any specific waste repository anywhere, but as an important rider, with applications to Yucca Mountain for a possible. But on the specific questions that's in the room today and all the time and--back in 1990 in the well known rethinking report done by the National Research Council, again there were indications that that a staged or gradual approach was a more sensible way to go in some kind of projects. And I'll try to define the kind of projects afterwards. So again, the idea was that you can change things in response to new information that comes in.

The most recent enunciation of this principal was in the last year's report, again produced by the National Research Council under the chairmanship of this committee, of Warner North (phonetic), and I was lucky enough to be the vice-chairman of this committee, and for my sins was penalized by the chairman of the committee.

And, again, in this report we pointed out that a step-wise process was appropriate and very importantly for making, decision-making under uncertainties and the two was important, technical and social or societal uncertainties. So this report placed a lot of emphasis on the fact that we have been underestimating the societal challenges in this waste management business for too long. So that was the lead-up.

When the committee started, of course, we got into the usual thing of definitions. Our waste management community has a real gift of taking words, trying to add clarity and making total confusion out of it. We had a good example of that yesterday with the safety case. We put so many words around these things that it's nice because it becomes a selective process. Everybody can choose his own or her own meaning. I forgot I was in the States. And what has happened with safety cases also happened with validation. It has also happened with state cooled, it has also happened with robustness. You know, the words are nice and we--but then meanings diverge, and I fear this might happen here as well.

And staging of course is nothing you--every major project is staged. You can't do a big project like that. It has to be staged. So what is new about staging?

Now, we looked at different kinds of things, before I come to what's on the screen now. We tried to differentiate and we looked at conventional, traditional project management type staging which we called linear staging. Linear staging means you are at A and you want to get to B. Everybody knows where B is, everybody knows what you're after, A, but to make sure you get there in a cost-effective and, I don't know what it was that Burt called these yesterday, a whole string of words like that. You chop it into stages and you put milestones, but the milestones are there primarily to check that you're getting to where you know you are going, to check that the costs are still in control, to check everything. So this is a linear process. And that's been tried in many programs. And I'll come back to this. It has failed in many programs as well.

When we looked around, and using the input from some of our other people on the committee, and we looked at a newer concept for management. Not project management like technical people are used to, but what's called adaptive management, which I'm also learning about. And this mainly came from the econological sciences. And adaptive management is something different. Adaptive management is more suitable when you don't quite know what the end phase is going to be, where you don't quite have agreement of what the end phase is going to be. And so we co-opted or took over this sort of adaptive and tried to put adaptive onto our staging to try to differentiate adaptive staging from other kinds of staging. So when I say staging in the future here I'm going to mean adaptive staging. And the attributes of adaptive staging that are given here at every stage, you don't just say, oop, take it off, let's move on. You stop me and say what did I allow in the last stage. Should I be just moving on in this linear way? Have I got new information that came in? And that's not normal in what I've called linear staging there. So that's really important.

The next thing that comes with it is the next step, which I thought in the beginning was the right step. Is it still the right step? Do I have other options? And you want to have other options, including reversibility. It's much easier if you take any decision for society in general and for technical people who actually belong to society as well. It's easy to take decisions, and if you know that they are not irreversible. So reversibility becomes very important now.

Now, we have another point in our adaptive thing that we should evaluate and update the safety case. I don't want again these complicated definitions of safety case. For me the safety case is the numerical stuff plus all the other stuff that makes the numerical stuff believable. That's a really bad definition with "stuff" three times in the word, but I'm sure that you can get about as much out of it as you can get out of yesterday's discussion.

We said that you should update the safety case. Has something radical changed? If it has do I have buy-in to the radical changes that have happened? Now, am I taking the whole community that's involved with me? So that's important. And then, not as trivial as it appears, decide on the next stage so the decision process itself becomes part of the staging process so that you have to see how the decision was made, what went into it.

All of these things become how we would envision adaptive staging happening and the blue part at the bottom is important. We originally had a bullet that says interaction and so on, and the more we thought, the more we realized that it's so over-arching. This is all what happened with interaction. And it's especially spelled out with input from and also feedback to the stakeholders. And if you don't like that word the interest and effect is far reaching, which I think is nicer as well. But, you know, they have to know when you move ahead that the views that were taking into and if they are not working on, they should know that you haven't taken them in. You should know why you haven't taken them into occurrence, so this input/output. So that was the kind of broad definition type approach for adaptive staging.

Then we tried to be a little bit more specific and formulate this in terms of what we call the essential attributes of adaptive staging. We put these up here and the top one I think is the most important, is the commitment to systematic learning. These are chosen words.

You know, this is just not how I learned anything. This is the intention to learn something. When you start out on this stage don't just think where I'm going to get. Think what can I learn along the way. So even if you have to stage because of budgetary conditions than anything else, use the occasion. Think about it. I can use this. What can I learn in this stage? How can I challenge the things I saw in you and so on? So this commitment to systematic learning is a very important point.

The flexibility kind of came in the previous slide, but this is flexibility--it has to be flexible, it has to include this reversibility attribute for as long as you can, although I think choices get narrowed with time, of course.

It has to be auditable. And by that we mean a complete record. And that's not just a complete record of what data came from where and how they are. This is a record of how the decisions were made, who took part in the decisions, how did it happen and so on. So auditable is important.

Transparent means that this complete record has to be available, has to be open, has to be available for anybody who cares to look at it.

The last part, the second to last part, the integrity part is important. By integrity, some of the issues in there is that all evidence--you don't just look at the bit that you people got. You look at all of the evidence. Yes.

Yes. John will bring me a--someone bring me a cup of coffee from the corner there.

SPEAKER: Coffee or water?

McCOMBIE: No, coffee is better. It's got drugs in it. I am suspicious. After hearing the talk yesterday about all the stuff that's in the water at Yucca Mountain it has put me off water forever.

So the integrity means look at all of the evidence and so on. It also means--integrity means keeping trust, and I'll come back to this afterwards. This trust issue is tightly bound into what we're calling adaptive staging here.

And the last issue there is responsiveness. Responsiveness means if you make stages, it's kind of--it's an optimization, to use a horrible word, at least as a choice in how big the stages should be, yeah? You want them to be small enough that you can correct, yeah? But you want them to be big enough so that you've learned something in between, and then where are the right sizes. I mean two examples, jumping ahead a little bit, 90 days is always too short for a stage which is supposed to get you from site suitability determination to a license. And that's already feeding into your system. Everybody has recognized it's too short and it won't be done.

On the other hand, maybe 100 to 300 years between the stages we saw yesterday, from first acceptance of waste to closure of the facility as one stage, maybe that's too long. So somewhere in between these, each one, there will be a right length of staged if subjective judgement goes into it.

So these are the kind of essential attributes. You should remember these exactly because I'm going to do a test afterwards. I'm going to go through all the programs in the world and look and see how they fit to some of these attributes later in the talk.

Before I do that there's an input which is not in our interim report yet, but did come from one of the committee members, Todd LaPorte, who has done lots of really good work on organizational systems and institutional systems. And Todd made us a sort of checklist which I have kind of used on the next overhead here. When do I use the linear and command and control strict project management staging approach? When do I use adaptive staging? If you look at this list here you can see that, if you have agreement on all these, if you answer yes to all of these, then maybe you don't need adaptive staging. And you've taken the problems out. If you all agree on a single program goal, then that's a big step forward. In Sweden they all agreed they wanted the repository. In many countries they don't even agree they want any repository. They don't want any repository at Site X. So if you're in agreement on the goals, if you're in agreement on the ways to get there, if you got lots of financial and other resources, it's good. If there's not a huge perceived--perceived as an important work, perceived hazards--it's not the actual hazards that counts because of the interaction, the societal and technical issues are perceived however. If it's not huge, if you can get fast feedback, if it's an emergency situation, adaptive staging would never be used in a war. You can't do it. You can't run an army like that. That's why command and control is the other extreme. And some of these, I mean some of the arguments which came up for Yucca Mountain recently and some of the arguments which have been used in the U.K. for example, we have to get this stuff on the ground now, or backed off from the 9-11 thing, and that would kind of come into that category. That suddenly increased that far. Why not? You've got to jump some things. If you got confidence and implement those you can do it and that's really important. Again, jumping ahead with examples.

In Finland, the chosen site that you all know about, the people at that site, there's been no underground work done now. But they all know that when the work starts, if any show stoppers come up, despite the fact it's the agreed site, they all know that their safety authority, their regulator, under-implementor will stop the project. It's not a question. It's not even an issue. And you can compare that with some other places where the social confidence is less high. A stable environmental part is also--so if you look at all of this you can maybe make it more transparent or imaginable to think of other projects.

Yesterday the man in the moon was mentioned. The man in the moon would pick yes almost all the way down here, you know. Let's get somebody on the moon. When Kennedy said it, nobody stood up and said, "Oh, a rubbish idea", you know. It was--it really fits in pretty well here. When they tried to use the same techniques later to a space station, for example, it started crash and ready to talk. Some people said we don't need a space station. It's not the right way to go and so on. So the history of the space station, for example, is a lot more checkered than the history of the man in the moon. So to give you some kind of examples. So these are the examples that we've been using to focus our thinking.

In the interim report I mentioned we then go on to list the pluses and minuses, the pros and the cons of an adaptive staging in the way that we envision it could happen. I won't go through all of the pros and all of the cons, but I've got some examples here in each of the areas. Programmatic area, it's good because it keeps options open as long as possible, but it can make things longer lots of times. It could also make things more expensive. As a counter argument it could make things cheaper if it leads to disclosure of real problems.

In the technical areas, the pluses that you can maybe avoid surprises. By keeping the stages short you can avoid surprises. You can therefore perhaps save costs, you can therefore, much more important, have a safer system perhaps or a more demonstratively safe system which I think is probably more important. The down side as well as on the technical side, if you stage it in the way that many programs are now doing, so let's keep the waste open and available for a long time. You have to realize if you do that some people will get real radiation doses when that's happening. You know, it's no use keeping it open if nobody looks at it. There's no use keeping it open if it's not accessible. Accessible means people can go there. So you have, if you're being logical about it, you have decades or maybe hundreds of years where people will go near the stuff all the time. And if you were really logical you would integrate the doses these people are going to get and compare it with the hypothetical doses of 10 millirum or

100 millirum 100,000 years in the future. So there is a down side, a potential down side, and it has to be accepted if you're going to go down this path.

In the regulatory area, there's an up side and I think from some of the stuff Steve said yesterday we will come under this regulatory thing today. The up side is the regulator gets more input. I talked about the 100 to 300-year thing and so the regulator should think about how he's going to get input in that stage, and if the regulator works instead as a champion of the public, then that's a good thing.

And there's also a down side, of course. If you get more regulator steps in you can also have delays, especially in litigative countries which you can find around the world without going for specific examples.

And institutionally there's a really important nice part here. Institutionally there's an up side to adaptive staging where you actually look at each stage, is that it gives the implementator a chance to prove that she is trustworthy. And Margaret Chu mentioned that a different way yesterday. She made this commitment to you guys that in September she would do something. And she knows you're going to measure her on her ability to deliver that. If you multiply that through all the stages in the system, what you learned, if you look at there's a positive chance, it gives you a positive chance to demonstrate over and over and over again that you are trustable, so each stage you see what it's going to do, and if at the end all of the other parties see that you have done what you said you would do then it's to watch out for it. It's a little job. A person is not up for it. And we all know about this slow rise in trust in the job foal (phonetic) if one time you don't deliver. So that's an important issue there.

The down side--and this is a really important down side--societally is that it can easily be represented as a, what I always call a salami tactic, you know. They don't like sausages. Slice it thin enough and they will have eaten the whole lot before they even realize it, yeah? So that's a real down side, so you have to be careful that's not what your doing; that you're not just chopping it up into bites that people can swallow easier. And that needs to be carefully explained and thought through and justified.

The last part is fairly straightforward. Societally, of course, this adaptive staging was a really marked decision process at the end or beginning of each stage. Gives you much increased opportunities for public participation, yeah, which is the positive side. Again, in some countries, in some places, and this is not the U. S.

referred to--also gives increased opportunities for what you might term disruption if people are not in agreement with the broad goals.

So we looked at these pluses and minuses in our report and we came to the conclusion very cautiously that we think adaptive staging and throughout the whole waste management program and also in the operational phase, stage, and in trying the good approach. It was cautiously framed because most of it was based on the observation that the other approach has not proven to be so good, this linear command and control don't include people approach.

So that's about as far as we got in our interim report. It was short on Yucca Mountain material for two reasons. One is that it was early in the proceedings, and two is that, although we were agnostic on Yucca Mountain, it's difficult to say anything about Yucca Mountain in the current climate of course. So that we really were very restrictive in what we said about the Yucca Mountain interim report, and that's one of the big areas we have to work on between now and November to try to make appropriate suggestions, conclusions, recommendations there. Okay, so that's what we've done in the committee up until now.

If I move on now to a wider view, I looked at the phases, deliberately using a different word here. Phases or of temporal type issues, and all programs can be divided into phases in different ways. This is a pretty standard way to do it on the left here. On the right I have a list of the countries that have been very active, most active. Not all of them. And the countries I happen to know pretty well because I've worked in most of them at different times. And afterwards I'm going to try with a color code to say the ones that perfect some positive aspects of adaptive staging and some which reflect less positive aspects because you're not allowed to use the word negative.

The way I've done it is to try to measure them against these essential attributes that you saw earlier. I've got the U.S. here on the list as well, but I'll kind of go low key on the U.S.A. because I've got one overhead at the end which tries to pick out some specific issues to do with the Yucca Mountain program. Again, my own opinions on it, because that's the part we haven't done in the committee.

So if you look at some of these national examples and start off with commitment to systematic learning, whose fault was that? Who brought that into the program early? Well, there's different ways you can do that. There's different examples of it. The ones I've used here are underground rock laboratories. There are key learning phases in many programs, and the ones mentioned here, Sweden was the very first, Switzerland was pretty early, maybe second. The Belgians have an excellent underground facility in clay for many years, learning lots of things and so on.

The U.S.A. gets red here in a way, not because you don't have underground facilities now, but because it took a very long time a very long time to do it and it only came at the actual site with a hugely important exception of course, the Climax facility which for reasons that are not very explicable to me, disappeared. Maybe it was before its time or something like that, but I thought you were up front with some very demonstration type experiments, but Climax went off the scale early.

The next one is a pilot phase. A pilot phase is a conventional way to learn when you start any big project. And then what's in waste management and waste disposal in fact, then a few people did it. The Swedes were the earliest, back in the 90s, where they said we will dispose 10 percent of the waste, and originally--I think they are slacking off a little bit on this--but originally it was, and if you don't like it we'll take it out again. Not if it's not safe, no. If you don't like it we'll take it out again. That sounded awful to the community, yeah? Because they felt so confident of what they were doing. So the

Swedes early had the pilot facility.

Switzerland, we didn't have it explicitly. I say we because I worked in the program in the intensabilities phase. But very recently with the new EKRA group, which is viewed in Switzerland, we have proposals for a pilot phase and also a demonstration facility, which would actually have the waste in its final configuration, back-filled and all, for all of the decades of the operational phase so you have a really long-term demonstration at the time you need it, which is when you start looking at closure decisions. So pilot phases--and the U.S.A. was negative, and that's proven positive. We're going to hear more about that today for there's much more talk now, about, you know, don't build the 70,000 tons in capacity all at once.

And the last point here is the use of performance assessment, or safety assessment as I would call it with my background. It's the systematic use of it to try to gauge a knowledge process. That is kind of weird. I mean again this same group of countries which got close contact is the Swiss, the Swedes, the Fins, started really early using interactive assessments to try to learn something. The states started later than many of you people here think, in fact, yeah? But when you did start you did it like Americans do. You did it really intensively. So you lined it up with very interactive TSPAs and thought maybe even too intensively, and had some of the criticism of there was too much weight and what not on the end, but using performance assessment or modern terminology, using an interactive safety case is definitely a good learning mechanism. And some countries didn't use it and have suffered from not using it, and the examples are the French program, which is very diverse and hasn't used it quite like that. And the U.K. program which has been pretty chaotic in terms of decision courses and in many ways including this.

Look at the next example on these essential attributes. I've lumped together--oops, I missed one. Flexibility. Yeah, this is another one where important points to be made. The concept choice, when I say all in red there, I mean that every single national waste program decided at the technocratic level that disposal was the right thing to do. We didn't put a concept up for public discussion, yeah? Now, I am one of the guilty people here. I still think it's the right thing to do in some ways. It's just--it's noticeable it wasn't put up for public discussion at that stage. And it came much later, hadn't been the buy-in to this is the only way to go. We said it, but we didn't get enough of a buy-in there. And that, in fact, I've got them gritting my teeth. I have these three countries green because what's happened there is that when they got further down the road they found that we did not have buy-in even at that level. So the French already in 1990 said we have a three-pronged program. We've got partitioning in transportation, we've got long-term storage, and we've got disposal, and we are not making any decision on which is the right one to do, and for the next 15 years then in the--and Canada came next and the Canadian report was total disaster when they found there was not enough so that one of the best programs in the world collapsed in a short time because this had been neglected. And in the U.K. the same thing happened, back to square one, in fact back to square zero or minus one. You know, let's think what we really want to do. So that this concept choice, I think all programs were kind of guilty of doing it too early.

The other ones, the flexibility, I think I'll jump these actually so I can get on to the more important ones. The next overhead lumps the auditability, transparency and integrity. And then I think I want to show this one because this is where the states comes out top of the heap. You people have the most open system there is. You have, if you look at your public consultation processes, they are extremely open in many different areas. You can look at today for example. No other country that I know has quite the openness and accessibility of the states. Other countries have it to some extent, and some countries, like in the original--in Germany and in the U.K. they had so little of it that they had major crashes, and they are now re-starting with this public consultation almost--well, in the German case, they have a new AKEND, A-K-E-N-D group, which is really trying to do siting from square one again, with public consultation. In the U.K., I've said this was personal opinions, they've gone almost too far. They are producing documents which say, paraphrase slightly. They go to the public and say tell us how we should consult the public about how the best way to consult the public is for consulting about waste management, yeah? Like three steps back. And seven years from now--this is not a joke. This sounds like the best joke on me yet, but it's not a joke. Seven years from making this diffuse set of questions we'll actually decide on what we're doing. And that's why, and there's been recent moves in the U.K. to try to pull that system back in line somewhat more. The openness again, the U.S. system is top of the pile there.

Responsiveness was the last one. And I think I'll jump the responsiveness totally. You can see it's to do with siting. Do I change when I get input even if I didn't want the input that came, I didn't like the input that came, how responsive am I with my site and with my design?

The one that's important here, let's try to wrap up on one side. Let's then be specific, me personally, Charles McCombie and not my committee, again. What about here in the States? Well, the siting process actually fitted pretty well to our adaptive staging thing all the way down until you had three sites at least, yeah? At the three site stage it diverged, and it kind of diverged--it's a policy decision. I'm in no way criticizing policy makers who decide, but one issue was taking them narrowed in from three to one. It crashed against many of the attributes which we've defined as adaptive staging. And it was done presumably with the justification that some of the parameters in my list from Todd LaPorte were fulfilled to a greater extent. So that when it narrowed down to the three to one it was not transparent now. It was done in the bigger sense.

And then a really big point is that there's no options. This makes me nervous every time I hear it. And it's repeated and it's DOE-ese, DOE's language now. As well we have no other options and so on. I have trouble getting around this because you talked way back about second repositories. You talked about alternative options. You decided in the States about a second repository program. Why? Not because you thought the first repository was going to be too small, but because you had this concept of geographical equity. Really nice. The States is the only country which has got enough waste and enough resources to actually do that. And a commitment was made to do that and then people backed off from it in a very big way. So that's a shame. I think the whole intensity of the debate might well have been weakened, rediced, if there were other options, and this keeping options open. Again, personal opinion.

In the programmatic area I've already talked, I was demonstrating there's really no underground labs or pilot stages that have been introduced since. In the program arctic air is also another points of introducing stages. The VA--I'm getting real American here, using all the acronyms--but the viability assessment and the siting recommendation were introduced as new milestones, which is good. The modular approach is also good, and we have, and it was originally thought of just to levelize costs and we in our committees were all going back to that thing. That's not the best justification. It might be a reason, but it's certainly not the only and not the best.

In the safety case, it was a two-way stop and it tended to get too narrow a focus into the TSPA. One important point is that my decision process, my perception, personal perception, is that in the safety case evolution in the DOE program, in the Yucca Mountain program, what lacked was major changes were made in the safety case and they weren't put on the table nearly as openly for discussion as they could have been. That's not just with the general shift from engineer to engineered barriers, from geological barriers. It's also things like dip shields suddenly appear, you know, and they come like if you're looking at the program from outside and I'm probably looking closer than most Americans, they appear to come out of the blue. And so they--and there's a major change in your safety concept there. There are also things like clodding (phonetic). The whole world never used clodding and allowances as part of its safety case, yeah? Including the States. And then suddenly the States had clodding. A huge safety factor, you know. It was a very long-life thing. I'm not saying that's wrong. I'm not saying it's technically wrong or anywhere. I'm just saying that these things appear as they are out of the blue, and they are not put on the table as we have made a major change in our whole safety concept. And that's what I would be criticizing there.

All of that is improving a lot. We've had, and in the water--I've been doing in the States with my colleagues who know much more about it than I do. We're noticing lots of improvements in the way we're--we've had very good interaction with all of the DOE people, and Lake Barrett in particular. And we're pleased to see that the messages that we've been trying to bring we think are being taken on board, and I look forward to hearing later talks to see how well that has been done.

Thank you.

KNOPMAN: Thank you, Charles.

Questions from the Board? Norm Christensen.

CHRISTENSEN: Let me say, Charles, I thought that was terrific, a really nice discussion, particularly the initial discussion about adaptive management and very much appreciated your analysis at the end.

I wanted to make maybe two observations and get your reactions.

If one looks across a variety of different situations, not just in waste management, but natural resource management, other complex systems, it's hard to find institutions, or situations that have behaved just the way you described. It's an ideal and yet it has been poor to realize. And it seems to me that there are two problems that are worth thinking about, particularly in our context about how we actually implement these. They relate to the institutional issue that you raised and also the societal issue. So I want to propose that there is in institutions something equivalent to a second law of thermodynamics that goes something like this: At every stage of decisions, vested interest increases, and incentives for critical analysis diminish in proportion. And that's a natural process. This isn't the critical statement. It's simply that something that happens. We move down a road and which suggests that perhaps there needs to be within an institutional structure some way of enforcing critical thinking from the outside because institutions are not going to be naturally prone to do it.

My second point is about society. And that is that I think societal expectations are run counter to the notion of adaptive management, even though people may see it as being incredibly logical. And again, my assertion here is that society expects that agencies manage complex systems in ways in which they know or ought to know what the heck they are doing and are very intolerant of--now it's very difficult in a societal situation for an agency to say, well, we're doing the best we can with the knowledge we have other than to say we're doing the best that can be done, and they are very different situations. So I'd like you to comment on that and particularly maybe think about this in terms of, as we move into, or potentially move into a stage situation, how do we deal with these particular problems?

McCOMBIE: Both good points, and as an old-school dinosaur technical person I have to be very careful what I say here, but we've looked at both of these aspects and the points you mention is really institutional culture. The question has been put in the room, you know, if this adaptive staging approach, can you do it in any institution. And the answer is no. The institution itself has got to have a certain kind of culture. If it doesn't have it it's got to be willing to try to get there. As I said, you can't have adaptive staging in this way in a military system. You know, if the high officer says jump, you have to have somebody to jump immediately or the system won't work when you come to stress it and test it, yeah? So that--and the question has been raised, and it's no surprise to the--for the DOE itself has in its culture the ability to do this institutional management, to take on board, to try to explain it to the public. Combine--that's connected, it's very closely to your second point. I'm not so sure I agree with you any more. The public expects agencies to do things and do them right, you know, if I look across the whole world, you know. Nowadays the public has been increasingly skeptical of the ability of agencies to do things right in many countries, and I'm not talking just about the States here. So--and that's why you learn that with this complex, very difficult efforts, what do you do in this case? You know, do you convince them that the agency can in fact do it right? That's a nice way to do it. That's the Scandinavian way that I mentioned, you know. But in Sweden on a public opinion polling, if you ask the public where do you get the most reliable information on waste management, then SKB, that's the implementor, that's the nuclear industry is top marks by far, yeah? So there they have got confidence or not. If you ask in other places, I know in the U.K. for example, well, you know, then any of the government agencies would be at the bottom. You know more about the U.S. system than I do. But--and so this, other agencies are expected to do it and can do it. It would be nice, but it's crumbling, I think. And that it's crumbling partly because we haven't fulfilled trust often enough--we, being, speaking as a technical person if you like now. And also we've pushed the whole issue up. The kind of example I quite often use is that any--now, we've kind of got ourselves in a situation where any house man or house wife, and is kind of expected to know about things nuclear and so on. And the whole world is full of other things where they are not expected.

And I happen to live near the biggest chemical complex in the world, New Basel in Switzerland, yeah? And I drive past these chemical factories every day. And they are complicated. They look like oil refineries but they've got other things, and nobody asks. We don't expect them and there's not expectation. If you ask your neighbor, you know, do you know how these things work, they all say no, unashamedly, yeah? If you ask them about waste disposal or nuclear things in general, we've managed to kind of give an air of that into it. So I think that we technical people are part of the problem here and it would be rather nice if we could become part of the solution. So does that answer your question?

CHRISTENSEN: Yes.

KNOPMAN: Dan Bullen.

BULLEN: Bullen, Board. Charles, thank you very much for the international perspective because it brings out a lot of benefit to our program and to the Board's understanding.

I'd like to actually talk a little bit about your international perspective on an issue that's on the U. S. National Resource Council 2001 report where they basically say that demonstrated reversibility of actions in general, and retrievability of waste in particular are highly desirable. As you go through your adaptive approach, what kind of criteria do you see either generally, generically or maybe in another international program that would warrant retrieval? What type--I mean how would you make that decision? And then I guess the other question is do the citizenry actually trust the implementor or the government to actually do the retrieval if they determine it to be necessary?

MCCOMBIE: Yeah, these are two questions. The second one is so hard I'm not even going to get there. The first one, let's try, on my--I didn't get into the details, but on retrievable issues, that's another issue where the technical people thought that it was two things: Either it was so unlikely that we would ever need it, you know, that why bother about it. And then secondly, and without really spelling it out, that if you did have to retrieve then you could always retrieve anyway. So these are the two things that we kind of, we knew inside us, and what we realized in the end, there wasn't, again, buy-in at a wide enough level to either of these, and to possibilities, yeah? So the demand for reversibility really came from a societal thing, very much so. And then the reactions have been actually all over the world I think have been good. The technical community has responded to that, built in the option of retrievability. It has to be explained a lot more to them and technically of course, it's easy still. I still think technically it's easy for--we have to make a case for that and show people that it should be easy. We have to do things that we might not think are really necessary as technical people. But, so that at every stage you have to assure them that it could reverse, yeah, and it's easy all the way down to the siting phase. You've got back in the same corner again here. You know, if you really came down and you said that the reason we want to reverse is because the site is not good enough, yeah? And when you reverse--reversing to--it's stated in our interim report--reversing to a situation where it's a dead end anyway, you don't know where else to go. And so if you reverse from that, then it's not the end of geologic disposal. I think it means that that particular site wasn't the right site. But that can be done as well. Russ mentioned it yesterday, so there--the whole issue of it's not irreversible. It has not even very expensive to keep reversibility in there for much longer than we thought. And it's not expensive in financial terms and it's not expensive even in safety terms. We were always very worried it would kind of destroy the safety concept, but we've looked at that in a lot of detail and it doesn't, you know, not for the times we're talking about. So I think all you can do is persuade people it's possible and so on and demonstrate that it's possible and so on.

And then the next part is the whole thing about who decides. Who pays is another issue, but who decides. The only way I think you'll get that is by having really independent stuff. If I were in Nevada now, I'd set up my own body and troupe that would do that for the next 50 years or something like that, build up, educate your own kids to do it, have your own special way to do it, get some kind of organization that you trust to do it. You know, I even made--in our world you either need trust or else you need control. You can compass in for lack of trust by increase of control and that's one of the ways you can do it. Not a very good answer, I'm afraid, but I'm a technical guy.

BULLEN: Thank you.

KNOPMAN: Jerry?

COHON: Thank you. I want to concur with Norm Christensen about what a wonderful presentation this was and very thought-provoking, and I think very useful.

Just a thought. Listening to the exchange you had with Norm and thinking about some of the scoring you did of various national programs, I realized that what we really have to look at is the entire process, not just the DOE. But everything around the DOE. So that one can--and one example actually is, I was struck by the fact that you colored the U.K. green with regard to flexibility on concept choice. It was that flexibility happened to them. They weren't flexible. The same idea that adaptive management could be forced on or could be built into the overall system, even if the lead agency is itself not flexible, or not performing in an adaptive way. Being very self-centered about this I would say that the Congress showed great wisdom in creating this Board in 1987 as a part of the process, the system that includes the DOE. And I think it has helped the DOE to learn and to adjust and be flexible, where they may not have been otherwise without that external stimulus. And your comment on that would be welcome, but I actually have a specific question.

Under commitment to systematic learning you listed systematic use of PA, which certainly makes a lot of sense. You made a passing comment that it can go the other way. That is you can become over-reliant on that mathematical tool and it could actually frustrate learning, I think. And your--if you would expand on that point I'd be very interested in hearing what you have to say about it.

MCCOMBIE: Okay, and a short remark, I did mention with the green for the U.K. was through gritted teeth.

COHON: Yes.

MCCOMBIE: You know. And it's right. It was forced upon them, but the fact is they did do it and they go back. Your associated point about bodies like your own is very good. I think bodies like that are very good. The U.K. does have a body and remark which was kind of ignored in this thing anyway. It has been, I think, rather marginalized in the most recent debate and so on now. So that--and it's--I may be hitting on the U.K. a lot, you know, but I have two passports and one of them is a U.K. passport so I feel entitled.

So the other part about the PA is right, you know. It's dangerous to overdo it and I--when I was running a small but integrated program, we always consciously--we didn't use the words because we always invent new ones--but we always consciously thought that. What input do we need to drive the PA and models that we've got, was always one of the things looking at something like a site characterization program or a science program in a broader sense. But we always stopped after that and then we said and what else do we have to do, you know? One to make the credibility of this whole approach, to make the believability of this data better, yeah? And what else do we have to do or what else do we have to do just to increase our scientific credibility?

And I think being maybe immodest, if you like, but with praise for my Swiss colleagues, when we started this program back in the beginning of the 80s, there was almost nobody in it. It had a very bad reputation, it had a PR budget which was 10 times its technical budget, yeah, which was all small numbers like, yeah? And we spent the first 10 years effectively building up scientific credibility. Very deliberately, we told our publications to do that, we introduced a publications series which the cost volume might be--our idea was scientific American. And all the insets said for people who knew Europe, yeah? But, you know, words like scientified American, if you read things outside your own specialty, well, maybe I'm more stupid than average, but if I read things I don't know in my specialty, I don't understand most of it. So it's a high level. So we introduced that and we set out to tell people also to international programs over a period of 10 years, and so on. And it was all meant to increase the scientific credibility as a balance for this hard, if you like, use of performance assessment. It's really dangerous. And all modeling--I used to be way back the modeler for reactor physics experiments, and every two or three years I would stop and try to do a self check and get this horrible thing, gee, I'm stunned to believe these models I'm using, you know. You start using the model, you use them, and for example, this is a typical case, you use the models in an intercomparative mode so that's not so stressy, you know. Instead of using them to give you absolute volume you use them to compare things. And then you do that, but you find out if you keep using the models and the models do this all the time, you use them every day and every day you get comfortable, you get familiar with it, you know, it's like quantum mechanics. Nobody really understands it, but lots of people get familiar with the word, sure, and you get further down the line, you know. Suddenly one day you find you're using it in an absolute mode. And that happens in all programs.

KNOPMAN: Priscilla Nelson.

NELSON: Nelson, Board. I was sort of surprised that there wasn't more in your comments about, relating to, let's say education about uncertainty by the public and by the decision makers because of the context that we're in it seems a case of much more flux and availability of information. And maybe being--having prior judgements calibrated on some sense to terministic approaches and now having to think differently about how you reach a judgement. It seems that, to me, that dealing with complex adaptive systems and adaptive management really requires a certain kind of education of the decision-maker and the public. And I'm wondering if you think that that's true and if there are in particular some countries that really have developed maybe a change or a new capability in the public's ability to understand the questions that are being asked as you go through management scheme.

MCCOMBIE: That's the hardest question yet, I think. And the whole thing is framed in the context of uncertainty. You know, we talked about the technical uncertainty, but also the societal uncertainty and the whole justification for the approach is really meant to be within that framework. But to be more explicit about how you raise the level of understanding for uncertainty is very difficult. And I think this is something we should build in here, and you give me a good hint for--be more explicit about. But then it's kind of in there in our decision process type thing, you know, so that as the decision process is made, because that decision process is a multi-disciplinary decision process, and that's where you have to accept the uncertainties that come in. It's not spelled out enough in what I said and it's not spelled out enough in what we've written actually now, but I think that's a very good point. And all you can do is make it as transparent as possible and avoid promising certainty. That's what we've done too much in the past. And not always deliberately, but certainly and unintentionally we've promised a degree of certainty which we can't deliver, but which nobody else can deliver either. We've set up a measure, a yard stick for ourselves which is very often not fulfillable, but we set it up ourselves to a large extent, and to come back from that and get ourselves to be run-of-the-mill and normal would be one of the objectives, but not an easy one. So I don't really have a very good answer, Priscilla.

KNOPMAN: Paul Craig.

CRAIG: Charles, I enjoyed that very, very much. Fascinating and important and for all nations and many technologies. I kept think genetically engineered foods as you were talking.

And then you provided us with a sobering list of countries that got into really big trouble like Canada, Great Britain and Germany. And I wonder if you have any suggestions or if the committee has any suggestions for rebuilding institutions that have fallen apart or have lost public trust.

MCCOMBIE: I take back what I said that it was the most difficult question. No, I think that's too much to even start addressing now, but then that's right. They have crashed these things. And the only thing I worry about, we contribute, you contribute to it as well, This choice of words, for example. And I can criticize you guys since you're giving me a hard time, you know. And what are these three words--weak, moderate and the one that's not used? What's this--

CRAIG: Strong.

MCCOMBIE: Two of the scale?

CRAIG: Strong, strong.

MCCOMBIE: Strong. Yeah, weak, moderate and strong. You're out in the real world and weak to moderate means something, I suspect, different than what I hope you guys meant when you said weak to moderate. Maybe you did mean that, yeah? But we do it over and over again, and--so that to spread the creases around in the NEA, IAEA report, which has also been vastly courted, again, the trace of words is really important. You know, and I'm not saying you should mince words and I'm not saying you should make things look better and so on, but very often we rush into words and without having a full really appreciation for what the echoes are going to be like when they come back. So we've done some of that, you know, a lot of the time. You know, in the kind of terminology we've used. So--and that happened also in the Canadian system, which was heavily biased incidentally on the non-technical side. The Canadian panel produced its report at the end, has been praised up in different places as being very inter-disciplinary, but measured in most panels around the world it was a very much--there were only two people in it, I think, with three technical backgrounds than the other six or seven came from, and so it was differently weighted from other panels. Or it's too difficult for--

KNOPMAN: We're running out of time, but I know Dan Metlay has one very quick question for you.

METLAY: Charles, Stan Metlay, Board Staff. I'd like to take a half a second and say I really enjoyed reading your report. I was particularly pleased to see the emphasis on reversibility, and I think some of the questions you got had to do with that. And you raise it as a sort of necessary and essential element. So I was really puzzled with the footnote in your report in which you say this discussion of reversibility should not be interpreted as a recommendation for Yucca Mountain. In the few seconds you have left can you talk about the vision of stage-- adaptive staging without reversibility?

MCCOMBIE: No, reversibility, I think that was just part of the general disclaimer. We were very sensitive and correctly so when we were writing that anything we wrote would be interpreted by somebody on some side of the fence as being specifically for Yucca Mountain. So any time we thought we might immediately get pinned down by that, then there was a tendency to put in disclaimers. I think that's really all there is to read into that.

KNOPMAN: Okay, thank you very much, Charles. It was excellent.

Our next speaker is Jeff Williams from the Department of Energy. Jeff is currently Director of the Systems Engineering International Division, Office of Civilian Radioactive Waste Management. He has been with the federal government for 21 years and with the Department of Energy in OCRWM for 16 years. And during those 16 years he has worked on and managed several aspects of the Waste Management Program including environmental assessments and site characterization plans for potential repository sites.

WILLIAMS: That might have been last year's resume. I think it's 23 years or something like that now, but anyway.

Yeah, this is the first time--I've known Charles for a long time. It's the first time I've had the chance to follow him and I don't have any opening jokes, so I don't know that I can live up to his high standards.

I did want to comment on two things that Charles said. First of all was he seemed to indicate that the public discussion with respect to the choice of geologic disposal in this country just appeared. Just want to remind everybody that that was suggested by the USGS in 1957 and it wasn't until 1982 when the Act was passed through much, much public discussion, including an EIS.

And the other one was the no options alternative. And the discussion about geographical equity. I guess what I would like to say is that if we don't have Yucca Mountain we've got the ultimate geographical equity through storage at 131 sites in 39 states. Anyway--

When we go on to the first one, I'd like to just start with, first discussing our recent consultation with the National Research Council. And I don't use that acronym, NRC, to confuse everybody, but it's the National Research Council. Many people refer to them as the National Academy of Sciences, related to repository staging.

In November of 1999, DOE helped to sponsor, along with several other countries, a workshop--maybe many of you attended it--on geologic disposal. As a result of that workshop, in June of 2001, the final report came out, and one of the recommendations among many was that for technical and societal reasons, that geologic repository programs should proceed in a step-wise manner. DOE separately requested advice from the National Research Council on design and operational strategies for repository staging. In our initial letter we suggested that the study may help to shed light on establishing measurements, analysis and criteria for permanent closure to help us guide our performance confirmation program that was set up. The interim report was released, as Charles said, in March and in that report they coined the term "adaptive staging". And then they defined that. The final report is due at the end of the year and it should be more specific to Yucca Mountain, and we look forward to reading that report and reading their conclusions and recommendations.

The objectives of what I would like to do today is basically talk about our modular approach, our modular construction approach and its relation to staging, and then also describe the staging that's already embodied under the current repository program through the federal law, through NRC regulations, DOE requirements.

I'd just like to quickly jump to the conclusion right now, to not hold you in suspense. And basically, this is, I believe, my opinion is that DOE repository program is an adaptive stage program and it's a continually evolving program. And it's an adaptive program. As new information is obtained, we'll continue to improve our designs and our operating concepts.

One other thing that doesn't seem to be given a lot of credit that our program is quite a bit different than Finland and Sweden and so forth in that every year on a yearly basis our program is essentially reviewed by Congress when we get our budget. And we are often directed to do different things. If you remember, in 1996, we got what they called a 250 declining budget, a mark out of the house, which was debated and so forth.

Anyway, and in addition to that we often get authorization bills through Congress, and Congress represents the public, the American people, and speaks for them with the knowledge of input that they receive from the Nuclear Waste Technical Review Board.

The U.S. program is a step-wise program. And I think Margaret described yesterday, as we continue to move forward, we continue to gather science. The real point of this slide--maybe some of it is hard to read, especially the science and technology that's ongoing. But this shows the various steps, and I think Charles pointed out when the law was passed in 1982 we've already had three things that have changed the direction of the program somewhat. We had the Nuclear Waste Policy Amendments Act which changed it a great deal, the Energy Policy Act in 1996, the Viability Assessment was included in the authorization bill. And then we have various steps, moving on, that are defined now, and I think he also pointed out from the 2010 time frame, if we receive a license to receive and possess through 2000, through closure, there have not been any prescribed steps; however, we fully anticipate that things will happen during this time, informed by the science and technology that is ongoing through the process.

This one, again, just shows in more detail some of the steps that are taking place. And the off ramps that can happen. This is in the near term where we are right now, and basically there's many off ramps or opportunities to reverse our process and decisions to be made. And we can consider alternatives as well.

After emplacement begins, Congress could further change our program through our authorization process or also through legislation based on any new information, based on results they get from their constituents, if the country no longer believes that this is the correct concept.

Okay, repository construction concepts. We've mentioned the possibility of constructing a repository in a modular fashion. Basically this is something that could facilitate a staged process, but it's not really required. Constructing in a phased process would enhance our capabilities to begin waste receipt and emplacement in 2010. It will improve our cross schedule and constructability, and it will also enhance our opportunity to learn to implement lessons learned through modular construction. For example, in underground we could construct, after beginning construction, we could put in certain type of ground support and we could learn and change to a different type of ground support. Surface facilities, we could figure out how to handle waste better, we could figure out how to weld better once we had started. The DOE studies that we have done so far are really assessing construction approaches that would facilitate staging, not evaluating staging options.

This is a conceptual approach of how the repository could be constructed in various phases. Really, the only difference in this is that in the current concept of construction is, basically you build what they call the perimeter drift around the whole facility before you begin operations. And there has never been any idea to construct all the drifts necessary to hold 70,000 tons before we begin waste emplacement. There has always been a concept of doing the perimeter drift along with the ventilation to support that, and then the initial drifts that would support initial operations. In this concept we basically just divided it up where we wouldn't--this right here is the exploratory shaft or exploratory tunnel with one module in the initial module which could hold 5,000 to 7,000 tons of waste, and it could be built in a shorter period of time. We could get operational earlier, and we could learn from what we're doing in this one and apply it to the second phase.

It's also possible that in the, in the NAS report they really haven't specified operational concepts, but you could, for example, with certain costs involved, delay beginning the second and third one at a lesser cost than we have in our current concept.

This is the surface design here, basically. And this design or this operational or construction concepts we've basically taken the same function and just shown how they could be built in various phases to facilitate the opening earlier, they could facilitate--what you learn after constructing and beginning to operate facility No. 1 could be applied to No. 2 and to No. 3. And so we basically lay that out.

Just to remind you, Charles just went through this. This is what's in the National Research Council's adaptive staging concept. Basically it's the repository development is divided into stages separated by explicit decision points. It provides opportunity to evaluate and obtain results and to decide whether and how to proceed to the next phase.

Reversibility is an option at each stage. It allows for program implementation, improvement in safety cost schedules, etcetera. The object is to increase repository safety, reduce uncertainties through systematic incremental learning. And that the safety case is at the heart of adaptive staging and the safety case is evaluated and updated at each decision point. And it drives the identification and choices of options.

I went through those rather fast because that is what Charles' presentation was really about.

This is the result of the Council's adaptive staging. And one thing that's very important that I noticed as I was looking through this that's left off of this is the public input in the transparency, which Charles had in bold at the bottom of his. And it was simply a mistake, an oversight here, but that is very important.

One thing that doesn't come out of the National Research Council's report is the operational aspects, the specifics. They don't describe them in specific.

I'd like to just turn to the NRC licensing process and basically state that we believe that this process is a staged process and allows us to proceed in a staged manner the way it's currently written. NRC's regulations embodies the three-stage decision process that is mandated by the Nuclear Waste Policy Act. We talked about this in the past. There's the construction authorization that would occur after the review of the license application. Then following a license amendment in which NRC would be informed by new information, would be granted to receive and possess nuclear waste prior to emplacement. And then finally, through the years and years of learning during emplacement operations and monitoring, there would be an authorization to close and decommission, which is a separate sub-step in the 10 CFR 63 process.

As Charles mentioned, there is no explicit immediate regulatory decision points between the license to receive and possess and close. However, continuous performance confirmation is required. DOE would report any significant deviations from the expected conditions and recommended actions. The retrieval option must be preserved for up to 50 years after initiation of waste emplacement. And a license amendment is needed for any substantial design changes. One specific example, I mean we've talked over and over and over about the drip shields and that this is a very long-term process. The drip shields wouldn't be put on for possibly 100 years, maybe even longer. During that time, through material science maybe there will be a plastic that they sell at Home Depot for $5.50 that we could use that's better and cheaper.

Reversibility--the next slide. You're right, you're right. The 10 CFR 63 process appears to be compatible with staged development. DOE can seek a license to receive and possess once the facilities are needed for initial emplacement are completed. We already plan to begin operations only after a portion of the underground facilities have been constructed. I mentioned that before. There has never been an idea to construct the whole repository with all the drifts to hold the 70,000 tons. And that emplacement of waste would occur simultaneously with construction. The studies that have been done on construction approaches are really looking at ways to reduce our underground construction needed for initial operations. And as I mentioned before, the modular construction is under investigation.

NRC can add at any time, indeed we can commit to, conditions and specifications to the license to require additional check points. Reversibility is a key to the adaptive stage process, as Charles mentioned. And we think that--well, Yucca Mountain is the unique site in relationship to many of the other programs around the world. It's the only site that has an unsaturated zone. None of the other countries have the particular unsaturated zone repository, which was a luxury for this country to be able to pick from those types of geologies.

Part 63, as I mentioned before, requires retrievability up to 50 years after the start of emplacement. The thick unsaturated zone helps us to be able to do that more easily. The license application must include plans for storage of retrieved waste. The Nuclear Waste Policy Act requires retrievability for spent fuel for period specified by DOE. Our own requirements documents, we've gone beyond the NRC requirements and have a requirement that says the design shall allow the repository to remain open for 300 years. And as I said before, the sub-surface conditions facilitate the extended retrievability period. Our current operating concept that we cost out is actually 100 years.

Many people have asked about, this seems to be a phased license approach. Well, I don't think there's any intent to have a phased licensing approach right now. If there were to be modular construction, for example, the way the license would be laid out would be that we would describe the entire system as it would be with all of the modules constructed. We would present the safety case for the full inventory allowed by the regulations, which is right now 70,000 tons. And we would describe the planned sequence for constructing the modules and loading the repository. And we would seek permission to proceed with the described sequence. This is the staged construction approach of a licensed full-scale repository rather than a staged licensing process. This approach does not involve deferring any major decisions until later.

Stages in the decision, the DOE decision process. A modular design and construction approach, these are basically internal things that happen in the DOE project management view. Basically the way it would be set up internally is that prior to construction of one certain module, we would have to go back within DOE and have our whole program reviewed and approved. And OMB and Congress have to approve the funding for constructing new facilities. And there's opportunities to reverse the previous program decisions and directions. Through reversibility we could switch to smaller waste packages, bigger waste packages, different materials if we learn, if it showed an improvement that NRC felt was an improvement.

And as I said before, this is a very key point. This is quite a bit different than the other national programs that are run basically by the industry, SKB, and at Sweden, for example. But the Congress reviews our program annually through the budget process. And the decision-makers will consider results of the repository operation, performance confirmation, and stakeholder inputs in deciding whether to approve the next stage.

As we construct the repository there's also time to review new information. It's inherent in the construction process whether you go slow, whether you build one stage and then wait a while and build another stage. Or whether you do it continuously. Basically, the underground drift construction schedule provides time to review the results of new construction before loading new areas. From the time you start construction to the time you start to emplace waste, it could be as long as a year. Before you put in the ground support, you come back in and you put in the necessary pallets for the waste. And during that time you learn a lot about the geology that you've opened up. The construction of each underground panel would provide an initial learning stage as the main perimeter drift is constructed before emplacement of the drifts begin. This would be true for whether we did it in a phased construction manner or the way it's currently laid out. The construction of each emplacement drift provides additional information before emplacement begins, and we'll evaluate any new information to determine whether changes are warranted.

In concluding, basically I believe that the current regulatory and DOE decision processes are compatible with staged development, and already allow for many of the features that are identified in the National Research Council's report as part of adaptive staging. As I said before, the specifics of what they believe is adaptive staging in terms of concept of operations haven't been laid out yet. The DOE development process, whether it's module or not, is basically a staged process. And we are really looking forward to the final report that will be out in, hopefully, the Fall, to give us further advice on our design and concept of operations.

That's all.

KNOPMAN: Thank you, Jeff. Question from the Board? Don Runnells?

RUNNELLS: Yes. Thank you. That's a very helpful presentation for me to understand the staged approach.

I wanted to ask about your map which is Slide No. 7. Now, that particular layout, is that the layout that would be carried forward into license application?

WILLIAMS: There hasn't been any decision made on that. The current map is the map that's in the EIS, that's in the SR. This is just a potential concept of how a staged repository could potentially be--I mean how you could do that same layout in a phased manner, in a phased construction manner. Okay? So it's not the current concept, but it's a concept where we could construct it in a different manner. Hasn't been adopted yet.

RUNNELLS: Let me ask about the high temperature versus the lower temperature operating modes. Does this tie to that in some way?

WILLIAMS: Well, my understanding is the way this is laid out it's not really tied to it, but my understanding is the way it's laid out is if you needed--for the low temperature operating mode you would need maybe five panels for the high temperature operating mode you may only need three and a half. Probably maybe somebody else here could address that in a little more detail, someone who is doing the underground design. But it's not really tied to that.

RUNNELLS: Okay, but your understanding though is that this would encompass that?

WILLIAMS: Right. Yes.

RUNNELLS: Perhaps in Section 5.

WILLIAMS: Yeah, right. That's my understanding.

KNOPMAN: Would you use the microphone and introduce yourself?

BOARD: My name is Mark Board and I work for Bechtel. And the low temperature mode would encompass the first four panels. The fifth panel is essentially an additional area that could be utilized if needed. And the high temperature mode, as Jeff said, would require the first three panels plus a portion of the fourth one. Yes.

RUNNELLS: Okay, thank you.

KNOPMAN: Alberto.

SAGüÉS: Can you quickly--

KNOPMAN: Alberto, would you use the microphone and--

SAGüÉS: It's my turn for the whole--

KNOPMAN: It's your turn.

SAGüÉS: Okay, thank you. Since you have that in there, please, can you delineate where is the present year phase in there?

WILLIAMS: Well, it's a little bit complicated because they are on a little bit different levels. Maybe Mark can do it better.

SAGüÉS: Yeah, maybe can you use a pointer or something?

WILLIAMS: Yeah, he's got it. I gave it to him.

BOARD: The present ESF facility, is that what you asked?

SAGüÉS: Yes.

BOARD: This is the north portal and this is the south portal here. And so this concept is on exactly the same horizons as the current SR concept. These areas are on the upper primary block horizon. And this is on the horizon of what was termed the lower block in the site recommendation report.

SAGüÉS: And the present--and the footprint of the SR version of the repository would be which one? Number 5?

BOARD: Well, no, it would be right about like this. And then that lower block area would be down in here which is eliminated in this concept.

SAGüÉS: Oh, okay. Thank you. Now, my questions actually has to do with something else. And that is has the project evaluated or is it evaluating the likelihood of the need for a major retrofit sometime during emplacement period. And by that I mean following. Look at the asbestos nightmare and suppose that you are so many years into the project and then something is found. Maybe the waste package design has some newly found weakness whereby people say, gee, this external alloy just doesn't make it. We're going to have to go in and put a cylinder of some material around each one of the 3,000 or 4,000 packages that we have put in place. Has the likelihood of that been evaluated or is it assumed that that is just not going to happen. If it happens it's going to be an unexpected disaster.

WILLIAMS: I think the point I was trying to make is the likelihood of that hasn't really been evaluated in any detail. However, our repository concept could more easily than some other kind of repository concept, facilitate that. We have the requirement for retrievability. We have a longer retrievability period built into our program. We could go back and retrieve rather easily and retrofit, although we haven't developed detailed designs to do that, but the thinking is that this repository concept could facilitate that should something like that occur. Or, for example, if, as they mentioned yesterday, transmutation was decided to be the way to go.

SAGüÉS: Right, but the--what I mean is that would be, for example, a retrofit of the purpose mentioned. It would be a very costly thing

WILLIAMS: Right. Right.

SAGüÉS: Okay, all of a sudden you may be out $10,000,000 to do that. Now, there is no provision for that right now in the present--there is no set-aside by saying look, there is a 30 percent chance that we're going to need a major retrofit so really, we have to consider this as the reality of long-term projects. That's not being considered right now, right?

WILLIAMS: I would say that's not specifically considered; however, I would like to say that what we have to do is we have to redevelop a total system cost for the program and then we do on an annual basis a fee adequacy report to determine whether the money that we receive is adequate to pay for this. And in that we add substantial contingencies and we add contingencies on top of contingencies to determine whether it's adequate. And the current fee adequacy report has substantial monies available for those sorts of things if the current economic conditions prevail that are predicted in the last year.

SAGüÉS: Okay. And finally, at the design level, is there plans to make the design such, for example, supposed to make now something, clearance between drip shield and the top of the waste package? Are the designers considering making the clearance more than what is absolutely needed by present needs? Are those kind of flexibilities being built into the design as well?

WILLIAMS: Yeah. I think that's something that Mark could better address this afternoon when he does his presentation. Is that right, Mark?

BOARD: I'm not going to talk about that.

WILLIAMS: He says he's not going to talk about that. Do you want to answer right now, or try to? Larry. Larry is here. He can probably best address that.

TRAUTNER: Larry Trautner, Repository Design Manager. Yeah, those kind of options are being looked at as part of our value engineering studies, and I will be touching on that just this afternoon. But we are currently doing, performing several different option studies, where we might go in the future for our repository designs, so those kind of things would be considered.

SAGüÉS: Thank you.

KNOPMAN: Norm?

CHRISTENSEN: Christensen, Board. Maybe want you to comment on, again, a kind of a general issue about staging, a little different one than I mentioned in the earlier talk. And that is a sense, and I'll make this as an assertion, that staged processes or evolutionary processes don't necessarily produce optimal solutions. At each decision stage options or decisions are made and future options are constrained, and that's almost a necessary process. I think one of the consequences of that is that innovation is often difficult in that kind of process because of that kind of constraint and your notion about going to Home Depot and finding that remarkable material, or whatever. So I'd like you to comment on a staging, how a staging process could be developed in a way, and you know, I think this footprint is an interesting, maybe, example, that avoids that particular trap. Is you don't find yourself by virtue of the process that you enter into, however well-intended, so constrained downstream that innovation, true innovation is in fact not really possible.

WILLIAMS: Well, again, I'll use Charles' line. That's a very tough question. But, you know, I think the best advantage of the type of repository that we have to allow those sort of things--and it would be costly for any type of change. Well, depending on what the change is. Some changes could be more cost efficient. You know, after we went through and we drilled the first drifts and we figured out a better way to do rock support, that probably won't be one that could be implemented very easily. If, for example, we needed a different type of waste package that required a whole retrofit of the facilities to handle the waste on the ground, you'd have to weigh that as to whether it's more cost effective to implement that new thought or not. So, you know, I don't know how to give you a good answer on that. And maybe I'm not the best one to do that, but--

CHRISTENSEN: Let me just follow with just a comment on that because I think it's really critical to the transparency and acceptability of the staged process. I think, to some extent, it's got to be very clear at the outset what it is that DOE wishes to optimize in this process. And three things are foremost--your performance, confidence and cost. And you talked about the cost issue, but I think that the, you know, these other two issues in the public's mind are going to be paramount.

And I think the other thing is, in outlining the staged process, is in fact a clear road map that deals really explicitly with not just the escape routes which you put onto the thing, but also a map that thinks explicitly about the avoiding these constraints.

WILLIAMS: Yeah, and I think that's--

CHRISTENSEN: I think it has been a concern of the board regarding the issue of design and perhaps that we locked ourselves into a design at an early stage that we've now kind of tried to change at the margins, rather than being able to step back from that design and maybe come up with something that is wholly different, but a decision process that has led us and constrained us in that way.

WILLIAMS: You know, you have to weigh competing interests and you have to weigh the need to move forward with the repository now versus gathering science for 20, 40, 50 more years to reach the optimum design, while at the same time you have other things going on in the nuclear industry that are not optimum. You have people building duel purpose canisters that can't fit into our system because we're not moving forward with those. All sorts of different things like this. I think the science program that Bob Card and Margaret laid out yesterday, I think will help to inform us as we move forward to better optimize in terms of performance. We can be better informed. Let's say, for example, there's uncertainty one--I use neptunium solubility because I think there was some wide variety of that a year or so ago. And we already meet the EPA standards with the design that we've laid out. We can continue science, and if we predict 30 millirums at 400,000 years, if we continue the science and show, well the neptunium solubility is really down here, then we can, with better confidence, say, well, our prediction of 30 millirums at 300,000 years is really two millirums at a million and a half years. I think those are the sort of things that need to be done. But you need to weigh where we are in the program, where the industry is and the country as a whole and whether you move forward now with the knowledge that we have or not.

KNOPMAN: Jerry?

COHON: Thank you. Just for the record, your response to Norm's question and his key point about design I think missed his point. But we don't have to traverse that. I just want to make sure that we're clear about that. Well, not for your benefit, Norm, but for everybody else's.

CHRISTENSEN: Yeah.

COHON: I want to pick up on a point that Norm made earlier in his comments about being clear on what it is we're trying to achieve. I think one of the concerns, one of the things that DOE is going to have to try to resist, is that, once you get a license to construct, the focus of very much of the program will be to build the repository. Your goal that--the mission of the department will be to build the repository. That's not your mission. Your mission is to isolate nuclear waste from the accessible environment.

WILLIAMS: Right.

COHON: So it's, you know, like the buggy whip manufacturer in transportation, forgetting what your real purpose is. That's why I think it's extremely important to have an adaptive management process using the very key characteristics that Charles laid out before, laid out in advance. Otherwise it's very easy to lose sight of that because of the strong push to build the repository, make it cheaper, make it, etcetera. I think that the character- istics that Charles gave us, essential characteristics, are extremely important to look at and very valuable in sort of testing ourselves against what is necessary. One thing I wanted to focus on is the responsiveness requirement. And as Charles talked about that and expanded on it, he said you have to have step sizes or staged sizes small enough where you can actually adjust, but big enough where we're actually learning something useful. And, as he pointed out, 300 years is probably too long as a step size, and that's obvious. Which also means that to say that don't worry about the post-emplacement phase because we're going to have continuous monitoring and performance assessment. That's not--you need more discrete decision points. We're going to do this, we're going to look at that. And then based on what we figure out, we're going to do this or that. And I think, and I know the department has been very resistive of this--I think that has to include clear guidance on when you would remove waste. You know, if we found this we will retrieve. Instead of saying it's retrievable, you got to lay out why you retrieve. Could we go to Slide 14?

WILLIAMS: Just wanted to comment real quickly. I think those are all real good points that you just made, and I think that there just hasn't been quite enough thought about that phase of the program yet.

COHON: The last bullet there. You referred to decision-makers. Who do you have in mind?

WILLIAMS: Well, it's a whole range of decision-makers. But, as I said before, the ultimate decision-maker is Congress as they decide whether to fund us to continue on with our program or not, informed by all the various stakeholders. Not stakeholders, interested public and affected parties. But, you know, they are the ultimate decision-maker and you can look throughout history of all the programs that they've terminated once they've begun as they've provided different direction, and, you know, the country's views have changed. But they are the ultimate decision-makers.

CHRISTENSEN: That being the case I think you're going to have to give a lot of thought to what information it is that you're generating for Congress and what decision you expect them to make. I mean if you think about it right now, they probably know more about Yucca Mountain at this instant than they ever have before and they are ever likely to know, you know, in the next several years. And I don't think they know very much at all. And it's, you know, no fault of theirs. I would blame DOE to some extent for the information they've been given, but it's a very hard thing for them to know. It's very complicated.

WILLIAMS: Right.

COHON: The information one needs to know to make the kinds of decision like, gee, we ought to close this down or retrieve waste or we ought to expand. I'm not very confident about Congress playing that role. So the key is thinking about the information they need. And I don't think you've done that.

WILLIAMS: I think that's why they established your Board, to help them.

KNOPMAN: Jeff, thank you very much. We're going to move on here just so we can have a little bit more of a break than what you see in the schedule, which at least in my version of it has negative five minutes because of the--

BULLEN: I thought that was just an implication that I could start early. I'll be talking during the break, so--

KNOPMAN: Oh. But we all knew that--new information.

Okay, Steve Frishman will provide us now with the State of Nevada views on staged repository development. Steve is a Nuclear Waste Programs Consultant for the State. He has been serving in this role since 1987. He's the Technical Policy Coordinator for the Nevada Agency for Nuclear Projects.

FRISHMAN: After the last talk I have to sort of rethink where we are here, because I didn't think about staging in the way that Jeff just thought about it because I think what he was talking about was a much more of a design options issue than the bigger question of staging that has been out there. And once again, it's a way to piggy-back on the meaning of another word. And I've been watching the concept of staging development mostly in Europe for as long as it has been developing. And there are some very interesting aspects to it, none of which I think are really applicable to the last talk that you heard. The last talk was just, you know, how do you do business once you've decided you're going to do business?

So I think we need to get back to what Charles was talking about and the ideas that are involved in staging with some of the pitfalls, and also I think I need to start out just by saying that if the staged repository program is to be accomplished in any publicly acceptable manner there needs to be a commitment to the process before the process begins. And from this I could probably just end my talk right now by saying as it relates to Yucca Mountain staging, a decision for staging at this point is totally inappropriate because we're too far into a process that nobody bought into except those who perpetrated the process.

So now I guess we can look at the way staging might yet try to be applied to this program. And the first one is one that I got partially into yesterday having to do with the idea of staged or phased licensing. And that would be--well, first, as I said yesterday, it would represent a real philosophical change in the existing regulatory approach, and the departure would result in essentially a pilot or experimental repository development approach that relies on future findings to bolster an initial safety case. And I think I went through that to some extent yesterday.

It's just as likely, though, that the future findings won't bolster the case. But then as is sort of being stepped towards today, one of the concepts that, as Charles pointed out, is deep in the staging is reversibility. So, missing from the reality in this program is reversibility, as I answered that question yesterday and as you have now begun asking, based on things that you've said over the past few months, where is the exit strategy and what is required to trigger it? And there are some realities that go well beyond what we're really all about here, which is safety and the realities would mitigate safety concerns to the extent that maybe safety would actually be sacrificed. And the reason that, with a phased licensing approach, we're concerned about maintaining safety as the, you know, as the actual goal in the whole system because ultimately what you end up with is a safety case, meaning, as I said yesterday, a safety analysis report for regulatory compliance determination would not really be known until the waste has been emplaced in the repository and waste isolation performance would be ultimately whatever the repository system turned out to be capable of providing. So if you go through this phased licensing approach where you don't make the final decision until all the waste is in, what you end up with is a case where necessarily the site creates its own standard. And the site will be whatever it is. And this certainly does not promote the ideals of safety that we put out there at first, which is we want to have some publicly acceptable goal of safety and then a site that is being reviewed, you know, it either meets that goal or it doesn't. And we remember well that we've already been through the sort of round of the Yucca Mountain site making its own standard. And we see that in things that, in the newly revised standards from the EPA, from the NRC, and from DOE. And we see it most dramatically, I think, in the EPA's definition of the boundary of the control area. And what that does is, and in this lawsuit that we filed against EPA just after the rule came out, but in a filing that we made just last week what we did was we attempted to draw what the controlled area might look like. And if you'll remember the constraint is that the boundary of the controlled area or the accessible environment on the outside is five kilometers from the boundary of the emplacement except in the direction of ground water flow where it goes as far south as the latitude definition of the southern boundary of the Nevada Test Site, which is 18 kilometers south of the waste emplacement area. So you end up with something that looks sort of like a big nine. And the extension area is the area that allows for dilution of the waste and allows for major extrafusion and all the rest. So, you know, here we have a case where the site made the standard. And there's no--as we point out in our filing there is no really good rationale for it being a 9 instead of a zero. So, but this is what happens when you do an intentional phased program where you're actually operating with what you find about the site and depending on new things that you find about the site.

So one of the real principles that has to be, I think, held very high on the list of things you think about when you think about phased licensing is that in no event should staged or phased licensing be justified by the expectation that future findings or technological advances will enhance competence in the safety case prior to repository closure. This, I think, has to be the real guiding principle. You can't depend on finding something, as Jeff just was trying to suggest, that we will find better things, and, you know, to me it's not a laughable, it's tragic that he suggested that they might find a plastic that's better than titanium. Really.

All right, so the phased licensing approach, at least in our view, does not promote safety and in fact it's detrimental to safety because it says ultimately you take what you get. The site is going to be what it's going to be. You've loaded it up with the waste and there isn't anything you can do about it at that point because retrievability is probably on the paper but not on the table.

Now, another opportunity for staging would be in the area of staged operations. And then again you're looking, if you think why would we stage operations? Well, the department pretty clearly would stage operations because of the undependability in the cash flow. But if you start thinking about safety reasons for staging operation, that comes back to mostly the question of how do you want to deal with thermal design. And do you want to go through the machinations that are going on right now about hot versus cold, by having to greatly expand the underground area or argue that you don't need to do it and get into the either continual argument that's going to be there about what is your real design basis and what's the rationale for that. But staging operations could be a way of eliminating the question.

You know, if you did as the Netherlands staged repository, or staged disposal program goes, this wouldn't be an issue because Stage 1 of the Netherlands program is stored above ground for 100 years. And if you store it above ground for 100 years, the above boiling repository becomes not an easy option to accomplish, if you could even accomplish it. What you've done is you've let the waste decay for a period of time to where above boiling is not the issue. The issue is back to how does the site perform. And how does the site perform without being artificially disturbed by a thermal pulse. Sure, it will be a little bit warmer, but it doesn't have to be boiling. So if there were decisions about staging for staged operations, then there might be some room to, you know, to have some discussion about what do we--what is the safest way to proceed if we're, you know, if we are predicating all of this on my belief that it isn't going to proceed anyway. But what is the safest way to proceed and a way that, while safety is most important, also has an understandable rationale. And that understandable rationale being that it's safer and easier to deal with 100 year out-of-reactor fuel than it is with 10 or 15 or 20 year out-of-reactor fuel. It's safer to handle, easier to handle, and it's a decision that, were we in an atmosphere that allowed for a real public discussion or debate of elements of staging a repository, this would be one of the things that could be a candidate for that discussion because it represents a real policy decision about how a, you know, a very risky process goes forward. But I don't see any willingness on the part of the department to discuss that at all. They throw out other options and just sort of a means of getting by one of the few places where they have to actually put something out there for the public to talk back to, like an environmental impact statement draft. So they also talked about other things such as maybe a long-term storage facility at the Yucca Mountain Site, holding up to 40,000 tons. It looks an awful lot like PFS that is used in Utah to me. But then they talk about other things for thermal management, for purposes of blending they are talking about building a 5000-ton pool at the surface facility. Well, if you start looking at receipt rates and 5,000 tons, then you have to start thinking, well, how do you get that 5,000 tons in there?

Well, that leads to another idea that has sort of come out and that's de-linking disposal or emplacement from receipt--from the reactors. So you can put lags in there. The ultimate lag was when Congress, fortunately, failed to pass the interim storage bill. That would be the ultimate lag. Get as much as you can in there, but their purpose was not to let it age. Their purpose was to let the idea of a Yucca Mountain repository mature with the regulators. But that would be the ultimate. And you could design other ways, but now if you start thinking about safety, this 5,000-ton pool at the surface facility, to me, has some real safety questions about it.

You know, the seismicity in the area is such that you probably would have a very difficult time, if not impossible time, licensing a reactor there, partly because of seismic risk to the pool. And so now we're talking about maybe the biggest pool in the country sitting in an area that we know is seismically active and the only reason it's really sitting there is because a thermal decision is a hard one to make for the department. It doesn't have to be there or it doesn't have to be that big, it doesn't have to be a storage pool. It can be a transfer pool. If you just made up your mind how much--what level of safety you want to attribute to thermal management.

So I guess what I'm sort of getting to is that, while staging as it is being discussed by Charles and as it is being discussed by other people around the world, doesn't really fit this program because it violated the first premise and that's that nobody bought into it before anything started. But there are other considerations, and they should all be driven by safety first, and then they can be driven by other factors such as logic. So what I'm hoping is that Charles' panel will take a look at the Yucca Mountain project at least similar to the way we are and rather than try to piggy-back on a one-word notion that they have redefined for themselves, that DOE has redefined for themselves, to sort of make it look like they are keeping up with the world. Rather, I would suggest looking at staging with the Yucca Mountain project where, is there anything that can be done that would be a clear obvious benefit to safety if there were some stages involved in DOE's and everyone else's decision. And I agree that

Congress is not going to be any more informed about decisions in the future on Yucca Mountain than they are now. And in fact, they are going to, within a couple hours they are probably going to demonstrate their level of information in the House. So I guess my point is to be talking with you and to Charles about being extremely, extremely cautious in terms of not sort of misunderstanding where the U.S.A. program is and attribute some benefits of staging that might be there if everybody had bought into the idea first and trying to marry them to a program that has already failed in terms of anybody having bought into anything.

So then I guess the final point is that if staging leads to this 100 to 300 years which my guess is is sort of integral to the Department's thinking because they are still, as I said yesterday, trying to escape the disposal decision, if it goes out to 300 years then it is not an improvement in safety. I think you asked the question a couple times what can you learn in 100 to 300 years that has any meaning to really to post-closure safety, because the post-closure repository is not the one that you would be looking at for 100 to 300 years if you keep it open or ventilated. So then the question becomes, well, what does it mean to safety? What it means to safety is that anything you found, once again, essentially becomes the standard. The repository is the standard because we have absolutely no faith or trust that decisions made 300 years from now will be anywhere at all faithful to decisions that were made when the license was issued in the first place. The decisions at that time are going to be whatever the practical decision is and at that point there's essentially no practical decision other than to just close it, regardless of what it is.

So that's my message after being sort of puzzled by Jeff's presentation of staging that is not staging in the language, that at least some of us have been speaking lately. And it's very disturbing to me to see that, once again, just as I pointed out yesterday was safety case. Once again, we now have the Department piggy-backing on a word that they think carries a good connotation, but then writing their own definition of the word.

Thank you.

KNOPMAN: Thank you, Steve. Questions from the Board? Jerry?

COHON: Just a couple of very brief comments. First of all, one's attitude towards DOE's approach to staging certainly is colored by what one believes their intentions are. Now, it strikes me as completely prudent, in fact, I'd be concerned if they were not thinking about technological developments in the future, over decades.

You can interpret that as a hunt for a silver bullet to bail what you think is a flawed program. But I believe that DOE believes that they are proceeding with what is basically a safe repository and they want to make it even safer.

The other point is, the Board is on record as saying that above ground storage is an essential component of a well-managed nuclear waste repository. So if Yucca Mountain proceeds, it most certainly has to have above-ground storage. And I'm not, I didn't quite get your point about that, but I'm not sure that it's important that I do.

FRISHMAN: The reason I mentioned the large above-ground storage is that for the Yucca Mountain Site especially it has vulnerabilities. And just as the waste handling building has vulnerabilities.

KNOPMAN: Dan Bullen?

BULLEN: Bullen, Board. Just a quick question, maybe to differentiate between staged operations versus, or phased licensing versus a staged repository, and I guess I want to harken back to what Jeff Williams showed in that five-panel map that we saw in the last presentation. And I guess I was a little bit surprised by his representation that it was Congress that was going to make the decision at each phase. I thought maybe the regulator would have provided some input or--and they also mentioned stakeholders. Could you comment basically on how you feel input should be provided from the stakeholders like the State in a repository design like that where there are phases or stages that are going to be developed? I know that's predicated on the fact that they are actually building a repository, but I'm trying to ask about how you think you got to have continued input.

FRISHMAN: Well, first of all, unlike anything that we've seen before, it would have to be a proposal that DOE says this is our proposal. Now, what needs to be considered? Not one where next week this is a modification to our proposal and the week after that this is the new modification to the modification to our proposal. They've got to have something that they put out there and they say that this is fixed for six months until we get the review. We're not going to piddle with it, schedule pressures aside. This is what we are proposing. Now what do you think? And in that case, what we would do is we would do a serious design review on it and look at it from all of the aspects that we think are important to look at, but with the expectation that when we provided our comment, it would be seriously reviewed and it would actually have the capability of affecting something. We're tired of reviewing stuff just because they are trying to keep us busy. And we're tired of seeing things change only because we talked about them and they didn't want to have to talk about them any more. So if they are serious, we're in a position where we will be serious, but at this point, you know, we've had literally everything that we've reviewed pulled out from under and replaced, sometimes even before the review is done.

KNOPMAN: Thank you, Steve. Thank you also to Charles McCombie and Jeff Williams for good presentations.

We're going to break now and reconvene at 10:15. That means we've just got 10 minutes here.

BULLEN: Bullen, Board. That means I start speaking at 10:10 then; is that right, Debra?

KNOPMAN: Yes. You--

(Whereupon, a recess was taken.)

BULLEN: I'm going to chair this session and I'd like to point out a couple of things that we have a daunting schedule ahead of us. We have three presentations between now and about a quarter after 12:00. I'll also point out that yesterday the only session that went over time was the one that I chaired. So I think one of the reasons that Jeff Long gave me this stop watch this morning is because of that. Maybe it's also because of the fact that this is the session prior to lunch and I know Jeff has dietary needs, just as we all do.

Today's session is going to change gears a little bit and we're going to talk about repository design. We're actually going to begin with an overview of thermal design that's going to be given by Woody Stroupe and actually, I got the opportunity to look at Woody's little bio here and I didn't realize that he was actually an attorney. So I have to be careful with what I say to Woody from now on. His training is actually in chemical engineering and he has had a long career in the management of nuclear waste at various operations like Lockheed and Yucca Mountain Project.

After Woody talks we're going to have a presentation from Nye County by Parvis Montazer. I first met Parvis in 1997, I think, when we did a repository ventilation workshop that the Nye County people put in and Parvis is going to give us an update on some of the recent development work that they've done.

And our final presentation is going to be by Mark Board. Mark is actually a rocks mechanic and mining engineer by training with 18 years experience. And he is going to give us an update on design from that perspective.

So, let me see, do I have a quorum called? That was with Mr. Hanour (phonetic), Doc Hanour, one, two, three, four, five, six. I have seven. Is that close enough?

So with that I'll ask Woody Stroupe to come up and we'll hear about Thermal Design and Repository. Woody?

STROUPE: First of all, I would like to encourage anyone who did not pick up a copy of the presentation-- It's the only colored one back there--you are going to need this because we have some eye test charts that I guarantee you that nobody in the room will be able to read other than the panel, and they may not be able to read them on the screen. So you definitely need to pick this up when we get to the charts. I want to apologize for those charts because I tried to take those and make those charts, put them in word slides and it just did not convey the message and so I put it in charts and we'll discuss those.

The second thing I want to do is thank the Board. I think the timing of this talk is very good because it follows the staging discussions and I think it fits in very well with the staging discussions and what we mean by a flexible repository and the thermal operating conditions.

One thing I would like everyone to think, I have used sort of a shorthand in saying flexible design. Would you think if I misused that word and say flexible design, what I am really saying is a design which allows flexible operation because that's where we're headed, is looking towards flexible operation.

On the next chart, the outline of the talk is I'll talk about the need for operational flexibility, I'll talk about the design approach that allows flexible operation, the approach to addressing thermal operating conditions, and then of course, just a very brief summary of what I've gone over and what I think the advantages are of proceeding in this manner.

The need for flexible operation, the next slide, please. Flexibility is needed to prepare for several things. One, we have a variable incoming waste stream. It's uncertain as to exactly what we're going to get when. We know what's out there, but when it gets sent to us and how much of it is coming in, that, as of today, is variable. The talk is about selection of the thermal operating load. Lake Barrett, I would like to say, had it exactly correct yesterday in what he said. We were able to get three sort of different issues where we talk about thermal load. The first one is do we need a limit on the surface of the waste package. That's the first one. And if we need that limit, what is it?

The second one is coupled processes and what that results in as a limit that says no boiling at the drift wall. And the third, the higher temperature of all, is one which refers to pre-draining of water through the pillars between the drifts. Free drainage right now is being translated as the 50 percent of the drifts below boiling. We have variability and uncertainty of the natural system processes. We will be doing testing in the lithophysing, we will be doing more thermal conductivity tests for the repository to reduce the uncertainties in those values. Then of course we have the variability in the funding profiles.

A flexible repository design approach. First, the first thing we will fix certain engineering parameters, such as the drift spacing and the drift diameter. We will, of course, finalize the thermal design criteria, and then we have variable operating conditions that actually provide us quite a bit of flexibility. Those conditions are the ventilation duration, the ventilation flow rate, the waste package spacing, the waste package loading, which is very much like waste package spacing. It has the same effect of reducing or increasing the kilowatts per foot of emplaced heat into the mountain. And then the aging the fuel either the varying of the amount we age or varying of quantity we age. And aging the fuel provides two benefits. One is that while it's aged on the surface it's rejecting heat to the atmosphere and that heat is not heating the mountain.

The second thing it does, as the fuel gets older the amount of heat it generates reduces. So when we place it in the mountain it has a less of an impact or less heat load being emplaced into the mountain.

Now, we achieve the repository flexibility by varying these operating parameters.

The approach to addressing our thermal operating conditions. We initially select the operating parameters assuming that the TSPA for license application will analyze the higher temperature repository. It is very important to note that with the flexible operation, this approach does not preclude the cold operating mode by adjusting only the amount of fuel aged, the aging duration and/or the ventilation duration or possibly the rate. While we have this flexibility we gain time so that our subsequent decisions can be well informed by the results of ongoing tests, additional analysis and refinement in the moss models where we find that is necessary.

Okay, to the first eye chart, and if you don't have a copy in front of you, you're in trouble. When I first was asked to look at how do we fit the testing in to what events are occurring in the life of a program, I spent a lot of hours figuring out how do I first understand it and then how do I display it. I had a lot of help in this, so to the point that it clarifies it's probably thanks to the help, as confusing as--and that's my responsibility. But I looked at the events where they could be decision points for making decisions about the thermal operating modes. And if I look, do join me in looking at the decision that we have to make in the left-hand column, we're looking at thermal operating mode where it is hot, cold, somewhere intermediate. The engineering parameters of that I talked about, the drift spacing and diameter, the operating parameters of waste package spacing and when we speak of a specific spacing--thank you. When we speak of a specific spacing, we're talking about an average spacing because it definitely will vary between cold packages and hot packages. The ventilation rate and the ventilation duration and the aging duration and amount are those items that we will vary to the point of meeting the thermal operating mode that we have decided upon.

Across the top row I have identified various events that are going to occur in the life of the program. Of course, starting with the license application, going through receive and possess and going through the timing for closure.

Now, along this line there are also licensing events there, but once we sent the first application I really wanted to look at things that had to do with construction and operating because that's where we start to commit money. When we start construction, when we start operating, that's where the expenditures get much greater. My key here, first of all, the design that I have noted here is a preliminary design. As no one points out, it's subject to change when conceptual studies are complete, as looking at it, 81 meter drift spacing, a five and a half feet diameter drift, about a two meter average waste package spacing, 15 cubic meters per second ventilation flow rate, and again, we would vary the aging and the ventilation to meet the target thermal operating mode that was decided.

The blue areas indicate about those various parameters. Where it is blue you can make a decision, but that decision does not affect construction or operation. If you want to make a decision, if we find out some information that drives us to make a decision one way or the other, you can make a decision, but you don't have to.

Where it's yellow, the decision has to be made because you're going to construct something, you're going to load the fuel, you're going to operate it. So there you have to make a decision because if you don't, when you get to the red point you've made the decision by default. You don't consciously make something and you start to instruct the panels, the emplacement drifts, you evaded the decision by default about where you are.

And then as I looked through here I said, okay, where do we really first have to make a decision, and these two columns possibly could be interchanged, or should be interchanged. But it's receive and possess. When we receive and possess that first fuel we're going to have to decide do we place it on an aging pad or can it go directly into the valve. So we will have to make a decision at that point. And the thermal operating mode that we have selected at that point will help us determine which we have to do. In fact, it will be probably be the key driver. So that's one point.

Now, I have--now to indicate that I have assumed, and even with the hot design we will have to age some fuel. We get some very young, very hot fuel we will probably have to age it. So I think we will have to have some aging anyway. But when we go beyond that initial pad and decide we have to have a larger or need to decide whether it's a larger aging area, then we construct that second pad or the third pad, or the fourth pad, again, we have to make a decision of, if we don't make a decision, we won't make a decision by default.

The emplacement into Panel 1. Panel 1 is the panel which will include our post-closure simulation test. And when we decide how we load that post-closure simulation test, we will decide--we will make the decision. Do we want to have a post-closure simulation where I simulate both hot or cold, do I want to just have one or the other, or both. And if I have both I need to remain flexible. As we move down, each time we start to emplace, again, we make that decision.

Now, there's a keynote here. Note 4 that is on the last column, the timing for closure. As we are loading this repository, we could load it such that it maintains flexibility and by maintain flexibility I am meaning what we do. We would load it so that the ventilation rate is the thing at the end of the ventilation duration or the thing that we can vary at the end and decide whether it's hot or cold. We can load it as such up until the time we turn off ventilation. We still have that option open to us.

Now, if you load it such that it's hot, you put in the fuel, you space it close together. I don't believe we can get a cold operation in a reasonable time frame. And by reasonable time frame I am saying the ventilation would be more than 300 years. So to keep flexibility we've got to load the repository as though it's going to be operating cold and then we can either decide approximately 50 years after the last emplacement that we could shut off the ventilation and operate hot or we could continue to ventilate so that when we do close, shut off the ventilation and it will operate in a cold mode.

If we go to the next chart we'll start to see how this ties into testing. This chart is just a list of the tests that will be ongoing from the drift scale test, which we know is in the cool-down phase right now, down to our long term waste package corrosion test, and our post-closure simulation test.

Let's move on to the next chart. This chart tries to tie the tests together with the time frame I talked about on construction. Across the top of the chart, again, I have the various events that occur as we move through the life of the repository. I tried to use below that some colored bars that show in the time frame where we are in the licensing area before we start construction. The only cost we incur for carrying a flexible design are the costs of tasks that help us decide the flexible design, the operating mode, excuse me--and calls for the analysis we have to run.

Now, actually, I should have extended that green bar out to where it ended with the construction because the design that I have pointed out there that is preliminary where everything is spacing two meters, where the average waste package spacing is two meters, the construction is the same for the low temperature operating mode and a high temperature operating. So there's no difference in the construction costs in those time frames.

And again, the red indicates, as I said earlier, when we start emplacing then we are impacting construction. Staging is the reason it impacts surface construction. So those things are where we really start incurring large costs for deciding between one or the other. But that gives a large time frame, that also in that time frame when we receive waste we make a decision on our post-closure simulation test.

Now, the left-hand column I've shown the tests that I showed on the previous page. The triangles indicate the type of information we will be gathering from each test, whether it has to do with coupled processes, whether it has to do with the waste package environment or waste package corrosion. You can see at about the time of construction authorization we will have additional information relative to coupled processes. Again, it's a time where we can make a decision, but at that time of construction authorization we don't have to make a decision, but if we find out something that would drive us one way or the other, we could make the decision.

Across the bottom of the chart I think is also very important. We have the ongoing waste package corrosion and environmental test that you see that those extend out through closure. And then also starting at the time we receive waste and going through closure, we have the post-closure simulation test, which will be feeding us information on these processes we're interested in. If we find some surprises, if the regulator finds something that it does not like, wants us to change what we're doing, we have the opportunities to do it all during these time frames.

I would also like to repeat what was said earlier. Truly, it is reversible, it's required to be reversible during this time frame so if we would find a significant surprise that said we had to take it out and keep it on the surface for a while and try something else, we have the opportunity to do so as we're gathering the information to provide us data that would either confirm what we are doing or would say we found a surprise and we have to change what we're doing.

The next slide, please. This just tells a little bit more about the tests that we will have. We will receive data from the final cool-down of the drift scale test. We will be conducting the natural convection test to help us understand the environment of the waste package more thoroughly. And then we will be doing the geotechnical testing to the lithophysal rocks. So those are some tests that are going on.

The next page also lists a few tests. Low thermal load testing which is going on right now. We will be looking at our 85-degree threshold on localized corrosion and looking at that as a probability on the temperature range and the waste package environment to give us a better understanding of where that threshold is.

The waste package environment test. Yesterday there was a lot of talk about how important this is. We agree with that, that those tests were ongoing. And then we have the waste package corrosion tests which are long-term and which will carry on through the end of closure.

So we have quite a bit of testing going on. We have a long time frame to gather this information, and this information will give us a lot more confidence in what we're doing. And if we find surprises we have opportunities to reverse decisions.

The summary chart, the repository design allows for flexible operation. This approach preserves the ability to improve both the operation and design as we get new information and new technology. The approach also provides the opportunity to make informed decisions on post-closure thermal conditions at appropriate times during pre-closure operations.

I think this is, it provides the chance for continuous improvement, systematic loading. It helps us reduce uncertainty as we move forward, and we believe that it will help assure that we have a safe repository upon closure.

BULLEN: Thank you very much, Woody. Questions from the Board? Dr. Nelson?

NELSON: Good morning, Woody, how you doing?

STROUPE: Just fine. How are you?

NELSON: Good, thanks. I'd like to ask a question about the decision on low or high temperature operating modes. And in particular, if the HTOM mode were chosen early, would there be any additional work on ventilation or on aging? I mean are they linked to, solely to the decision about operating mode?

STROUPE: First I want to make an assumption about what you mean by work. Would we continue to do some ventilation testing to assure that we understand what happens after closure on the natural convection? And the answer is yes. Those tests are not dependent on whether a licensed application goes in hot or cold. Those tests are planned. In fact, they are under way right now.

On aging, the work there is really do I build the pad or not? You know, how large a pad do I build to age material? We know what aging does. I don't think we have to do any tests on that, so it just becomes a decision point at the time when we start to construct surface facilities.

NELSON: Just one quick follow-up on convection testing and heat removal. Just the ventilation aspects. Are the only tests that are being run both related to natural convection?

STROUPE: We've already run some tests at Losey

Road (phonetic) in forced convection. And the tests that are ongoing right now are the natural convection, and if I get this wrong, Mark Peters will pop up and say, "Woody, you got it wrong." And I don't believe any additional forced ventilation tests are planned at Losey Road.

NELSON: Thank you.

BULLEN: Dr. Knopman?

KNOPMAN: Woody, I appreciate that you're talking about the design flexibility, but you know how much the board loves natural analogs, and to some extent, decision-making process on thermal operating mode is something of a natural analog we have as to the program's ability to alter its course. And I guess it would be interesting to know in the process that you outlined, you show in theory where you could make these kinds of changes if you were going to change the operating mode. We're not even in construction now, or not even in license application now, and there has been, in part, because of the regulatory apparatus, an in-ability to make that change if that were warranted. And I guess this is partly a question for you. It's partly a question for others here from DOE as you're trying to establish that you in fact have this flexibility to make changes as new information is learned. How do you explain what has gone on so far with selection of the operating mode with what you're telling us we'll see in the future in terms of your ability to make changes as new information becomes available?

STROUPE: If I may start back at the VA design. We have come quite a ways from that very hot operating mode to what we now call an operating mode. So the project has shown an ability to change. It's viability assessment, design, we drop down from where it was basically boring a hole in the mountain to the free draining concept. We are continuing to look at thermal couple processes. We are continuing to look at laser package corrosion. And those decision points I believe are theoretical decision points. We have not found a driving reason yet to go to a lower mode. If a driving reason does occur, and I know this is a matter of judgement, but if a driving reason does occur, we have set this up so that we would have to re-start emplacement at the average two meter spacing. We could age the fuel so what we preserve the oxygen to be flexible. We have fifty, maybe 100 years, possibly longer, to decide is there a driver there that would cause us to change. I think one of the speakers yesterday said it's not a slam dunk decision either way. And when we find the information that would drive us to a colder design, if we can find what the project believes is a good reason to do that, we will change when we can change. We don't see that driving reason yet.

KNOPMAN: Would increased confidence be a sufficient driver?

STROUPE: I am not the policy maker. And I think increased confidence is certainly one of the factors that would be considered.

BULLEN: Dr. Sagüés?

CHU: I just want to make a comment.

BULLEN: You have to use the mike. Margaret Chu. Go ahead.

CHU: Well, I thank you very much for the comment. Something that is on my own agenda so I understand how decisions will be made, so I don't have an answer yet, but I hope it will become clearer and clearer for all of us down the road because this is something I will be working on personally. Say when is a decision made, why? Who makes that decision? And then what are the criteria when we make a decision? I will be working on that. Okay, thanks.

BULLEN: Dr. Sagüés?

SAGüÉS: Yeah, I just wanted some clarification on your, if you go to No. 7, you refer to a closed drift thermal test, and then further down there is waste package corrosion and environmental tests. I'm just wondering if that testing would involve like full size or near full size waste packages with an actual closure weld, and all its opportunities for surprises in corrosion behavior of the closure welds which would be evaluated somewhere else. What is--would there be like near, say half-size or full size waste packages placed in the closed drift and someone would intend to evaluate corrosion behavior in the real finished product?

STROUPE: At the cross-drift, the answer, again, Mark or somebody, correct me if I'm wrong--no, we will not be putting full size waste packages in the cross drift. The cross drift test is more near term than we will have a full size waste package to place in it. We will do full size mock-ups and testing on the actual welding processes. Those are being studied right now in Larry Trautner's organization, repository design. Now, remember, the performance confirmation program, which runs for the length of the full length of the emplacement period and the ventilation time thereafter, we will have full size waste packages emplaced in the actual conditions. All the testing it will do during that post-closure period is not yet decided. But those are the types of things that the people who are designing that test, who won't be designing the test will look at. What are the key things that we need to know out of that test to help us make an informed decision on is this repository operating the way we expect it to?

SAGüÉS: And if we go to the next one, to No. 8, when you have the time goals that say that with package corrosion that by that I guess the early triangles, you mean continuation of the tests of the, for example, of the long-term corrosion test with corrosion couples and the like. That's what you mean when you say waste package corrosion, right? You don't mean corrosion of the natural waste package?

STROUPE: And I meant to mention that during the talk. Yeah, we have two things going on here. One, we have the coupon testing, and then also in the post-closure we will have the actual, in the post-closure we will have the simulation, we will have the full size waste packaging simulating the post-closure conditions, and looking at those. So we will have both, but that's exactly right. These early ones are Q Pod (phonetic) testing.

SAGüÉS: So there will be somewhat in between. It would be something approaching a full size package or maybe half size or something like that? Is that the idea?

STROUPE: I do not know the answer to that question. Whether we have any half-size corrosion test on weld material planned or not. And I don't even know if we have looked at that portion of the testing program to make a selection.

SAGüÉS: Okay. Thank you.

BULLEN: Bullen, Board. And then the last question will go to Richard Parizek.

Can we go back to Figure 6, please, first? I'm actually intrigued by a number of things here and maybe you can clarify stuff. I realize that this wasn't meant to be all-inclusive, but you go from blue to red to blue. And I'm assuming that's just because it's red for that panel only as opposed to being red for, you know, the emplacement Panel 1, basically engineered parameters are done because you built it.

STROUPE: Exactly.

BULLEN: Okay. So that explains it.

Now, I wanted to come back to your item, Footnote 4, which says that physically loading hot precludes reasonable cold operations. I understand that completely. But by that you mean physically loading it to, say a 10-centimeter spacing, which was the TSPA-SR base case, and LTOM base cases?

STROUPE: That is one way to get to a hot design. I'm sure we could find others, but that is one way, is to load them to not age as much and then loading them close together would get you to a hotter design.

BULLEN: But the current plan is now to go two meters? Is that--that's what I'm looking at here is the grade panel in license application is going to be a two-meter panel?

STROUPE: I don't have--I can't make it bold and I can't make it large letters. Please, that word is "preliminary."

BULLEN: Okay, that's fine.

STROUPE: And the design is being studied right now to determine if there are ways, if there are things we can do to improve it as we move to LA. But until those conceptual design studies are complete, this is a preliminary design.

BULLEN: Great. Now, that actually leads me to the other question because we saw the nice five panel layout and I understand that for FEIS and license application and all sorts of things, you have that panel that you're going to say, well this is what the whole footprint looks like. But you fixed the drift spacing and drift diameter both. And yet there are blue boxes that say you may be able to reevaluate that. Is there a possibility that between Panel 1 and Panel 2 and Panel 3 that drift spacing may change from 81 meters to something less or something more based on what you find out?

STROUPE: Well, yes. It certainly is possible. Now, the reason the 5-1/2 meter space which has been looked at recently in some conceptual studies and I believe the results of those studies said simply to fit everything in to replace the waste package, to replace the drift shields, you've got to stay about 5-1/2 meters. The 81 meters I believe that stayed the same because there's not much of a driver to move it either way. You can gauge some, but if you move it closer together your waste packages are going to get hotter, so we really don't want to move it closer together. You could move it further apart. The waste package, for to give it spacing, would get a little cooler. Not a big driver, but it is something that could change if we determined there was a driver.

BULLEN: Thank you. Now, can we go to Figure 8, please? I'd like to compliment you on the fact that you finally laid out all the experiments and you tell us where the data is going to come, and you tell us how it might be impacted or it might have the effect of impacting the schedule or the design. I guess the key question, and maybe you're not the right person to ask this, is how do you tie the results of the experiment back into the design process and the operating mode and all the decision-making that's going to be necessary. And if you want to dodge that one you can say you're right, that's something that we ought to consider, but I want to compliment you first on laying this out because I think it's great. But I guess I want to sort of ask for the next step, which is, okay, how am I going to use the results?

STROUPE: Well, I'll choose the waste package corrosion because, although I'm not a corrosion engineer, at least I'm an engineer. And I'm not a scientist, okay, so I can't comment on what we find in coupled process. But if we would find that the passive film would not perform as we expected, then clearly, there would be a pause in the program and we would have to say, "Now what do we do"? If it's affected temperature, then we could go to a lower temperature. If it's some other effect that we didn't expect, we would have to make the changes. But anything we find along there we see these right now as tests that will confirm our design because we think we have a good design. But they are also there to test that design and find out, well, did we miss something? And so if we find a surprise, we find something we don't expect, then that will very quickly feed back into the program and we will be working with the NRC to say, okay, what do we do now to correct this problem to give us a safe repository to continue on with the design and licensing of the repository.

BULLEN: Last question for me, and that deals with the post-closure test simulation that you have. Is the plan to put in, I mean fully loaded waste packages I understand, but is there an effort to put in a de-rated waste package and they have lower power output to look like a thousand-year-old waste package, or potentially a degraded waste package with maybe a thinner wall that would say, you know, we want to look at the corrosion characteristics or something that may have thinned by half of the wall thickness?

STROUPE: Okay, I will now take off my project hat and put on my personal hat.

BULLEN: Okay. The Woody Stroupe opinion is?

STROUPE: This is the Woody Stroupe opinion. But if we're going to simulate post-closure, we cannot put in fully loaded hot waste packages because that would then not simulate the closure at the time that it's closed. So we're going to have to find a compromise between how do we simulate that postclosure condition to be a lower waste package, a power, a waste package power that's 100 years, 50 years from now. We will also have to find a compromise of how long do we ventilate to simulate the dry-out period of the drift? And those are the things that our scientists, that our engineers are going to have sit down and say our objective of these tests are to determine the following dozen things and how do we best do that? And I know there will have to be some compromises. But I think one of those we very definitely will have to use de-rated waste packages, we'll have to use a very low power fuel or somehow to simulate the corrosion conditions.

BULLEN: Thank you. The Dan Bullen opinion is that he hopes that the project listens to the Woody Stroupe opinion. Last question from Richard Parizek.

PARIZEK: Parizek, Board. With regard to both Figures 6 and 8, you show more or less an orderly progression from left to right on assumption everything proceeds in an orderly manner, but you do show you could make adjustments in case you find something from the testing that justifies adjustments. What I don't notice here is the loop on the decision to retrieve. Suppose the decision is that we do need to retrieve, and going to Jeff Williams' slide 12, he says, you know, LA must include plans for storage and retrievable material up to the full amount that has been emplaced which might be close to the day when the last shoe packages are going on. Is that part of your responsibility to think about where you'd go with these wastes? I mean to pull it all back out where would you put it? And is that part of this thought process, the loop to have to retrieve? You've done adjustments, but now all of a sudden decision is made, retrieve. Who does that?

STROUPE: The law requires that the project make sure we have a design for retrieval and make sure that we have emplacing to put the waste if we have to retrieve it. Again, I'll put on my Woody Stroupe hat and not my project hat. Obviously, if we're going to pull this out, it's going to take us a while to pull it out, so we won't have to have the entire retrieval storage area available on the day 1 of when we would start pulling out, so you can construct that or most of that as you'd need it. If we do have some aging pads, those could remain there to be reused if we had to put it out. But out of this time frame, the post-closure simulation test is really to look at, is the repository, is that test telling us that the repository is going to operate the way we believe. If we find a surprise there, depending on the size of that surprise, it's either going back to the NRC with a re-analysis or if the surprise was big enough it would be retrieval, pulling it out and rethinking. And that wouldn't go into a pool. Steve Frishman talks about this huge pool. This should be maybe that pool plus dry cast storage on site or--out of this time frame that fuel is--it's going to be very close to 100 years old, so--

PARIZEK: It's cool, so it just--

STROUPE: It's just stored in the desert. It's relatively cool, so--a whole lot cooler than it was when it came out of the reactor. It could be stored in dry storage, easily.

BULLEN: Thank you, Woody. In the interests of time we're going to have to move on. We appreciate your candor and your talk to day.

Our next speaker is from Nye County, talking about the Nye County Ventilated Repository Concept. It's

Dr. Parvis Montazer, and I note that in this great pile of paper that he gave us, he gave us a nice report, and an entire volume of slides. I'm hoping that he will keep to his 25-minute time limit. And I'll start the clock anew here and hope he can get through his 37 slides in 25 minutes, okay? Parvis, it's all yours.

MONTAZER: Thank you. And can everyone hear me?

BULLEN: Put that on your tie, will you?

MONTAZER: Can you hear me now? Better?

BULLEN: Yeah.

MONTAZER: All right, it's a pleasure to address the Board on Nye County's part, and this is an important aspect of the potential repository at Yucca Mountain. As the Board is aware, this subject has been close to the heart of Nye County, whose prime goal is the safety of its residents. I greatly appreciate the support of Nye County, especially Dr. Dale Hammermeister who has made significant suggestions for improvement in this regard. Also, I would like to acknowledge Dr. John Walton who is in the audience, who has provided many useful suggestions and comments.

It is also important to note that the Department of Energy's support and receptiveness of new concepts and ideas in this regard has been appreciated. DOE recently invited Nye County to present this concept. We received many useful suggestions and appreciate the opportunity to to share these thoughts with the Department of Energy and its contractors.

Dr. John Bredehoeft of Inyo County has been instrumental in providing critical reviews of the concepts and modeling results. Most significant for me, his encouragement and support has been extremely valuable.

The purpose of this presentation are to briefly describe the objectives of the conceptual design, assumptions used to arrive at the preliminary design, and major features of the design. In support of the feasibility of the design, numerical analyses have been conducted and a summary of the results will be presented. Also, a brief description of the activities undertaken to prove the analytical tools will be presented. Nye County recognizes that more work is needed to address many questions that are still unanswered. Therefore, future modeling are planned to provide answers to some of these important questions. Nye County also recognizes that without in-situ and experimental data, the results of the analysis will remain questionable. Suggestions for some in-situ testing will be presented. Backup slides provide more information. And we've provided copies of a preliminary report that was released in February for your information, and additional copies, of course, can be obtained from Nye County.

Early recognition of the benefits of keeping the repository cool and dry using natural ventilation has significant impacts on the direction of site characterization, overall design of the repository, and ultimately the safety of the potential repository. Nye County has proposed natural ventilation design in several occasions from 1996 to 1998. In the past few months, Nye County has been studying a new concept that is expected to offer the advantages of the original naturally ventilated repository, as well as a securely closed repository. The objectives of this are listed in this slide.

We evaluated numerous configurations of the waste emplacement boreholes, ventilation drifts in heat loading scenarios. I will be abbreviating waste emplacement boreholes in many of my slides as well.

The most favorable results that were obtained with two waste emplacement boreholes between ventilation drifts and assuming that the heat load is removed by ventilation during the first 250 years. This configuration is referred to as Configuration B as shown in this slide. It's really a depiction of a typical arrangement of ventilation drifts and waste emplacement are shown here. In this we have two ventilation drifts and in between there are two waste emplacement boreholes that are shown in red. And this is just one of the many configurations that we have tested. The diameter of the waste emplacement boreholes is preliminary, just, this is--just for conservatism. A hybrid design in which ventilation air is allowed to flow through the waste emplacement boreholes may potentially improve the performance of the repository, but has not been analyzed yet and will not be discussed in this presentation.

This slide shows a conceptual arrangement of all the proposed 97,000 MTU placed in 60 waste emplacement boreholes. Each waste emplacement borehole is 2000 meters long. This configuration provides about 50 percent of heat loading. The weight we have is by one canister and the one gap as it's shown in this enlarged view. This configuration occupies about 445 acres

This is a portion of the east-west cross section of Yucca Mountain on the western part. Some details of the construction of the chimney is shown. We just received some comments from Jim Blink of Livermore who suggested an auxiliary shaft may be a better idea, and we put that in there just recently. We realize that we have not considered many details; however, at this point our main goal is to verify and validate that this concept can help remove heat and moisture substantially enough to justify further detailed study of other components. Therefore, please remember that many of the intricate details are just thought models, I call them, and need many analyses to support, reject or modify them. On the average, the chimney will allow a differential elevation of 1,000 meters--I'm going to show in the next slide more details of this--an overall view. This is a cartoon of the whole cross section of the Yucca Mountain. Basically it is intended that the air enter somewhere in the broken part of the Tiva Canyon (phonetic) and this does not have to be exposed and it makes through a certain series of ventilation drifts that come through the repository area. And these gray lines, the cylinders, they are the ventilation drifts, and in between them they are going to be the waste emplacement boreholes. And then the hot air basically goes up because its density reduces by the heat and makes its way to the chimneys and out, and this we believe is going to provide a considerable amount of flow and cooling, as I will discuss in the following.

Today I will not be talking about several components like the drainage system and the chimney so I'll just focus on the repository area. And once we have gotten a better understanding we can continue on other aspects of the system.

In this section I will describe some of the simulations that I have made in support of the conceptual design. We first used the original A-TOUGH2 to, one, conduct a preliminary evaluation of several permanently ventilated repository configurations. I'll be referring to it as PVR. We model a two-dimensional slice through the waste emplacement boreholes and ventilation drifts, and a standard preliminary estimate of potential cooling that can be attained.

Here is a simple course mesh used in Phase 1 Configuration B analysis. The inset in the lower right shows where the cross section is. I'm not sure if you can see it in back of the room. The mesh is two meters thick in the east-west direction to the plane of the slide. Only one third of the waste emplacement boreholes are simulated in this particular case. I only have 20 waste emplacement boreholes in this case. There are 20, and 11 ventilation drifts for this configuration. The ventilation drift elements are practically set to constant temperature, pressure, and relative humidity. The transfer of moisture and heat between the rock and ventilation elements are simulated by constant eddy mass and eddy thermal diffusivities. Back-up slides provide some more detailed description of what these parameters are. Only from the top of PTN to the upper 45 meters of the Calico Hills is simulated here. A percolation of 10.1 millimeter per year specified by the Yucca Mountain project as a maximum was used in this case.

This just shows the heat loading history for this particular application. As you can see, we've assumed that the first 200 years or 250 years, the ventilation cools the system, and after about 250 years have used the decay curb provided by the Yucca Mountain project, the DOE project, and applied that indefinitely. That's a conservative assumption. And we've used that basically for simplification of the assumption. It's not a limitation of what we can do.

Here are the results and after the 527 years I'm showing in 725 years, you can see that the temperature maximum is about 55 degrees in this case.

Here, this slide shows variation of temperature along selected profiles. Profile No. 1 goes through the ventilation drift, and No. 2 through a heater, and No. 3 through--somewhere in the middle. The main thing is that the geothermal gradient changes substantially and you can see that as we go inside the array, the temperatures get hotter.

In conclusion of Phase 1 study, the assumption of the no heat load during the first 250 years is very important. Substantial cooling is calculated as a result of the presence of the ventilation drifts. It appears that by applying 50 percent of the heat load the host rock may be kept below 60 degrees centigrade. The Configuration B only requires about 445 acres of footprint area.

In the original A-TOUGH2, the eddy mass and thermal diffusivities were input parameters. A-TOUGH2 was revised to enable internal calculation of eddy diffusivity from velocity profiles. In order to compare the results with the original A-TOUGH2, some simulations were repeated. A wider mesh was used to incorporate all the 60 waste emplacement boreholes. And some finer meshes were used to understand the near-field conditions.

Here is the mesh that has all the 60 boreholes. I have spaced them purposely to incorporate some gaps to see if there's any temperature benefits from that. And the next--basically it's equivalent in size and everything to the previous mesh. It's just the results have been used, and we use the same exact temperature history or heat loading history and results are shown in this slide. And as we can see, basically, the results are almost identical to the Phase 1, with the original A-TOUGH simulation.

Here is the 2000 years and we can see that there's a little bit of increase in the temperature, in this case, getting ground water warmed up near the saturated zone getting warmed up.

In conclusion, Phase 2 modeling with revised A-TOUGH2 provides results very similar to the Phase 1 study. As part of the testing capabilities of the revised

A-TOUGH2 and to answer some of the questions raised, additional experimental simulations were conducted. One of these questions were related to the potential for cooling effect of direct ventilation of the waste emplacement boreholes during the first 250 or 300 years. For this case the near-field environment had to be discretized more finally so that the temperature and humidity variations could be examined. Numerous cases were tested. I will only discuss the following two cases. A two dimensional case with detailed mesh and rock properties, and a simple three-dimensional case.

First, the two-dimensional detailed mesh case. This mesh is 15 elements wide and 75 elements deep. Element dimensions vary from .1 to 2 meters. The area of flow used for the drift was equivalent to a 5.5 meter diameter drift in this case. In this particular case, full heat loading was used. That is, there's no gap assumed in between the canisters.

On the left-hand side of this slide the simplified depiction of the mesh is shown. The actual mesh is too complicated to show for presentation. On the right-hand side the graph of the temperature variation is shown. This square with the circle inside basically represents the stimulation area here. And I'm showing the temperatures in the rock at the top and the bottom, as you can see in this slide. What basically shows is that there's a significant cooling over the 300 years like this, this scheme.

I'm going to skip this slide--basically shows similar results.

In conclusion, a significant cooling is achieved during operation of the repository if one can supply at least one meter per second of ventilation air, either through the open or retrofilled drifts. In this case I have used an open drift. Therefore, in our Phase 1 and Phase 2 dimensional--the two-dimensional simulation cases the assumption of no heat load during the first 250 years seem to be justified, at least from a modeling perspective.

So far, I have been talking about two-dimensional results. When a slice is used a cumulative effect of heat buildup down the drifts is not considered and lower temperatures are calculated. We have examined what happens along the length of the drift in the near-field environment. I should note that we realize that this data need to be validated and verified by actual in-situ observations. A simple mesh like the one I'm going to use can be very useful in these kind of validations/ verifications. Also, I've only analyzed a 5.5 and a 8.5 meter diameter drift. This mesh can serve to accommodate simulations of various size drifts in the future.

The mesh has 10 by 10 elements. The bizarre dimension of 1.88 meter happens to conveniently provide an almost exact area of an 8.5 meter diameter drift when 16 such elements are fit into a square. Again, full heating loading was considered in this case. No gap between the canisters.

Let's look at the mesh in a three-dimensional depiction as shown in this slide. The pink squares represent the drift area. There are two red prisms if you view this 3-D, of basically the canisters. And the rock here is just Topopah Springs Welded Unit properties.

Here are the results. The average relative humidity variation with time for all elements in the drift is shown in the graph above. This humidity over time. And down here we have the canister surface temperature, .9 meters into the wall. It happens to fall right on the drift. There's about, less than a degree difference between .9 and drift in this particular case.

These charts are a different way of looking at the simulation data. In this slide, variation of temperature and relative humidity are plotted along the length of the drift. Each point represents the average of the parameters of all the elements in one cross section. Please ignore the beginning and end of the--the end points which are controlled by the boundary. Against, as the temperature rises relative humidity increases and as it cools the relative humidity tends to approach that of the air stream.

The results of the Phase II simple 3-D simulation corroborates those of the detailed mesh results. That is there is significant cooling achieved during the first 300 years. Also, this cooling occurs throughout the entire 600 meter length of the simulated drift. However, we're not certain whether the temperature along the 2000 meter length of the waste emplacement boreholes in Configuration B can be kept below a reasonable threshold. Currently simulations are under way to answer these questions at least by numerical experimentation.

There are other questions that need to be examined such as the sensitivity of the results of the size of the grid and can natural ventilation really create air flow rates that are assumed in these simulations? Future Phase III modeling is planned to attempt to provide some insight into these questions. Nye County recognizes the fact that numerical models only provide educated guesses and need to be validated and verified with experimental data. These data need to be obtained from in-situ experiments.

Three-dimensional modeling of the configuration B is needed to improve our understanding of the full scale repository heat loading. Nye County has collected a substantial amount of data from ESF and ECRB in previous ventilation experiments. Those data and what is available from Yucca Mountain Projects should be analyzed and compared with the results of simulations to increase our confidence in the simulation results. However, only data from ambient temperatures are available at this time.

Higher temperature data are required to fully characterize parameters needed for modeling. In this slide some of the most important parameters as far as ventilated drifts are concerned are listed. The momentum flux determines the eddy thermal and mass diffusivities. In rubble-filled drifts, if the are proved to be practical, turbulent flow characteristics and permeability and porosity variations are essential in any long-term predictions.

Nye County has proposed a series of tests and data collection activities to be conducted in conjunction with Alcove 5 heater tests. Nye County also has some preliminary plans to conduct low temperature experiments in some readily accessible locations to be determined within the ESF and ECRB complex.

In summary, the realism of the permanently ventilated repository modeling results can only be validated by in-situ data collected somewhere in the repository horizon. If we have such a great option, does it save significant amount of money? Nye County is in the process of developing a cost estimate for some preliminary options.

I would like to end this presentation with an introduction to the backup slides which are organized according to the listed subjects. I would be glad to go over these topics during this meeting formally or informally or in another time and place, as appropriate.

Thank you very much for your attention and I will entertain any questions you might have.

BULLEN: Thank you, Parvis. That was perfect timing. You did a great job in getting through a lot of information and we appreciate it. I think maybe in a previous life you were a professor, right, because a professor just talks faster. They don't have to worry about whether or not they get it all in in time or not.

Dr. Sagüés is going to start, and any other questions from Board members?

SAGüÉS: Maybe you can clarify things for me and the other Board members. You are addressing the permanent ventilation as opposed to the concept of a passive ventilation based on natural convection and the like.

MONTAZER: Yes, sir.

SAGüÉS: There is a couple of things that we don't understand. If that is the case what is the meaning of that transparency that you have where you show what appears to be a transition from--in ventilation mode. That's 17 I believe is the one. What happens at 200 years?

MONTAZER: Okay, this is for simulation convenience. Here actually this, at 200 years I have linerally wrapped this up for convergence.

SAGüÉS: For what?

MONTAZER: For convergence. It makes the model converge easier. There's really no real meaning to this from 200 to 250 years. There's no physical attachment to that.

SAGüÉS: Okay, so this is some sort of a computation, a test of your procedures?

MONTAZER: This is my decision as an input. I can do it as close to 250. I have to input these incrementally.

SAGüÉS: Okay, but isn't it like--does it represent--when do the packages go into repository? At what time in that scale?

MONTAZER: At time zero.

SAGüÉS: At time zero? So--

MONTAZER: During this time--

SAGüÉS: Yes.

MONTAZER: --the repository is ventilated any which way possible. That is the canisters are being kept cool.

SAGüÉS: By some kind of a forced ventilation?

MONTAZER: Either forced or natural, whatever way the project determines that it's workable. It's after this point that the effect of the rubble-filled drifts come into play.

SAGüÉS: Okay, so you fill the drifts with rubble at year 200? Is that right?

MONTAZER: They can be--okay, can we go back to 7, No. 7? This portion of it can be filled at any time. Actually this portion of it can be constructed by rubbleized mining techniques initially. They don't have to spend too much money on fancying this up. But this part is going to have to be open at least during part that they are going to do the emplacement. So some sort of ventilation system is going to be operating while they are operating. Whether they can piggy-back on natural and forced, that's something that the engineer is going to have to decide. And again, this part of it also can be constructed and filled in almost at the very beginning. After the closure, and we haven't really come up with what is the best time for closure. There are other alternatives that we have looked at. The optimum one with the lowest temperature is the one I just presented. There are many, many, many options we've looked at. We can close it at 50, we can close it at 100. We've looked at different times that we close and let the natural ventilation take over. And the bottom line is that--can we go to 12?

And there is no magic in this simulation. You can calculate, you can do these calculations by analytical thermoconduction. And the basic thing is that these blue spots, those are the ventilation spots. They are going to keep the temperature down. Basically we're providing a boundary condition.

SAGüÉS: Okay. I don't want to--but let me just tell you what I think it is and then we can--I think that we are talking is a repository that is open to the outside air by some means for a couple hundred years, and then you close that and there is some kind of internal circulation of air, no? Okay, well in that case, what are you leaving open to the air?

MONTAZER: Continually open to the air. Okay, that will get--

BULLEN: Bullen, Board. Actually, the current way we talked about previously was just his way to deal with the step function. So all he did was, he had another heat input that he had to add. Dr. Craig, next?

CRAIG: Paul Craig. Parvis, you've been talking about this kind of concept for some while and now you're getting into the kind of calculations that are needed so you're really making a lot of progress. Yesterday, Margaret Chu talked about thinking outside of the box. Not my favorite terminology, but everybody uses it so I will, too. And she did. And this is an example of that kind of thing. There's a timing issue. DOE is coming up on a license application. If this concept is going to make a difference, time is running out, and I'd like you to talk about your interactions with DOE and the kind of process that you think might be necessary if your ideas really are going to affect what actually gets built.

MONTAZER: We are constantly communicating with the Department of Energy as far as what we think and as soon as we feel comfortable about presenting--and it's usually me who is holding things back because I don't feel comfortable exposing some of the calculations that I'm not comfortable with. But Nye County is very open, has been open. And DOE has been showing interest, as you have seen, over the past, since 1995/96. And it's very, in thinking out of the box has been very useful from my perspective to the project because I think DOE has been at least taking Nye County seriously in looking at the changes, etcetera. We cannot do--Nye County, we cannot really figure out what Department of Energy is going to put in the licensing. The main thing that we're going to be able to do is we say, okay, we have these ideas and it looks good, but then DOE has to go and put it in their whole big picture because there are so many different things to look at. And they come out--we don't have the resources to, and it's not really Nye County's position to do so. We just come up with an idea and DOE takes it and runs with it, and it has been working fine I think.

BULLEN: Dr. Parizek, a quick question and then a quick question by Nelson gets the last one.

PARIZEK: Parizek, Board. A board member is shaking his head. You opened the door downstairs, you heat the house, you open a window upstairs and the house ventilates itself. That's sort of what this mountain would do by this mechanism, to give you an analogy. What I'm interested in is not the fact that you get rid of the heat. It's the water that goes with the heat and the fact that then keeps that mountain dry and there should be no free water dripping anywhere so you get rid of the water, the corrosion goes away, and we're happy. And so you might then save big bucks in terms of getting rid of some of the drip shields and other things by this technique, right?

MONTAZER: That's exactly--

PARIZEK: Well, okay, so the moisture has got to keep going out whether you put rubble in doorways or not. That's another matter. But the heat keeps going out, the air keeps going out, the moisture keeps going out, the thing is self-perpetuating. Then it gets cold and then the pluvials come and it's raining and then the humidity goes up in the desert and now you're bringing in more moist air than what you started with when you did this in 2010, or whatever. Wouldn't there be moisture condensing in the repository? Have you thought about the reverse problem, bringing in humidity and then wish to hell you had shut the door after all?

MONTAZER: Actually, John Walton beat me up by a lot just not too long ago, and--thanks, John. We, not as part of this, but that part of it is not complete, but in previous more simplified calculations that I did several years ago, I did some calculations and I think I presented it to the Board. However long it takes for us to do the ventilation, it takes twice as long for the moisture to return to its previous condition. That is to its ambient condition, pre-heated condition. That is if I dry--and in my older calculation if I just had one ventilated drift, I could dry about a 50-meter radius away. And it would take, and it took, like if it took 1,000 years for that 50-meter radius to dry then it's bone dry. Those calculations it shows that we go to single phase based on the model. Model predicts that if about 50 meters away from that hole goes into a single phase. And when things go back to the normal, what happens is that the potential difference is not the way, and is not as strong as when you dry it. The potential gradient is much, much smaller so it takes much longer for the water to come back. What I'm getting at is moisture comes in, it comes through the rubble-filled drifts, humidity comes through rubble-filled drifts. It's going to take it a long time to get to the canisters, even though they are 10 meters away. It's going to take hundreds if not thousands of years for it to get the rock back to 80 percent saturation that it is now.

PARIZEK: Yeah, but the other point is just more humid air coming in contact with say a cool waste package and then it condenses right on the spot and bypasses the need to resaturate or remoisten the rock mass.

MONTAZER: In this design there's no--well, I shouldn't say no, but there's no direct contact of the air with the waste package. The waste package is isolated in the rock.

PARIZEK: Okay, so that was your 2.5 meter drill hole. And I didn't quite know whether you were going to bore them and just stuff the packages in there, or are these really emplacement drifts with rails? Are you just poking them in there?

MONTAZER: Can we--

PARIZEK: That's Slide No. 2.

MONTAZER: No, the better one is Slide No. 45, please. It's a backup slide. This is conceptually, basically you drill a hole 2.5 meter diameter, you case it with appropriate material, and you can slide the waste packages into the hole. When you're ready to close it, you cap it, actually in the report we refer to filling this casing with a natural gas, basically to totally dry the system. That will buy some time. We don't know how long. If you seal this completely and then we have a heat sink, this then is going to be exposed in one of the ventilation drifts. Removing at least some heat in the axial direction. We believe this helps, but we're not taking any credit. We haven't done any calculations on this. But the ventilation drift is somewhere out in here. It is going to--the moisture that comes through the rubble is going to come through here and it's going to require to saturate this before it gets to the waste package.

PARIZEK: The air does not see that yellow casing? That's C-22 or titanium or just old junky iron?

MONTAZER: Leave that to DOE, but--

PARIZEK: No specialty.

BULLEN: I'll cut Mr. Parizek off and ask for Dr. Nelson. You have a quick question? Just one short one.

NELSON: This is just a yes or no question. Nelson, Board. One, suppose these boreholes, WEB emplacement boreholes collapse at various places. Does that stop effective heating for your model? And the second part is, you recommend some testing or some properties being needed. Are those properties not produced by the project now? Or are they unusual properties needed for your model only?

MONTAZER: They are standard. Okay, can this be answered, the last one first. The properties are standard properties that's been in use for decades. It's not my invention.

NELSON: So have you--can you get those properties from the project or are they not being produced by the project?

MONTAZER: No, the project is not producing presently. We have produced some as part of our testing, but project is not currently producing those. But they are using an equivalent corfice which we believe is very conservative in the sense of what I'm calculating is 10 times more efficient--I'm sorry, five times more efficient than the heat transfer corfice than the project is assuming. And we see a lot of differences in the predictions and we are--we have talked to--we've made two presentations recently. One of them was specifically about the testing program that we proposed. And it's in the backup slides. I can show briefly, but I don't want to take time. I want to answer your other question.

As far as the collapsing of the borehole, the collapsing of the borehole does not affect the temperature.

It does effect the--how this borehole is basically isolated by the rock from the ventilation system. If any collapse or anything happens here as far as heat removal, there's not much that is going to be affected. Of course, if this casing collapses and becomes exposed earlier then there's--when and if the moisture gets there, then there's earlier corrosion, etcetera, going to start.

BULLEN: Thank you, Parvis. We really appreciate it and appreciate the Board's patience in letting us go a little bit longer. --Geotechnical considerations of the repository design. And I want to point out to the audience that we're going to have one public comment prior to lunch. Those of you who were here yesterday know that Dr. George Danko from the University of Nevada, Reno, asked for a comment today and we're going to allow him five minutes. And so that will be right before the lunch break.

Mark, you're on.

BOARD: Thank you. Well, I'm going to talk to you today about the status of the geotechnical considerations of the repository design.

The outline of the talk that I'd like to give is in three areas. First I'd like to go over the issues that are currently outstanding for our license application in the geotechnical area. I'd like to talk about our strategy for resolution of these issues, and I'll work in our current work effort. We have quite a substantial amount of work that's currently ongoing, and give you a summary.

I've tried to boil down the issues that are outstanding in the geotechnical area into three primary areas here that I've listed. And the first area is in the thermomechanical properties of lithophysal rocks. As most of you are aware, about 80 percent of the repository layout is in the lower lithophysal zone. And about 20 percent is in non-lithophysal rocks. And the primary difference between those two that I'm sure you're aware, is that the lithophysal rocks contain cavities that range in size from a few centimeters up to, at the maximum, they are about a meter, but in general they are up to maximum size of around football, basketball size.

Our main, as I'll point out in a minute, we have a large database of information on the non-lithophysal rocks. Our main areas right now that we're doing work in is beefing up our information on lithophysal rocks. In particular, the areas that are needed right now are additional measurements of thermal conductivity and expansion, strength and deformability on mechanical measurements, and a better idea of the thermal and mechanical coupling behavior and long-term strength degradation, particularly in lithophysal rocks. And also the impact of variability of geologic structure. And by structure here I mean the structure of the lithophysiae themselves on their rock mass properties that we're using in design and performance assessment.

So that first item is an understanding of the properties of lithophysal rock. The other two areas are in pre-closure ground support specification, is an issue that we're dealing with now and also post-closure drift degradation and rockfall. Okay.

If you look at those three primary issues that I just talked about, we have a number of testing needs or--sorry, this thing is at an angle and everything wants to fall off here. Okay, there we go.

We have a number of testing needs to feed those information or issues that I just talked about. First of all, I wanted to point out that in terms of the nonlithophysal rocks we have an extensive database that currently exist. Over the past, oh, 20 or so years, just about, most of the testing has been centered on these nonlithophysal rocks. And there's an extensive database of mechanical and thermal testing, and also fracture mapping. All the fractures in the ESF drift were all fractures greater than a meter in length were mapped and there's a database in excess of 35,000 measurements of fracture geometry and aperture and things like this. Our main--and we think that we have sufficient data in that area. Our main requirement now is what we're currently doing and that's developing additional database through laboratory and field testing in these areas of thermomechanical properties of lithophysal rocks. I'll mention in a second what type of tests we're currently doing, but I wanted to point out one thing that's very important in the testing program in the sort of logic of how we're approaching this problem. Is that the properties of these rocks are porosity-dependent and size-dependent. It's very clear that we need to do mechanical tests, for example, on these rocks that there's a heavy influence of porosity in strength and deformability. And there's also a size effect. In other words, if I have an area that has lithophysae that are a few centimeters in diameter, it's a whole other matter to test something that has lithophysae that size than it is lithophysae that are the size of basketballs. As you can imagine doing mechanical tests become a bit problematic in trying to capture the essence of the mechanical behavior of the large scale sample.

The other thing that I wanted to point out is the evaluation of geometric properties of joints and lithophysae and their variability, is something that we're doing in addition to physical property testing. And that is that we are using the data that has already been gathered by the geologists on the site to try and get our best picture of how these lithophysae vary throughout the site. The basic goal that we have here is to insure that our models that we're developing, our numerical modeling capability is based on site-specific geology. In other words, we want to make sure that the models reasonably reflect the actual situation under ground.

Charles commented this morning about modeling. I definitely share his opinion and that is that I'm very skeptical about the use of numerical models unless they are adequately examined and calibrated, in that I can see a direct correspondence between the geology that we see under ground and the observations that we can make, just very practical observations with what the model predicts.

Finally, the other area of work that we're doing right now is looking at time related degradation effects and in--that's termed static fatigue on both lithophysal and non-lithophysal rocks. Obviously, this is an area that people haven't looked a whole lot in the field of rock mechanics, that we're trying to deal with understanding how the mechanical and thermal characteristics of the rock will behave as a function of time.

Finally, the area that we're also working on right now is developing post-closure site-specific ground motions for use in our rockfall calculations. Okay.

I'm sorry about this slide. It looked very brilliant when I made it and unfortunately it doesn't show up very well when you convert it to this thing. But let me walk you through our strategy for how we're trying to resolve these issues and incorporating them in design.

We're trying to take a step-wise approach to this problem to make certain that at the end of the day when we use these models for sensitivity studies and design, which are actually currently going on and will continue on until the license application, that we have confidence that we understand the behavior of this rock mass. And that we have done everything we can to reduce the level of uncertainty that we have in its mechanical and thermal behavior.

The step-wise program that we're using is first starting off with field geologic characterization work and although it's a bit difficult to read there, this is work that we've--that has been done and we're continuing to re-evaluate the variability of the rock mass, in particular the type of structure of the rock mass. That includes its lithophysal content and the jointing in the middle along with the lithophysal unit which are the primary controllers for mechanical behavior.

In the backup slides I put in some slides of some of the work that we're currently doing here to identify, for example, the lithophysal rocks, how the size and shape of the lithophysae vary, how the porosity varies as a function of distance up the ECRB and then also extrapolated across the repository block.

The next thing we're doing is moving up in a series of testing scales where our goal here is to understand the basic mechanisms of how this rock behaves, particularly the lithophysal rock, which is a bit new to the field of rock mechanics. There isn't a lot of excavations in this type of rock that exists. What we're doing is we're right now conducting a fairly extensive laboratory testing program to supplement the data that we currently have. This is being done at Sandia labs and also at the US Bureau of Reclamation in Denver. What we're doing is collecting large diameter core samples which are 12-inch diameter which is about the biggest that we can practically handle. And we're doing mechanical and thermal testing on those rocks and we're also doing static fatigue tests which are long-term creep tests, if you'd like to call them that. And as I mentioned earlier, it's because of the size effect that we have these large scale samples, or the large lithophysae. It's very difficult for us to sample sufficiently large samples and take them to the laboratory. So that's the reason, if we go on to the next step, which is in-situ testing, an in-situ testing level and conformation of our models, here and in fact right today we're conducting in the ESF meter, one meter plus scale compression tests on lithophysal rocks. We're--our first test that we're doing right now is just to determine the mechanical constitutive behavior, but in future we're going to conduct two more tests over the summer where we're going to heat that and conduct long-term loading tests on meter plus scale sample sizes of material from the lower lithophysal zone, and the upper lithophysal zone.

But even after doing all this testing, of course, it's still a limited database that we have. And we feel that we need a methodology for extrapolating that behavior to a larger size scale over the variability of the lithophysal rock. In other words, with the access that we have, which is in to the lower lithophysal zone, it's essentially through one drift, it's the ECRB. And we feel that it's necessary for us to be able to have a tool that we can say, what if the lithophysae change the size distribution and porosity over a range that we expect to have for the whole repository? How will that impact the output design properties that we need to use for design performance assessment?

So what we're doing is we're doing what I would term sort of an intimate coupling of the numerical model with our testing program, and I'll show you an example of this in the next slide. We're using a computer program called the Particle Flow Code, which was developed by a company called Itasca Consulting Group who is helping us on this work. They are out of Minneapolis. And we felt we needed a model that actually represented the physics of how this material behaves, that actually, physically had holes in it and so that we could use it as sort of a sounding board, a test bed, if you like, so that we could understand the mechanics of how the material behaves. Because we think it's necessary for us to come before NRC and before you and be able to justify the properties that we're putting in these models and the ranges that those properties have. So we're doing a calibration of this model against the lab and field testing scale to assure ourselves that it can reasonably reproduce the basic mechanisms of the behavior.

Then the next step is we are going to use that model then as a test bed or extrapolation tool to try and set ranges of design properties so that it gives us a higher level of confidence that if the lithophysae change across the site by a certain percentage that we can understand how that's going to impact the design behavior.

Finally, these design properties are going into a numerical models that we're using for calculation of drift stability and ground support loading.

Okay, next slide. I thought it might be

interesting for you to see an example of what it is that we are doing. I know this process may sound a little different or strange, but I wanted to show you the kind of thing that we are doing in calibrating this model. This is a calibration, one of our calibrations against the testing that's being done at Sandia. And this is a simulation of a laboratory sample here that's being subjected to uniaxial compression by an axial stress. And the model that we're using is this Particle Flow Code it's called, which is actually a micromechanical model in which the rock is represented as a series of spherical particles that are bonded together at the contact points. Now, this model was originally developed to examine problems in rock mechanics, and has been used extensively by the oil industry to look at things like hydraulic fracturing and blasting and pillar failure and things like that. But it has now found its way into great use in the powder compaction industry and rock fracture mechanics, and granular flow.

Essentially, the power of this model is it has very simple input properties. It's just simply the sheer and tensile strength of those contacts, and once it is broken it assumes there's a frictional contact exists.

But yet it's able to provide very complex behavior because it reasonably represents the way that rock fractures. And what I've shown here is just simply a simulation of one of our uniaxial compression tests where this is the stress strain curve that's produced by the model itself, and the slope of this line is Young's Modulus, and that's the peak strength of the material.

And we can actually calibrate the model very simply by adjusting the contact properties to reproduce the behavior of the sample. And then we can compare the actual way it does fail in the laboratory as a back example, and in this case it's showing a typical sort of shear failure mechanism that you get in a hard rock in which you get extensional fractures here which are in red, at graying context which coalesce to form major shear fractures through the material. Okay.

What I wanted to show you is that at first blush you look at this lithophysal material and you think, gees, that must be very complex material to represent mechanically. It's full of holes and it's got solid matrix between it. But in actual fact, what our results are showing is actually it's really not so complicated at all I think. Here what we've done is take exactly the same sample I showed you in the previous slide, with exactly the same material properties for the matrix material. And we have always made the assumption, I guess, or the project has, that the matrix material is the same whether it's in the middle lithophysal unit or the lower lithophysal unit, that mineralogically it's the same and mechanically we felt it was probably the same as well. And tests do tend to show that compression tests on small samples. But, merely by adding in, in this case, a distributed porosity of 20 percent, which is what this particular rock has right here from Sandia where the testing was happening, we use exactly the same properties only we had holes in it and did the same test as we did before. The interesting part is now we've dramatically changed the deformability of the material and its peak strength which is now dropped to about one-fifth of the strength of the middle non-lithophysal unit. And now the failure mechanism which we can see which was exactly the way it occurs in the laboratory is we get extensional splitting between lithophysae and forming major shear fracture through the material. And I show here a comparison with the actual laboratory data from this particular test here. This is acoustic emission data that we're using to also help us to understand what failure mechanism is occurring between the lithophysae. But here we can, with no fudging of data or anything, we can reproduce approximately the behavior of the sample, its peak strength and also the strain of failure. So this approach that we're using in calibrating this model is to try and gain a greater level of confidence as we go along and a greater level of understanding. And right now what we're doing is we're modeling our in-situ tests ahead of time using our model which we've calibrated the properties against, and now we'll be comparing it to these data that we are getting from the field. Okay? Next slide.

The objective that we have is that by the end of having run these in-situ tests we are hoping to have, be able to confirm the mechanism of how this material behaves mechanically. And also going to be able to use that with some confidence for extrapolation of the "what-if" cases that I mentioned.

This shows--I tried to show an example of that process here that we're going through. I show a plot here of the compressive strength of all the Yucca Mountain Tuffs, not just the Topopah Springs, but all the Yucca Mountain Tuffs as a function of effective porosity. And you can see that there's a heavy dependence of strength on porosity. And I show here the addition of our field tests that we're doing to supplement this data.

Now what we're doing with our numerical model is extrapolating from this as we're trying to set the upper and lower bounds of what the lithophysal material is expected to behave, and from this we can get our material properties. Okay.

All right, the next topic then outside of the material properties is our ongoing work on looking at evaluation of ground support, and what I wanted to point out first is that the modeling that has been done today, especially in the lithophysal zone has used conservative properties to estimate what the deformations and loading of the ground support should be, and I just wanted to point out that, under the various thermal operating modes that have been examined, the deformations and support loads that the ground support must maintain over the pre-closure period are relatively small. They are certainly within the realm of standard mining type situations with standard support methods. The one area that we are currently looking at is time-dependent degradation of the material from thermal loading, which will potentially be a major source of yielding of the rock mass around the excavations.

The estimated support function, and I put here "function" meaning that what the support has to do in these different rock types in the pre-closure period is as follows: In the lithophysal rock we think that the primary way that that material will actually yield is to yield on small scale fractures between the lithophysae, and it will have a form of what I would term a raveling type rock behavior in which if it--as it yields it will form small size particles that will detach from the surrounding rock mass. And that those particles have to be retained in some way. And I term a membrane type support here is well suited for that purpose. Membrane meaning that it provides some form of continued support around the excavation.

In the middle non-lithophysal unit which is a jointed hard rock mass, support of so-called keyblocks or blocks that are wedges that are formed by these joints, we feel is probably the primary support mode that we have to maintain. And that some potential to maintain surface spalling is also necessary. Again, a membrane type support with standard methods is--it can be used here.

For the license application design that's currently going on, we're looking at all types of ground support. I mean nothing has been eliminated right now. And that includes methods including rock bolts and wire mesh steel sets and shotcrete which is a sprayed-on cementatious lining material. Nothing has been ruled out although of course, you're probably aware of a lot of discussions in these areas in the past.

Some of the main issues that we're looking at right now are longevity of the steel supports and also the impact of ventilation air as it passes through on drying out. The rock and how that's going to impact corrosion of these different steel support members. And also the impact of thin layers of shotcrete on cement carbonation and water chemistry. Shotcrete has many advantages from a ground support standpoint. My background comes from the mining industry and from just practical support specification. It has many advantages, especially in lithophysal type materials, but it also potentially has disadvantages on impacting water chemistries. And that's something that we're going to be trying to tie down here in the next little while before making a final decision on the support type.

We're also looking at our approach for observing and maintaining the support over the pre-closure period. There are different ideas that are being currently developed in that area. Okay, next slide.

The final thing that I wanted to mention to you today is our work in post-closure rockfall and drift degradation analysis. We're currently working on several different areas right now. The first is development of site-specific ground motions from the Probablistic Seismic Hazard Analysis that's currently ongoing and this is being done primarily by Walter Silva, a seismologist out of Oakland, but with assistance from Carl Stepp and Allin Cornell. These ground motions are, like I say, currently being developed and they will all be completed over the summer.

We've made a change in the approach that we're doing to analyze seismically induced rockfall and that is that we've gone away from maybe what you've heard in the past on this so-called keyblock type analysis method. We feel it's necessary to get a good understanding of what range in size of particles that we will actually be producing that we actually use a true dynamic, three-dimensional modeling approach. It's not what I would prefer to do, but I think in this case it's something that we need to do. And we're using what's termed a discontinuum method. The program is called 3DEC, and this program allows site-specific joint geometries, input of site specific geometries. We apply site-specific ground motions and determine the kind of rockfall that we get. We're doing this in combination with this Itasca Consulting Group and the U. S. Geological Survey with the joint geometry specifications.

Our goal here is to develop probablistic output of rockfall mass that is consistent with the TSPA model that's being produced. And what that rockfall masses and velocity is based on many discrete simulations or deterministic simulations. It's a large job to do that and we embarked on that now and we're under way. Okay.

This slide, which is my last slide, other than the summary, shows the approach that we're taking. We have many parameters here. In the middle non-lithophysal unit it's primarily the joint geometry parameters and the lithophysal geometry in the lithophysal unit as well as properties. These are all--have been examined in terms of cast and statistically-based input. It's a very, very large database, as you can imagine. And as we're getting into this calculation we're getting smart very quickly as to what range of these parameters actually have an impact on it. So what I'm not proposing here is we're going to be doing five million simulations with this model. We're seeing what important parameters we have very quickly and narrowing down to that.

We have input ground motions from the hazard assessment, essentially we have site-specific time histories that are being developed right now for Yucca Mountain. These then feed into this discontinuum modeling, which is, as I mentioned, a deterministic program. We essentially run cases where we shake the model here with the time history that some given exceedence, annual exceedence value which corresponds to a peak ground acceleration or peak ground velocity. And I've shown an example of what we do for one of these. Let's say it's 10 to the minus 6 annual exceedence frequency. We generate a series of runs and this series of runs here may be around 100 simulations or something on that order, in which these parameters have been varied as well as the actual frequency content of the input wave form. And we actually determine a probability density function of what the rockfall looks like at that given peak ground acceleration. And this is being done for both the middle model lithophysal unit and the lithophysal unit is set because they require separate analysis methods. So we're actually calculating the tons of material that is released, the size of the largest block, and also the kinetic energy of the material because as it impacts the drip shield and this other thing, what's important is not just the mass, but what a velocity it has when it's released. This material we're generating right now and we're feeding it incrementally into an analysis that's a similar type analysis of the drip shield which is a structural analysis to determine if that structure is sufficiently stout, essentially, to handle this given rockfall. We've embarked on this process. We're in the middle of it right now, and as far as the time frame goes, we're hoping to have these calculations completed by December of this year and to have completely entered into the analysis of the drip shield at that time. Okay.

So my final slide and summary is that the major geomechanical issues here are specification of the pre-closure ground support, estimation of the seismic stability of the post-closure time, and to increase our database of thermomechanical properties, primarily those of the lithophysal rocks, and to assess their variability.

We're trying to--we're doing this project through a series of new tests that are being completed and analysis of existing data. We're doing additional lab and field testing of the lithophysal rocks, as I mentioned. We are incorporating site-specific geology into our numerical model development. We're continuing to do validation of these models against lab and field data and we're going to use those for extrapolation of the behavior to varying geologic conditions. The ground support studies need to be completed, and this includes calculations of loading and deformations of the openings to make certain that the support can actually function under those conditions, as well as longevity estimates.

And finally, we're doing discontinuum analysis of rockfall. Okay.

BULLEN: Thank you, Mark.

BOARD: Yes.

BULLEN: Questions from the Board? Dr. Nelson?

NELSON: Hi, Mark. Welcome to the project.

BOARD: Thank you.

NELSON: Very happy that you've joined the project. And I really enjoyed the approach that you're taking, and look forward to hearing a lot more about the progress as it goes on.

I think there are just two questions. Seems in evaluating some of the longer term response a lot of the focus has been on the thermal pulse, and along with the thermal pulse is also the pulse that changes the water content. And we've asked in the past about water content sensitivity, not just a porosity dependence, but also water content dependence, and the fact that although you may be sure that you have only one thermal pulse, you may not necessarily be sure that you only have one pulse of water content change through the life of the repository. So can you separate those two effects at all and give us an idea of whether there is a water content effect?

BOARD: Yeah, it is a little difficult to do that, although we--all the tests that I mentioned here we're conducting at different saturation levels. So we are conducting saturated or dry essentially because it's very difficult to control, you know, saturation at some in-between point. And so we're trying to separate that impact out by looking separately at thermal effects only as opposed to saturated effects only. So we're varying saturation and temperature both. That's how we're trying to get at it. This is through the laboratory testing. Of course, the field testing, we're just taking what we have that exists at the location.

NELSON: Okay, let me just follow up on that because it's not only how it affects the properties, but whether there's a water content change affecting deterioration. Is the rock sensitive to that?

BOARD: Yeah. That's a good point, and that could be an impact in a lithophysal material in particular because there is a degree of fracturing that exists between lithophysae and the lower lithophysal unit. Those are generally clean fractures with very little alteration on them, but at any rate, there could be some impact. And what we're doing in that regard is, on our strength data fatigue tests that are being done at Bureau of Reclamation, we're trying to keep, do the same thing--saturated and unsaturated conditions. How we're going to get down to the mechanism of that I'm not exactly sure yet. If you've got ideas you can throw them out. I mean we're trying to do our best when we do these lab tests of essentially taking the sample apart both before and after we test it to make certain that we're taking thin sections through the material to study how it actually yielded, you know, what mechanism. And perhaps that will lend some picture about grain to grain boundary and joint alterations of water, but it is an issue.

NELSON: I'll finish so the others can comment, but I really look forward to hearing you saying more about the effects of heterogeneity in the rock mass on the performance. You hinted at it in a couple of ways and I think we'll learn more about it, particularly regarding rockfall.

BOARD: Yeah, it's a very important issue and we're really trying to get at that, like a goal that I have is to make certain, as I said, that these models accurately reflect or--I shouldn't use the term accurate. That's a bad one. But that it reasonably reflects the variability of the rock mass. And because we are faced with this issue of having a limited database of information because we can't obviously do, you know, a huge number of large scale tests, that's why we're trying this extrapolation. We figure that the only way you're going to believe us in detail is if we show you that we understand the basic mechanisms of how it behaves and start from that basis and work our way up. And so the whole goal of using this test bed particle code is so that we can demonstrate we understand that, and then use that as a launching pad then to say if I change conditions in lithophysae like this, this is how it's going to change my output response. And properties probably isn't a good term to use there, I prefer to say how it changes the constitutive response of the material. So that's where we're trying to head for anyway, so.

NELSON: Thanks.

BULLEN: Dr. Craig?

CRAIG: Paul Craig. Greetings. That was a very clear report, but I am confused, which is probably not your fault. I'm neither a geologist nor an engineer. I'm probably on this whole board because I don't know anything about any of this stuff and therefore somebody wanted somebody to ask dumb questions. But what I'm hearing from you is that the lith is enormously inhomogeneous.

BOARD: No, I didn't say that.

CRAIG: Let me go--I'm probably misinterpreting you a bunch. I'm expressing this because I want you to clarify things.

BOARD: Okay.

CRAIG: I'm honestly confused. And what I'm getting out of this is a potential concern for the low temperature operating mode because if you have inhomogeneities and the possibility of tunnel collapse and if you have to use new materials like shotcrete, with which there is not long historical experience, and they have to hold up for hundreds of years during the ventilation period, then you have the potentiality for having big chunks of the repository exceed the temperature bounds.

BOARD: Right.

CRAIG: And if the inhomogeneity is large that could be a big issue. If the inhomogeneity is small enough that it's not a big issue, and so the inhomogeneity is right at the heart of my question.

BOARD: Okay. Yeah, that's a very good question. I'm sorry I didn't--I guess I'm speaking more to specialists in my area than to everybody. But the material is not inhomogeneous on, essentially on a lateral basis. If you take the lower lithophysal horizon for example, there is somewhat of a variability in lithophysal content in the top 10 meters or so of the flow itself where the lithophysae tend to be larger. When you get down below that level which is by far and away the bulk of the repository, is in that area beneath that and we've put it there specifically for that purpose. The lithophysal content is relatively regular and the porosity is quite regular. The porosity, we've done studies going up this ECRB where we've taken one-meter by three-meter panel maps and mapped every lithophysae in great detail and done this marching our way up and determined how the porosity and size variability changes. And the porosity is almost right around--almost on 20 percent, almost all the way up through the flow like that, even though the size may change slightly within that. So I wouldn't call the material inhomogeneous. It's actually, I believe, in its mechanical and thermal behavior is probably quite, actually quite homogeneous, in that you can represent it as a averaged material. That's what my guess is or my feeling is once we finish all this testing we're--as far as the type of ground support for use in this material, obviously, it's my feeling and I'll tell you straight out that I don't believe that there is a collapse problem in the pre-closure period at all. I mean this material is quite good construction material. It is very lightly supported right now with only occasional rock bolts in it with some wire mesh. So it's actually a very good--I mean like I told you, I came from the mining industry and we would have killed to have rock like that to construct in. So I think the main issue with the ground support is just maintain any loose material that might ravel free from that over the retrieval period. Whether that's shotcrete or another common thing like raw bolt and mesh remains to be seen. But I don't see it as an overwhelming issue that we have to deal with, and here I mean it's something that we can engineer around I guess is my feeling. And, obviously we're going to have to maintain the support over time, which means we'll have to observe and have a plan for how we're going to maintain it if necessary because, you know, it depends on the length of time, if it's 100 or 300 years. As you said, these are unprecedented times when it comes from a ground support standpoint, so we'll have to have that option.

BULLEN: Bullen, Board. You don't want to go there because then I'll start talking about associative packages, so--

CRIAG: No, no, I just wanted to--thank you. That was a clear answer and I feel much more at east.

BULLEN: Last question. Very short question, very short answer. Dr. Runnells?

RUNNELLS: You may have been on the project a short time, but you are absolutely correct in saying that the Board will not believe you unless you demonstrate some understanding of the system. Absolutely true.

BOARD: I should be on the Board. I feel the same way.

RUNNELLS: Demonstrates you came from the mining industry. Slide 11, please. Second bullet. As you were talking you said something that really caught my ear. You said we're going away from the keyrock or keystone, keyfall, whatever you call it.

BOARD: Yeah. Yes.

RUNNELLS: Model to--and I know nothing about this field so I feel completely free to ask this question. To this model--

BOARD: Yes.

RUNNELLS: --which is not your preference. That's what you said, is not your preference. And then you went to the third bullet and talked about how it was going to fit into TSPA.

BOARD: Yes.

RUNNELLS: Why isn't it your preference and are you being forced into something that's not your preference because of TSPA?

BOARD: No. That's not it. I was being somewhat facetious there. My background, the work I did before I came here was primarily in assessing seismic stability of underground mines and damage assessment of underground mining operations. And what I would prefer that we could do would be to simply argue from an empirical database whether there was an issue here or not. And that's what I was referring to, is that based on experience from the mining industry, I wish that we didn't have to go through an elaborate calculation procedure. But I feel in this case that we do because the ground motions are sufficiently different with an earthquake type ground motion and you get with a typical underground seismic event, which tends to be higher frequency, short duration. So what I really meant by that comment was I wish that there were a bit simpler way to attack the problem without having to do a very large number of three-dimensional calculations using a discontinuum model which actually represents rock as blocks of material that contact one another across joint surfaces. It's really not that much different than what the auto industry uses for examining the impact of, you know, automobiles or something like that. It's, I'll call it a large deformation program. It takes very long to make these runs. So consequently, what we're doing in this second bullet is is we're utilizing many computers to make these discrete runs that we're trying to cast into a more probablistic framework that is usable with the same framework that the TSPA model has in place. So I mean I'm happy to do this work. It's very interesting just from a scientific standpoint, but as far as the--I would rather be able to just simply say based on mining experience we can ignore the problem, but I don't think that we can do that in this case.

BULLEN: Thank you, Mark. I think you're correct. We can't ignore it. And we actually look forward to seeing the results of these calculations at a future meeting.

BOARD: Sure.

BULLEN: With that I'll call the session to a close, but open the public comment session for one individual who is Dr. George Danko and I promised him five minutes and 30 seconds. So we have five minutes and 30 seconds, Dr. Danko. You are there getting the microphone, okay. That's great.

DANKO: Thank you very much. I would like to thank the Board for their permitting me to do this public comment before I have to run for my return trip to Reno.

BULLEN: Okay, go right ahead.

DANKO: And I want to thank you for the audience to stay here an extra five minutes into the program before the lunch break. I would like to make my public comment on ventilation simulation results and modeling. And would like to give the Board a copy of my comments for consideration for including in the public report.

I based my comment on past and present ventilation results and 10 years of involvement in ventilation calculations, which included hot and cold repository concepts, design options that probably have to come to the point that we have a ventilated option in today's considerations.

And during this 10 years of work we developed the MULTIFLUX, which is a hydrothermal ventilation code based on--modeling the rock processes with heat and moisture transport. The current studies are in the AMR Revision 01 report. And we participated in this with MULTIFLUX, the report compared MULTIFLUX modeling with ANSYS based model done by BSC. This ANSYS-based model is a simplified model using only line load and cold and dry heat conduction in the rock. And it has a spreadsheet and a calculation in it so I will reference it as ABVS, ANSYS-based Spreadsheet Ventilation Model.

The recommendations and questions are based on the simplifications, which I used in the ANSYS-based model. The first question, how does EBS compare with MULTIFLUX if the heat load is point-like with large gaps between waste packages? Woody Stroupe showed us a two-meter distance between waste packages, and then the waste package will be varying in heat load so it will not be resembling an average line load. I would like to assure you the agreement between ABVS and MULTIFLUX in my report is very good because of the task level and very low simple model configuration. Where we see differences which are not addressed in this report, and then of course in the future, the applications that will be different. And then I would like to comment on this, that there is time to use model which can account for those variations.

The second question is how does ABVS compare with the MULTIFLUX--within that in fact is included. In that is on the bottom of the brief time that it uses and then has--it had to be left out in the Revision 01 report because it caused differences between ANSYS model and the MULTIFLUX. If rock grind is used you can consider, the grind effect will increase temperature because it is drying and then the drying will reduce the conductivity from 2 to 1.2 or 1.2 that the dry rock is conductivity. So the drying effect may increase temperatures through rock drying. The drying effect may increase temperature through the decreasing conductivity, but it would also decrease temperatures through the latency defect. And these two are competing against each other and has to be modeled. It's very difficult to factor these two factors into this. So I argue that a--ventilation has to be in the future.

The third question is how is rock drying going to affect the second thermal cycle and then this is an example showing these two cycles which we are expecting. One is during pre-closure. That's a small and almost insignificant cycle and under the control of the thermal management. The second cycle is spontaneous on, not under our control any more, but it's affected by the output of the first cycle so if the rock drying is in use and then you know it is by ventilation it will affect through the conductivity the peak of the second cycle. And then that needs has to be addressed in future ventilation calculations. So a hydrothermal model has to be.

And that brings me to my fourth group of questions. How will the ventilation software and models be refined and qualified? I believe that there will be so much work to be done in the future that the ventilation models as a subtask will not be handled unless it's cleared out really quickly and then qualified and then the right models used. There is no need for too many modeling and in past ventilation models which--two minutes because we have time enough to do the job well, but we need to qualify these models, not put it on hold and then clear out the way for the real studies. These models have to be--it's time to move from the--to computation of fluid dynamic model, decide just like what MULTIFLUX use is and then the results has to be pitted against the DOE test facility for ventilation, test facility to check these models and then it's time to move on.

Thank you very much.

BULLEN: Thank you, Dr. Danko. Could you leave a copy of your paper and if possible a copy of your overheads for the record.

DANKO: Yes.

BULLEN: This session is now adjourned. We will reconvene at exactly 1:30. 1:30. Thank you very much. I would like to thank all the speakers, too.

(Whereupon, the session recessed.)

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

DR. COHON: I congratulate those who made it back from lunch on time, we appreciate that. And to those Board members who didn't make it, shame on you.

Our session this afternoon is focused on performance confirmation and R and D testing, and Priscilla Nelson will serve as chair.

Priscilla.

DR. NELSON: Thanks, Jerry.

What we're going to do, as indicated earlier this morning, is have a little change in the schedule. We will first of all have a 25-minute presentation from John Kessler. If you're talking, then you have to stop talking so you can hear me. We're going to have a 25-minute presentation from John Kessler of EPRI, and then a 15-minute Q and A period. Following that, we will have the start of the presentation from the BSC team. Peter Swift will take on Nancy Williams' introduction, because Nancy's not here, and he will be followed by Larry Trautner, who will do the design aspects presentation.

I ask after each of those two presentations that direct questions that really are needed for clarification in your mind, fellow Board members, be the ones that are asked, because we will take a break at that juncture for 10 to 15 minutes, and we'll set the time at that point. And then we will reconvene and Peter Swift will go into the performance assessment and testing priorities on the part of BSC. We'll follow his presentation with a Q and A period in which either he or Larry Trautner could be addressed for Q and A.

At the conclusion of that we will hear from Steve Brocoum and a Q and A will follow that. And at that point I will hand control of the proceedings over to Jerry Cohon for public commentary period.

So, we are set to start, and I would like to introduce and ask to come up John Kessler. John is the manager of Spent Fuel Storage, Transportation and Disposal Program at EPRI. He has a background that began at the University of Illinois academically and culminated at the University of California at Berkeley, where he did work with hydrology and hydrogeology. So we'd like to welcome John to talk about a performance confirmation exercise that EPRI established, managed, and that a few of the Board members and staff were fortunate enough to be able to attend. Thanks, John.

MR. KESSLER: Thank you, Priscilla.

I'd like to start with a few seconds of shameless advertising for an upcoming conference. The International High-Level Radioactive Waste Management Conference is now scheduled for March 29th to April 3rd of 2003 in Las Vegas. The calls for papers is literally hot off the press, I got it this morning and put out some copies in the back for those of you that may be interested in contributing papers.

UNIDENTIFIED SPEAKER: Who's the technical chair of that, John?

MR. KESSLER: Right. Okay, quickly what I want to talk about here is a couple things that lead into performance confirmation long-term R and D activities, starting by decision making in the face of uncertainty. After all, performance confirmation is part of that concern. Then I will talk about the EPRI Performance Confirmation Panel, the recommendations that that Panel made after the workshop last year. I'll talk about DOE's eight-step process. Actually, I should have taken this off because there isn't time to go through a container corrosion example. This is DOE's eight-step process on how to identify a winning performance confirmation program element, so to speak. And then I'll end with an analogy to reactor licensing in terms of--well, I guess it has some relationship to staging, so to speak, and how performance confirmation activities would fit in that.

So starting with some background, decisions, as we've been talking about or heard a lot about the past day and a half, are iterative. Certainly the SR that I understand is being debated on the House floor as we speak is the first required by law, but it's based on nearly 20 years of study now. So it's not without some basis that the SR was made.

Just some lists of future decisions assuming the SR is approved by Congress. Some NRC decisions are the license to construct, receive and possess, close, and the amendments, which I understand some of those are. And then just a few of the many DOE decisions, some of which you've talked about in the past day and a half. The license applications/amendments themselves, DOE has to decide whether they're ready to proceed with those. The transportation issues, the how, where, when, has all got to be decided sometime in the future that hasn't been decided yet, and the repository design you just heard about in terms of the decisions that are planned for that.

I suppose a comforting thing, or however you want to look at it, is that the relative importance of the decision increases as the knowledge increases. So really, until the waste starts moving to Yucca Mountain, the risk here is mostly institutional to DOE and economic to the Waste Fund. The health risk to the public hasn't really begun yet.

The public health and safety doesn't come in until--in terms of radiological risk isn't incurred until the waste starts moving. Well, that's not going to happen until the second license decision. Transportation and surface operations come first, and the post-closure risk is decades to centuries away. So there's still time to gain a lot more information before real risk to the public begins.

Well, we all know that uncertainty is unavoidable, so how is it being managed? There was some discussion about that in the past day and a half. There are regulatory approaches that NRC themselves are applying to deal with uncertainty in a sense that they've got a dose to a "reasonably maximally exposed individual", the RMEI. The RMEI dose limit is a fraction of natural background. NRC requires multiple barriers. They also are insisting that the waste is retrievable. We don't have to take DOE on faith or trust, we've got also NRC that is requiring waste to be retrievable and that NRC is going to want to see a real retrievability plan that actually has some meat to it. And it's not just a matter of taking DOE on faith that they're going to keep things retrievable. And I consider that a very important part of developing confidence, is maintaining the retrievability option. Then there's longer term R and D that NRC requires. The "Safety Questions" provision in the NRC review plan is always there, and then there's the performance confirmation program, which I'm going to talk a bit more about.

Then there's additional DOE approaches. They can reduce uncertainties with design modifications. We've already talked about what some of those are. I would argue that the analyses are conservative on the whole. That's another way to manage uncertainties. And at present they have "margin", meaning that they're below, not right at the limit, not at the 14.99 but well below that. So these are all ways to manage uncertainty that I think DOE is already using. And in addition, they've got long-term R and D and a performance confirmation program that helps them manage those uncertainties.

So the question is, you know, for us at EPRI, which was why should we look at this issue now, how do we view it in terms of where the whole Yucca Mountain process is? And we felt it was useful for the Site Recommendation decision makers to know that this isn't the end of the road on data, that DOE is going to continue to do R and D and monitoring for a whole lot longer, and as TRB rightly pointed out in your letter of last January, "Confidence in DOE's projections can be increased." Certainly the SR decision makers need to know that, and that there's a way to do that. And a decision to proceed is just the next step. Licensing is going to follow, NRC will thoroughly evaluate, and the TRB will very much be part of the process of continuing to question and challenge the project as they proceed.

So the EPRI "motive", in a sense, was to identify "meaningful" long-term R and D/performance confirmation bases as Site Recommendation input and a key licensing tool. Really, one of our concerns was, are we relying too much on performance confirmation? Do we just say, "Oh, well, it will get answered in performance confirmation"? Maybe it will, maybe it won't. And we wanted to explore in a bit more detail about, you know, what is it that makes a good performance confirmation program? What questions can they answer? And if they can't answer important questions, what else is there?

So our performance confirmation activities--I'm probably going to switch into PC lingo here, so forgive me if I do--is we reviewed the DOE draft Performance Confirmation Plan and we focused that review on DOE's proposed eight-step process, which I'll talk more about later in the talk. We hosted a workshop last November where we had representatives from DOE, NRC, as Priscilla mentioned, Board members and Board staff there, and local representatives, government representatives, were present. We instituted a Performance Confirmation Panel to make observations, recommendations. They participated in the workshop. We identified a few examples of potential performance confirmation activities and perhaps how one might better exercise all eight of these steps that I'll talk about. And it's all in the EPRI report that I believe we've sent copies to the Board that came out at the end of last year.

So one of the things that came up in the discussions during the workshop is what's the distinction between long-term R and D and performance confirmation? And it seems that they're sort of--there's this regulatory definition, or at least the understanding of a regulatory definition and performance confirmation, which are those activities that are specifically designed to evaluate the technical bases for the licensing decision. What do you need to do to support the assertions that were made that NRC may choose to use to make a licensing decision?

Then there's long-term R and D, of which performance confirmation is just a part. It might be any other activity not specifically directed toward evaluating licensing bases. Remember Robert Card talking about, gee, you know, he would be doing R and D if for no other reason than to reduce costs. Claudio Pescatore and others talked about confidence building as other things you might do that aren't directly geared at the components of the case that was made upon which a licensing decision might be made.

A detailed performance confirmation plan doesn't have to be available right now to proceed in. The final performance confirmation plan must be based on the completed licensing basis, and that's not going to be developed--isn't developed today, but the plan is, as you know, it's going to be developed over the next few years. And NRC may require additional performance confirmation work.

So the intent right now is that we should explore the role of both long-term R and D and performance confirmation to support the Site Recommendation decision and perhaps "stepwise" license application, or at least in terms of there's first construction then loading then closure, and the amendments if the SR is approved.

I'm going to switch and talk now a bit about the particular recommendations that the EPRI Performance Confirmation Panel made. I'll quickly go through, here are the members of the Panel. We have some that were from National Academy of Sciences. Matt Eyre, Rod McCullum and Al Ross have licensing experience. Barry Gordon has experience dealing with container corrosion issues. Bill Miller has dealt with the performance confirmation issues outside the U.S. Alice Shorett has been involved with stakeholder interactions and was involved with getting input from stakeholders at the Hanford Reservation in terms of what they wanted to see for how the site was cleaned up there.

This is the overview comments, and I'll get into a few details on some of these. Performance confirmation and other long-term R and D is useful and appropriate. Big surprise. We'll talk about, you know, how they felt it was useful and appropriate in the next viewgraph. There are many interested parties in performance confirmation. The obvious ones, NRC, the Board, members of the public that might want to see certain monitoring or performance confirmation activities or other long-term R and D happening. And the idea there is to keep all of them informed and provide them with some sort of input into how these things are being developed.

NRC and DOE need to start now in developing a shared understanding of how long-term R and D and performance confirmation will be carried out. It was clear at the end of the workshop that they weren't quite on the same page in terms of what long-term R and D and performance confirmation were. And it's more than just understanding, you know, what's in and what's out of the formal performance confirmation for licensing but how do you implement that. And so the recommendation is that the two parties need to sit down early and start hammering that out.

Certainly the commitments that might be identified for performance confirmation and license application in any near-term amendments have to be hammered out and a common understanding is critical to that.

A flexible adaptive plan is needed. Yes, Charles, we--they came up with the "adaptive" word all by themselves in terms of how performance confirmation, at least, should be carried out.

Another important one was prioritize performance confirmation and other long-term R and D activities now using risk-informed judgment and clear criteria for prioritization. And I'll get into a bit more about what that means, as well as avoiding certain traps in defining a performance confirmation program that I'll also talk about.

Why long-term R and D and PC is appropriate facilitates "stepwise" repository development, and that would be performance confirmation. It's a regulatory requirement. Society is going to demand pre-closure monitoring. It can help reduce uncertainties. And then the other R and D things would be like investigate opportunities for design improvement that you've heard a bit about in the past day and a half, as well as make use of technology advances as appropriate.

In terms of what NRC and DOE need to do in terms of getting a shared understanding, I mentioned that the commitments are going to be defined in the licensing process, even those not starting much later. So please start now, NRC and DOE, is the recommendation from the Panel.

NRC and DOE have made a commendable start. The final regulation has quite a good deal of useful information, as does the standard review plan in terms of helping to identify that. But that's not good enough. Some sort of Appendix 7 technical exchange on what is meant is really needed.

DOE's draft performance confirmation and their long-term R and D plans are really quite good. They've got a good start at defining what's in there and what the program should be.

Differences between the two approaches need to be resolved. DOE, at least as of last year--and I know that DOE is working on incorporating the final guidance from Part 63--at least last year DOE was at the overall performance objectives are achieved, that's the goal of their performance confirmation program. Whereas NRC's thinking is more broad, that, as we heard from Tim yesterday, natural and engineered barriers are functioning as intended and anticipated. That has some implications in terms of what is--needs to be included in performance confirmation activities.

Another recommendation from the Panel was that the scope of the long-term R and D and performance confirmation activities should be quite broad. Challenge assumptions, data, models, expert judgment that support elimination of FEP's. I think that also addresses the confidence issue that Claudio Pescatore mentioned a bit yesterday. Identify alternative conceptual models, challenge the technical basis for an NRC regulatory position--so here's one for NRC as much as for DOE--and build confidence with local communities, are all things that the Panel recommended.

In terms of using risk-informed judgment and clear criteria for prioritization, now. The sooner these criteria are developed, the sooner a performance confirmation program can be developed.

Some potential criteria that was offered by the Panel: the relative "value" of information is certainly high on the list, i.e., stay risk-informed in terms of what you're going to go after; the timing of the need for specific information; cost of conducting it; interference with other activities; agreements with stakeholders; concerns of stakeholders; potential health effects to workers and the local population of actually conducting the performance confirmation activity itself; and the ability to define sufficiently the activity such that "confidence" is truly enhanced in a reasonable amount of time, i.e., don't start an activity if you're not going to get there. "There" being whatever level of confidence or corroboration of a model you're looking for in that particular activity.

Some traps in terms of what to avoid in defining a long-term R and D program: NRC, DOE, don't agree to things that can't be done; agreeing to measure parameters that do not affect performance; monitoring of too limited duration or extent; requiring unnecessary accuracy or precision in measurements. Sometimes you just can't get there. You may think you need to know a lot of accuracy, keep it in perspective, keep it risk-informed.

Satisfying parochial interests. Don't do something because--I guess we call this the "rice bowl issue". Keep your eyes on the prize, which is when in doubt, look at these top requirements in terms of prioritizing.

Assigning excessive levels of conservatism on bounds because it's easy in the sense that, "Well, we can get away with this because we can--you know, we've got that much play." That kind of thinking "eats" margin, and margin is an important part of managing uncertainty. Don't throw it away too easily or too quickly.

And neglecting institutional aspects. You've got to maintain in terms of this is a long haul to get through all these performance confirmation. You know, decades to potentially centuries depending on the approach taken. You've got to maintain technical capabilities over decades, no matter what happens with the rest of the nuclear industry. There's got to be something like periodic "report cards". And I think that the NRC requirement for two-year intervals of updates of data is an excellent device in terms of report cards.

I'm going to shift to DOE's Eight Steps in defining performance confirmation activity. And just for you, Priscilla, I put a star after "Steps" to note that those steps can be iterative, because this was a comment that Priscilla made during the workshop.

Well, it makes sense the first time through to perhaps think of them in this order as you try to define a performance confirmation activity. As you learn things and you get down here, there's going to be times when you want to cycle perhaps all the way back to the beginning of these steps to redefine a program. I think the general consensus, even of the entire workshop, but certainly within the Panel, was that we really like these eight steps that DOE proposed in their draft performance confirmation report.

Quickly going through them, you start by identifying what it is you're trying to measure--that is, the key performance factors; define the data base and predict performance; establish tolerance and predictive limits or deviations from predicted values; identify completion criteria and guidelines; conduct the planning; monitor the performance; analyze the data; and recommend and implement appropriate actions if there are deviations.

The ones in red here, especially 2, 3 and 4, we spend quite a bit of time discussing in the workshop. These are not easy issues, especially establishing tolerance bands, and I've already heard you asking questions about "Well, how do you take action if the data you collect suggests that you need to revise your understanding?" to put it mildly.

Okay. I'm going to cut out some of this detail because I want to get to the end here.

In terms of Step 2, defining the database and predicting performance, you've got to think about what your "baseline" data are and keep those needs separate from other modeling desires. In terms of prediction concerns, the licensing basis model has to be optimized for very long-term projections. And if you can do performance confirmation projections for 50 to 300 years, are you going to use the same model that you're using for 10,000 years? Maybe not. How do you get those two to link up?

Okay, I'm going to skip a few in the interest of time, Priscilla, and talk a bit--ah, I've got to talk about tolerances, that's certainly one of the group's favorite subjects. Tolerances, what is it that you're measuring, how do you know whether you're confirming performance when you're trying to do a shorter term test and project it over 10,000 years is a toughie. It's a key step in a successful performance confirmation activity. You've got to combine baseline data with projection, and be warned that it may become a license condition, "If...then," "If not..." specifications.

I'm going to skip the next one.

Some options for establishing tolerances. It's not--the group was thinking more than just what I would say is the NRC basis, avoiding exceeding particular parameter range value is the, you know, anticipated and projected. But there's maybe other alternatives that I think DOE was trying to keep in mind by staying risk-informed here. It may be okay, for example, to avoid--if your real objective is to avoid exceeding regulatory criteria, it may be okay for parameter to be outside the range if the criteria are still met. You may want to support the refinement of an engineered system with a particular test, and you may want to avoid needing to re-engineer something, even within the regulatory criteria.

Certainly in terms--I'm going to skip some now.

For Step 8, recommend and implement appropriate actions. They've got to think of everything. No action, limited testing, more testing, modification of original license bases, all the way through temporary halt of emplacement while they figure out where they're at to potentially retrieval and abandonment of the site. All of those are legitimate options.

Other long-term R and D that's not performance confirmation would be the alternative engineering designs, the impact of technology improvements, and testing and monitoring to ensure retrieval capability were things that at the time we felt were potentially outside performance confirmation. I think NRC has a different view of that now in some cases.

Okay, I'm going to try to wrap up here and talk quickly about, you know, how does performance confirmation fit into what we term "Step-wise" licensing. This idea--you've seen this now from several of us in the past day and a half--is that maybe over time what we're after is greater confidence, whatever that confidence is, and that while we're here at Site Recommendation--and I wanted to make sure I put in that, well, I've got the axes this particular way--confidence is a whole lot greater than 0 at where we're at today.

And there are analogies to reactors here that, for example, we've got the construction, start up testing, low capacity testing, and full capacity testing with normal operation analogy out here after closure. So this isn't a totally uncharted territory, this idea of step-wise development. There's a lot of analogies here to what happens already in the reactor industry and how you have risk that increases in terms of the public later on and the amount of information that a reactor needs to provide as they move into actually receipt of fuel and initiating the reactions.

So performance confirmation is similar to the "Tech Spec" surveillance program for reactors. In that case they verify equipment is operable, they have what are called "Limiting Conditions of Operation", what equipment must be operable and, if not, what actions to be taken. So repositories, there's likely to be differing degrees of inoperability, so the analogy has to be changed a bit there, and the timing in terms of, you know, how much time do you have to react here. It could be decades before operability needs to be restored or alternative action taken. For example, if something doesn't look good about the casks and you may want to do something like Alberto was asking about this morning, you don't have to do it like tomorrow, you may have mitigating things you can do and take quite a bit of time to think about it.

Last viewgraph. So the keys to the next stage for Yucca Mountain, assuming the SR is approved, is that we feel that there is sufficient confidence now for societal decision to proceed to licensing. Long-term R and D and performance confirmation is part of that confidence, in addition to the 20ish or so years of work that's already gone into understanding the mountain. There also needs to be a strong vision for what the license should look like, and I think that NRC and DOE together are thinking about what that--well, together or separately are thinking about what that should look like. There's certainly the need to further improve confidence. In response to your letter from last January and for licensing, there needs to be an improvement in confidence. Clearly identified approaches to enhancing confidence in important FEPs through successive stages of licensing. Performance confirmation is one part, conservatisms, analogues, all of those things address that. Maintain a viable plan to adjust or reverse course. That's really an important part of the program. If nothing else, that element of confidence always needs to be there. And monitoring to establish broader confidence.

One that I think I skipped over in time is this idea of not everything is going to be amenable to performance confirmation testing. You can't get there in 10 or 20 years. A plan has to be developed real soon on how to deal with those FEPs that are important to performance that are not unamenable to performance confirmation testing.

Thank you.

DR. NELSON: Thanks very much, John, very well done.

Questions from the Board? Dr. Craig?

DR. CRAIG: Paul Craig. Yeah, a very interesting report. I'd like to explore with you a moment the issue of how much R and D is enough. And many years ago, back when I was working for the Science Advisory Establishment here in Washington, we spent a lot of time asking how much is enough. And dollar figure is a great--you need to have some reference points and there can be such a thing as too much, but confidence is lost if it drops too low. And I'm wondering if your committee gave some thought to establishing some criteria as to what is the right amount. It seems to be particularly important now as we're getting signals that the science part of the DOE budget is starting to crush.

MR. KESSLER: We did not address how much is enough. Again, speaking personally, it's more of an issue of--it goes beyond just the performance confirmation program itself. From a licensing standpoint, NRC is going to be satisfied that the key licensing issues are addressed by whatever that R and D is. Before even DOE makes its case to NRC, DOE itself has to be satisfied that they're confident. We just talked about this at lunch, a few of us, this idea that DOE has to have confidence that they have made the right case internally, then they can work on it outside. But we did not talk about how much is enough. That's clearly a subjective decision in part.

DR. CRAIG: Well, it's subjective and people will make judgments, and who makes the judgments matter and the kind of input that they have matters and whether it's a parochial viewpoint or whether it's a broader viewpoint--

MR. KESSLER: Right.

DR. CRAIG: --international viewpoint, whether stakeholders are involved, all of these things matter. So it would be possible to put together a criteria discussion that would allow one to run this conversation at a high level, and it seems to me that's important right now.

MR. KESSLER: You could develop some criteria, perhaps, up front, but others will depend on what information you're getting as you run along. I mean you may think you need so much information, but what if you find out that something looks a whole lot better or a whole lot worse? You may change the amount of information you think you need as you go along.

DR. CRAIG: Absolutely. Adaptive management, right.

DR. NELSON: Okay, just a warning to the Board, I have Jerry, Dan, Debra, Norm and Jeff, that's five people. Please keep that in mind as you bring your questions. Jerry?

DR. COHON: I'll be very brief. If I can only remember what I was going to ask. Oh, the diagram showing confidence going up?

MR. KESSLER: Yes.

DR. COHON: I'm sure that when you drew that you just wanted to make it as general as possible, but there's actually--

MR. KESSLER: Right.

DR. COHON: --a point that you show confidence going down.

MR. KESSLER: Absolutely, we wanted to make sure that was there.

DR. COHON: Have you thought about a situation where we might see confidence go down as we go out in time?

MR. KESSLER: It's one of those unknown unknowns. We're going to expect surprises. Some of them will be pleasant, some of them will be unpleasant, so we'll get some dips in confidence. If that dip, for example, in licensing speak, is a new unreviewed safety question, at that point NRC is going to come in and make sure that that question gets answered. And, you know, there are plenty of cases where the applicant never got there, and the applicant, after receiving a barrage of unanswerable questions, backed out. Assuming DOE can put together a plan and move past that, they will. But this is, you know, in licensing speak, sort of a new discovery that's something that NRC hadn't considered before in making their licensing case. This may cause a halt of redo, reengineering. But I can't be specific about what I see that being, Jerry.

DR. COHON: Okay. Just one thought for your consideration. On your list of traps, another trap, not specific to this situation, is equating measurability with significance. That is, we can only measure what we can measure, but that doesn't mean that the things that we leave unmeasured are not significant.

MR. KESSLER: Exactly. Right. That's what I was trying to say with that extemporaneous comment right at the end, is that there are some things that just aren't amenable to performance confirmation program, and natural analogues or whatever are going to have to be used to deal with those issues.

DR. NELSON: So in follow up, do you consider analogue studies to be an important part of performance confirmation?

MR. KESSLER: Yes.

DR. NELSON: Okay. All right, Dan.

DR. BULLEN: Bullen, Board. Could you put up the one you didn't show?

MR. KESSLER: Okay.

DR. BULLEN: Because actually I had a question about that one.

MR. KESSLER: Sorry about that.

DR. BULLEN: You talked about the--

MR. KESSLER: Which number is that, Dan?

DR. BULLEN: It's the one that's--20, Number 20.

MR. KESSLER: Okay, thank you. Got it. All right.

DR. BULLEN: If you talk about the things that are operating as intended and anticipated, there are a couple of things. If you take a look at the example--and this is out of a DOE document, I understand--

MR. KESSLER: Right.

DR. BULLEN: --and it shows the predicted bounds of operation and, you know, one of the discussions, I was very fortunate to be at the meeting--and actually, thank you for inviting Board members to come--we talked about the fact that what if it doesn't fall within the predicted bounds? Then I could see it as a case that Jerry mentioned where, you know, your confidence goes down because your model said this is supposed to go up.

MR. KESSLER: Absolutely.

DR. BULLEN: It's not bad that it didn't go up because it's actually performing better, but if it didn't fall within the predicted bounds, then maybe you don't understand the fundamental mechanisms. And so how did your panel address those kinds of issues?

MR. KESSLER: Well, we talked about it may not fall within the bounds because you set the bounds based on a conservative model, and you wouldn't expect it to fall within those bounds in terms of when you really do a measurement. Other cases they may have gotten it wrong and they would have expected it to fall in those bounds and for whatever reason it doesn't. If it doesn't, they're going to have to go back and rethink, and I would imagine this is going to be something that resembles an unreviewed safety question in terms of licensing space. But in any case, whatever it's called, they're going to need to go back and look at that and assess from, you know, the global perspective as well as everything else, maybe this is important to one barrier and maybe their defense of that barrier now becomes shaky. They're going to have to go back perhaps all the way back to the beginning of those eight steps and rethink, or even ahead of that.

DR. BULLEN: Bullen, Board. One last question, then I'll be done. We heard this morning from Woody Stroupe that there was going to be a panel that will have--a first emplacement panel that will have the performance confirmation tests in it. Any dream tests that the EPRI or the industry would like to see in there? I mean I asked mine about a degraded waste package already, I was just wondering if there's any kind of input that you think you'd like to see thought about as they develop those types of panels.

MR. KESSLER: Yes. It's not a test, it's a methodology for defending a test. I'd like to see a methodology developed such that "Here's why we're going to do this, here's why we're going to get there, here's what we think we're going to measure, and here's what it addresses." That's the wish list.

DR. BULLEN: Thank you.

DR. NELSON: Okay, Debra.

DR. KNOPMAN: Knopman, Board. John, on your last slide, the second to the last bullet said, "Maintain a viable plan to adjust or reverse course."

MR. KESSLER: Yes.

DR. KNOPMAN: And then your Slide 23 had what I guess you were filling out from DOE's Step 8 about potential options.

MR. KESSLER: Yes.

DR. KNOPMAN: The missing link has been brought out before, is what are the decision rules, the trigger points, that would put you into any one of these options? Or put another way, how do you make a plan viable? And it seems to me you make it viable by laying out in advance what those triggers are for any one of those options. What's your panel have to say about that, or what do you have to say about that?

MR. KESSLER: The panel only--I'm not sure we really addressed that in any detail. In terms of options, it's going to--I hate to even say it, but it depends, it really does. I mean, what is it that's not working? How important is that? Is there a fix in terms of more data, a different design? Is this a critical component to the whole repository such that if you don't have it you'll never get NRC confidence of that key barrier? Maybe the confidence will increase that they can't meet the limits. That's a different kind of confidence. So I'm sorry, I can't answer in advance.

DR. KNOPMAN: Well, no, you actually have answered to some extent that you'd follow some kind of fault tree type of--

MR. KESSLER: Yes.

DR. KNOPMAN: --progression of questions, and if you got to the end and weren't able to get off that, you'd probably be down at the bottom with abandoning--

MR. KESSLER: Exactly. That's why I brought up--

DR. KNOPMAN: But the point is, you know, has anyone actually stepped through that progression of questions, that sequencing or branching through a set of questions?

MR. KESSLER: Not to my knowledge. There was some general discussion in the draft DOE performance confirmation plan, a little bit in the long-term R and D plan, but not in any detail to my recollection.

DR. NELSON: Okay, Jeff, Norm has yielded because Jerry stole his thunder, so you're next.

DR. WONG: Jeff Wong, Board. Thanks for the extra time there, Norm. Slide 26. You talk about performance confirmation increasing confidence, and I think of two kinds of confidence. One is technical confidence, which it looks like your efforts or your presentation is directed toward increasing the confidence on the part of the regulator, and your last slide talks about moving toward a societal decision. Do you think that the confidence or the slope is going to increase as sharply for those or not--

MR. KESSLER: It's a cartoon, Jeff, a cartoon. And all we've--

DR. WONG: We have other stakeholders out there.

MR. KESSLER: Sure. I mean one would think that it's sort of the classic learning curve, and we probably should have had this inflect the other way, but be it as it may, all I wanted to do was make sure we had one of those in there. There is definitely going to be some point, or many points, along the way where confidence will go down to whatever magnitude you want to think about it. Now I understand your --that was the technical part, and where is the broader confidence issues in here? Well, I look forward to hearing what Steve Brocoum has to say in terms of dealing with other long-term R and D, how might they get challenging models, how might public input be addressed in terms--this isn't what Steve is going to address, but certainly performance confirmation needs to address what monitoring is going to be done. There will be some monitoring. For example, the Nye County Wells, they were put in there for monitoring and for confidence of Nye County. There's going to be other things that will be put in to build that kind of confidence. I think NRC's already alluded to some things that to me look like they're more public confidence building necessarily than technical confidence building, but that's my personal opinion on that one.

DR. WONG: Yeah, I mean if you have an institution in which the public has low confidence, I mean, does the Panel believe that this particular process is going to be sufficient to overcome the threshold and that their confidence will grow or they'll just keep flatline with no confidence in the institution?

MR. KESSLER: We only got in a bit to institutional confidence. The big concern there that was discussed among the panelists was maintaining the sufficient knowledge about what's going on. I think Steve Frishman even mentioned it in his last remarks, this idea that it's a long haul and the institutions need to be maintained to keep the information and keep informed decision makers as we go along, and the public will change as things go along. And that all needs to be considered. I think that's about as far as we got along those lines, Jeff, in terms of the panel recommendations.

DR. WONG: Okay, thank you.

DR. NELSON: Okay, last question, Richard.

DR. PARIZEK: Parizek, Board. That kink could have had after operating license was issued? You had that downturn. That could be really after operating license?

MR. KESSLER: It could be, sure. I mean the point is, is that performance confirmation testing will go at least to the time of closure, and now there's discussion about potentially after that.

DR. PARIZEK: Not just--

MR. KESSLER: Yes, it's just--

DR. PARIZEK: --you can put one in, but it can be anywhere.

MR. KESSLER: It's just a cartoon, put it in there somewhere so we could talk about it because I knew you'd ask questions about it.

DR. PARIZEK: Yes. Well, we're going to also ask about research and development, the long-term kind of studies, the short-term studies to support LA.

MR. KESSLER: Yes.

DR. PARIZEK: There's any number of these points.

MR. KESSLER: Right.

DR. PARIZEK: And I guess the program will give us some highlights on that shortly. But from an EPRI point of view, you've done a lot to help facilitate this whole process, showing the way, how to make these analyses, you did one-on analyses one-off analyses, you did things that are very helpful. What research and development does EPRI plan to do from now on in order to help with these sorts of understandings in order to facilitate all of this? I mean you must have some goals and some plans of your own.

MR. KESSLER: Well, I was really depending on Jerry to ask me the same question he asked Bob Loux, which was do I have a big enough budget, but well, my boss is in the audience, so I--

DR. PARIZEK: Well, do you have a big enough budget?

MR. KESSLER: No, seriously, our goal for this year is to do our own evaluation of the KTI agreements. We want to understand what we think is most important about them. You know, we're transitioning into thinking about licensing, assuming that SR gets approved, and we want to basically question, well, are they all the right ones, are they the right priority, what's the timing for them? We want to have our own understanding of that. So that's our next goal, and we view this initial performance confirmation activity as a basis by which to help us understand and potentially prioritize things like the KTI agreements, as one example.

DR. PARIZEK: Yes. And then according to what one's fallout is being difficult to deal with, you might then do some research on those specifically technical in nature and so on.

MR. KESSLER: Right, right.

DR. PARIZEK: Other than administrative review.

MR. KESSLER: Right. And in terms of what EPRI specifically will do about them, all we can--our plans, at least for this year, are to highlight our understanding and our methodology and how we develop criteria for which ones come first or which ones are well supported.

DR. PARIZEK: How about next year? I mean, you must plan at least two years in advance.

MR. KESSLER: I'd love to. In terms of next year, I haven't really gotten there other than it's going to be--we always look for opportunities to tell a different story, fill in a hole where for whatever reason we think we saw a hole. And at that point it hasn't been identified. The project is moving fast.

DR. PARIZEK: So your vision is just kind of keep an eye open for where you can be both most useful it seems like.

MR. KESSLER: Right, right.

DR. PARIZEK: Thanks.

DR. NELSON: Thank you very much, John.

MR. KESSLER: Well, transportation certainly is something we're getting into, that's a new one for us.

DR. NELSON: Good. Okay, thanks, John.

MR. KESSLER: Okay.

DR. NELSON: We will move on into a suite of three presentations. The first one is going to be given by Peter Swift. You want to come up, Peter? And he will be making the presentation that had been prepared to be presented by Nancy Williams. Peter has degrees through doctorate in geosciences. He worked at WIP for nine years before coming to the project, and I think he's been here since, when, '97?

MR. SWIFT: '98.

DR. NELSON: '98. And Peter is going to tell us the story of where science is in this project and how science and engineering testing within the PA work interfaces with science and technology project and activities generated out of the office of the chief scientist. Please.

MR. SWIFT: Thank you. Is the microphone okay, you can hear me?

DR. NELSON: Beautiful.

MR. SWIFT: I want to start off by apologizing for not being Nancy Williams. She couldn't be here, she apologizes for that, so I offered to do this. The first portion she'll present--I'll present--is just an introduction to talks by Larry Trautner over here on design, and then again by myself on performance assessment science and testing. And I'll speak on my own behalf following the break.

This is a little bit of a switch from what John just talked about with performance confirmation. We're talking rather about the R and D work that is in our plan heading forward in the next two years. This is basically what's in our license application plan. And then Steve Brocoum will talk about science that goes beyond license application plan.

Can I have the next slide, please?

The overall planning goal that BSC took here is to be able to submit a license application, should that be appropriate and should the DOE ask us to do so, by December of 2004. We didn't go into this with that as a given date, we went into it with a target date, can we do it, and the work that we'll talk about here in the next hour was designed to evaluate whether or not that was an achievable date.

The work falls into three general areas, which we call performance assessment now within the project--I'll say more about that in a second--design, and LA--that's an abbreviation for "license application". Performance assessment here, the project has reorganized, and I'll do something that may be a bit unusual for a presentation to this Board, but I'll go through some organizational charts from BSC. I think they are relevant just to see how we've chosen to reorganize the work. Performance assessment now incorporates the science programs that I've been familiar with for many years and the testing programs, the postclosure testing.

And the greatest challenge we felt was within the performance assessment scope, testing, modeling, analysis. This would be where it was most difficult to--where the questions were hardest, we felt, as to whether or not we could achieve a license application in December of 2004. The emphasis was on making sure we had a sound technical basis, and yes, we made organizational changes.

Next slide, please.

The two other parts of the three key paths to a license application: design--and I'll really just defer here to Larry Trautner, the manager of the design project, and he will talk next; and development of the license application documentation and the licensing strategy, how will we actually document our case for the NRC, based on, for example, what the NRC has given us recently in the review plan, the key technical issue agreements that we have made with the NRC, and of course the ongoing work.

May I have the next slide?

I apologize for the eye test. I also apologize for showing an organizational chart, but I really do think it's relevant here. First, Nancy Williams here (indicating). I'm not her. You won't actually find me on the org. chart, I'm off the bottom down here (indicating). I'll start at the bottom here other than to know that Nancy's at the top. Across the bottom here are four projects--they're called "projects within the BSC projects". It's the way we've organized the work. The four projects across the bottom are familiar terms we all should recognize. The Site Recommendation Project, Jerry King's work. This is the group that put together the documentation that supported the site recommendation. This group is still active but is obviously winding its work down. The Repository Design Project led by Larry Trautner. The Performance Assessment Project, which as I mentioned now includes all of the familiar science and postclosure testing programs, and the License Application Project led by Steve Cereghino.

Two other points I want to make. I'm not going through the whole thing, but one of them here, this box here, the Science and Technology Project, this is brand-new as of the last two or three weeks. This org. chart is still very much in flux. This has Mark Peters in it, who's familiar to the Board, I'm sure, from having managed the testing program for many years. Mark will be moving into a new project, a direct report to Nancy Williams, to be the interface with the group that Margaret Chu described to you yesterday. This would be the new science and technology team forming within the DOE. This is new work. This is a job still in transition. Mark is here in the audience, and he can probably offer you more opinions on how that job will evolve through time.

The other thing I want to mention here while I've got this up is this thing called the Project Oversight Board over here on the far left (indicating). This is an advisory group that reports directly to Nancy Williams. She is the chair of it, and this group has meet quite a few times during the course of the winter to advise her on important decisions related to science and testing. And the membership of this group, just to go down quickly through who's on it there. The names should be familiar. They're representatives from the licensing and strategy groups, Don Beckman and Jack Bailey; from the project's Chief Science Office, Jean

Younker; from the National Laboratories, Andrew Orrell, Bo Bodvarsson, Joe Farmer; Tom Cotton with licensing experience; and Zell Peterman from the USGS.

The attempt here was to give Nancy a group of people who had a broad perspective on the project, understood the science, understood the licensing strategies and the implications. This is essentially the final court of appeals within the project for decisions about what work does and does not get done. And I will have an example here when I give my own talk of how that group actually functioned.

Can I have the next slide, please?

Within Bob Andrews' Performance Assessment Project, we've reorganized here basically to provide Bob more management support and a better focus of the science programs reporting to him. Down across the bottom here first: Testing Project, Engineered Systems, and Natural Systems.

Within the Engineered Systems--these are called subprojects--within the Engineered Systems Subproject you'll find the familiar science departments formerly, and still, called Waste Form, Waste Package Performance, Engineered Barrier System Performance, and so on. Those groups are managed by essentially the same people we've known for years and report through Tom Doering.

Natural Systems would be the unsaturated zone, saturated zone, the biosphere, and disruptive events.

And a new subproject created, Performance Assessment Strategy and Scope. This subproject has two groups in it. One of them is Total System Performance Assessment--that would be Jerry McNeish's team, which has run the calculations for years, built the TSPA model. The other is a group with did the work, which I'll describe in my talk, that provided the decision analysis support. And "support" is the key word. We didn't make the decision out of this group, we provided the information to support a decision by the project oversight board on what work would be done. So that's the strategy and scope part of the title of that subproject.

Can I have the next slide, please?

And this just--mostly it's in the handout here to make sure you have a copy of it available here--lays out some of the key milestones that we believe at a very high level will need to be met to make a December '04 license application submittal. And I'm not going to walk through them, I think they're there. You can ask me questions or I'll defer questions to others in the audience if I don't have the answers for them. We are now somewhere just past April '02, we're in there. So things on the left-hand side of it should already have happened, indeed they have, and the rest of it is laid out to the right of us there.

And I'm actually going to stop at this point. I'll field short questions, I think that's appropriate. And then Larry Trautner will speak, and he will talk primarily about the design paths to license application. I will then come back after the break and talk about the strategic work we did this winter and the performance assessment and modeling work on the path out to LA.

DR. NELSON: Thanks. Can I ask you to go to 4, Slide 4? It's the org. chart.

MR. SWIFT: Sure.

DR. NELSON: And I took one of these before, but there was another box on there. Can you just show me where that Office of the Chief Scientist is, Mike Voegele is?

MR. SWIFT: I'm sorry, I don't have that organizational chart, it's one up from Nancy Williams.

DR. NELSON: They're up.

MR. SWIFT: What you need is the top level org. chart for BSC, which starts with Ken Hess, who is here in the audience, and Don Peerman (phonetic), his deputy general manager. And then the direct reports at that level include a Chief Science Office, a Chief Engineer's Office, an Office of Projects--that would be Nancy Williams. That's the office through which work is actually implemented. And you'd also find the various essentially the support functions of the organization at that level as well.

DR. NELSON: Okay. Thank you. Any other clarifying questions? Yes, Dan?

DR. BULLEN: Bullen, Board. Go ahead to Number 6, please. Just a quick question. We saw a new--or we saw a different repository layout today that had another tunnel going in and saw five panels and the like, and we were told that that's just a conceptual design, it's not the final one, the TSPA-SR design is still what it is. But where would a design like that have to be frozen or changed, at what time frame in here in the design box that's blue? I see April '02 has "Conceptual design evaluations complete and requirements established," and then "Conceptual baseline update" by September. So somewhere in there I'm assuming there has to be we're making five panels, the first one's going to have the performance confirmation drift in it and all that.

MR. SWIFT: I think that's--

DR. BULLEN: So it hasn't been done yet, but that's the time frame should you be told to go forward? Is that kind of you're sort of waiting to do that?

MR. SWIFT: Um-hum.

DR. BULLEN: Okay. Thank you.

DR. NELSON: One more clarifying question.

DR. SAGÜÉS: Yes, Number 4 again.

DR. NELSON: This is Sagüés.

DR. SAGÜÉS: Sorry. In Number 4, again, of the Science and Technology Project, what does that box do?

MR. SWIFT: Well, as I say, that box's function is essentially waiting to see how the science program that Margaret Chu outlined briefly yesterday morning, to see how that evolves, to make sure that we at BSC are ready to implement it when DOE gives us direction.

So at the moment, Mark, would you like me to call you up here to comment further on that? I'm going to do it anyway.

This is Mark Peters, he is in that box and on the spot.

DR. BULLEN: Bullen, Board. It wouldn't have been an official Board meeting if Mark didn't talk anyway, because he's spoken to us the last nine times. So, Mark, we're glad you're here.

MR. PETERS: Thanks, Dan. Mark Peters, Los Alamos. As Peter already mentioned, it will be an interface with the function that you're going to hear from Steve Brocoum here shortly, so there will be some component of the out-of-the-box kind of thinking. But the other part of what I want to be focusing on, is Peter's going to tell you in the next session about testing that supports the LA. Part of my role is going to be to think about the testing and analysis that takes us out to, say, the 2010 time frame and work with people like Woody on some of the concepts that he presented this morning as well. That's about as best as I can go from here, it's a brand-new job.

DR. NELSON: Yes. Well, that's going to be a question that's going to come up again. If you don't understand it, raise it with Steve Brocoum, because the issue about what constitutes long-term R and D or scientific work beyond the time that LA application is filed is a question.

Okay, thanks very much. We will ask Larry Trautner to come up right now and make his presentation. Larry has had a 31-year career thus far with Bechtel, and he, too, did some service down at WIP and also at the Hanford Waste Site and the Nevada Test Site in earlier days, prior lives. Larry's job now is to manage the Repository Design Project, which you saw in the org. chart, and he will be talking about those plans to get the LA design set, maybe.

MR. TRAUTNER: Thank you, Priscilla. Can everybody hear me all right?

I will summarize the Repository Design Project's work plans for this fiscal year next and also try to describe how we're going to manage the key interfaces between engineering and science or performance assessment within those work plans.

Our first viewgraph?

The scope for Repository Design Project is fairly straightforward. We're going to design the waste package, and read into that a broader term, the engineered barrier systems, not just the waste package. And of course the subsurface and surface facilities that would go along to support the repository.

The overall percent complete we'd expect for the cut off for the license application would be about 30 percent complete. We'd expect the waste package design to be brought beyond that, the subsurface to be less than, you know, the waste package, and the surface facilities to be less than that. So it's not going to be a consistent level of detail, and I'll talk more about the level of detail.

Next viewgraph.

There are several goals, or you might call them guidelines, that were driving our scope for this work plan. The first and probably one of the foremost is to have sufficient work done to support the License Application. How are we defining "sufficient"? Well, that's does it comply with 10 CFR 63, and of course the Yucca Mountain Review Plan, which has quite a bit of detail in that. And, you know, John mentioned before me, and several other people have mentioned this, this design not only includes the design construction operation but retrievability/reversibility. So we will be providing in that License Application a design for retrieval of the waste packages and reversal of the process, so that is part of the requirement.

Consistent with that Yucca Mountain Review Plan would be a graded approach toward a level of detail or the level of design detail we go into for the different system structures and components. And that graded approach will be dependent upon the relative importance to safety of each of the systems, structures and components that we'll be designing. And that's driven, of course, by the performance assessment in terms of postclosure and by the Preclosure Safety Assessment in terms of Preclosure. So our design detail will be driven directly by the risk-informed performance-based processes that the safety analysis people go through. So we're providing a lot more detail for those systems important to safety than, say, for warehouses and admin billings.

A third area that's very important, of course, is to address the outstanding technical issues. Peter's going to address that in more detail about how we went through and prioritized that work, but about 10 percent of the outstanding technical issues are engineering based. In other words, they're designed at the waste package and a lot of the rotten mechanics things you heard Mark Board talk about earlier. So say about 10 percent of our effort--10 percent of the KTI effort is in engineering, and we'll be providing that and supporting that and making sure that those issues are addressed before the License Application is submitted.

And finally, an important point that Russ mentioned yesterday, is the support at the procurement acquisition process within DOE. DOE orders as well as the Yucca Mountain Review Plan require us to lay out detailed plans on how we're going to buy special equipment, how we'll construct the repository, and of course there will be things also tied into reversibility in that stage.

When you add all this up, what does this mean? Well, we'll have over 900 design documents, drawings, specifications, calculations, to support that, and other support documents, like a design analyses and studies and so on. That will be part of this License Application design effort in the next two years.

Another point worth mentioning is over 70 percent of those will be tied into the safety-related systems. So we'll still have some information there on the site plans and things like the interface control documents that aren't really tied directly into design but do have a lot of other types of documents in there. But nearly 1,000 documents will be prepared in those two years.

Next viewgraph. Our priorities.

Clearly the design is a performance-based, performance-driven design. If there ever was a facility or ever was a project where performance drives design, this is it. So clearly TSPA and, secondarily, but to the NRC just as important, the preclosure safety analysis are going to drive our ultimate designs. And we will be focusing during this period on ways to support PA and TSPA, especially where we can enhance confidence. You know, we've heard a lot about enhancing confidence.

One example here, you saw this new layout that we're pursuing. We haven't it adopted it yet. But one of the elements of that would be to drop the northern and southern extensions that are now in the layout in the SR because there were some issues there about water rise in the north and fractured rock in the south. So one way to improve confidence, enhance confidence, and not affect the ultimate result of the design, because it still is going to meet 15 mrem, would be to maybe look at not using that space for the repository.

Close integration with science. I'll have several viewgraphs that talk about this in a few minutes.

Provide flexibility. Woody talked about that this morning. Our design, our goal and our priority is not to provide a design that will prohibit or prevent or preclude any certain design options. Our goal is not to have certain options that are actually precluded because it was designed to perform, so that's why we want to have a design that can go hot or cold, we want to have a design that can handle different waste streams, variable waste streams.

Now, there's a lot of other variabilities involved that we need to be able to take that into consideration. So our goal here is to give the decision makers in the Department of Energy the maximum time available to allow them to be able to go and make these decisions, get the maximum amount of information they can. Again, you saw Woody's presentation this morning where you lay out timelines for that. Let's not let this design preclude some of those options in the future.

And last, certainly but not least, is to reduce cost. In the near term we're going to be looking at only providing a level of detail that's absolutely necessary to satisfy the requirements in the Yucca Mountain Review Plan and the 10 CFR 63, and of course to support science and the performance assessment.

In the long term, though, we'll be doing a lot of value engineering studies. We're undergoing some now. You saw Jeff talking about a couple of them this morning in terms of the layouts, the modularization, that kind of a concept. We'll be looking at materials as a result of the Waste Package Peer Review. They questioned the titanium in the drip shields. We'll be evaluating and taking another look at that and whether titanium is the right material or not. Always taking and leveraging on the SR design. Not necessarily changing it for the sake of change, but only if we can improve it somehow.

Next viewgraph. The integration.

I mentioned how important what we do is with integrating with science. A couple of the things, major things, that we've done, a reorganization. Peter described that briefly, the new organization that we have. You saw Tom Doering's name in the EBS Performance Assessment box. For those of you that know Tom, well, Tom was design manager for me for Waste Package and EBS Systems three, four months ago. Nancy and I and Bob Andrews agreed that we need to have better integration within the Waste Package EBS Systems and said one way to make that happen is let's take the design manager, put him in charge of the performance assessment effort. And you know, Tom is very capable of qualified to do that. He brought several of his good analysts over with him, and so we're driving integration that way, is one example.

Another example is the schedule. Bob and I spent hours and hours putting together a very detailed integrated work plan for Plan B to get us to License Application. That plan has 6,000 line items in it and over several hundred logic ties between science and engineering. So we've spent a lot of time doing the planning. You know, the concept in good project management is plan the work, then work the plan. Well, we did a good job, I think, of planning the work.

Now we've got the work plan, what do we do? Well, we've managed that also. Bob and I meet several times a week. Two of the important meetings we have each week, I'll highlight one, is we sit down with Nancy and Bob and I's direct reports and subordinates and analyze that detailed critical paths schedule. We do a 60-day look ahead and say, "Okay, what key activities on critical path or near critical paths are going to occur over the next 60 days?" and "If I'm giving something to science or vice versa, or to performance assessment, what does that do to the schedule, and how can we have work-arounds to recover from that?"

Another area that we meet once a week is I call Management Interface Meeting, where Bob and I meet and we invite Priscilla, the CSO, you know, Mike Voegele, or Jean Younkers if Mike's not available, and the engineering functional manager. The four of us sit down and talk about, you know, major top-level issues, like key staffing positions, you know, the kind of thing we talked about with Tom Doering, we talk about other top technical issues, possibly, whether it's seismic or whatever topic of the week it happens to be that's critical.

Okay, and also, one other thing we talk about in these meetings are information exchange drawings, and I will get into that in the next couple of viewgraphs from now and talk about what those are.

Next viewgraph would kind of highlight some of the logic ties. What I've done here is go into that 6,000 line item and pull out of there about 15 or 20 top key logic ties between science and engineering. Bob and I use this as a tool to look at these interactions on a weekly basis. And I'm not going to go through all of these, but let me just highlight three or four of them.

If you look under "Subsurface," the fifth item there, "Geotechnical rock parameters data". Well, Mark Board talked about that this morning. Very important element that we understand and we get good data, rock mechanics data, from the current testing that's ongoing out there. And Mark in this sense is working for both Bob Andrews and I to solve this problem, to develop this data, have the program, the testing program, generate that data and provide it to design so we can design our rock bolts and so on.

Another example of a different kind of interface, if you'll look at the third item under "Waste Package," the corrosion samples, or any testing that science is doing, performance assessment is doing on these material samples. Well, we procure those material samples. We'll go out, write a specification, buy those materials, and send them to science to do the testing on. So we work that way. That's another example of a logic tie that we have in that schedule.

A third example, and maybe a little different kind, if you look under "Surfaces," where seismic design is a soils layer engineering data. Well, you know, when we get into doing detailed design on the waste surface facilities, we have to do a seismic analysis which says, you know, what's your soil structure interaction look like? And so we need to have certain engineering parameters in that soils data. We didn't need to know that for Site Recommendation, but clearly we need to know it for License Application, licensing the facility.

So those are just three examples of the kinds of interfaces and logic ties that Bob and I review weekly.

And the last viewgraph I have here is another version of interactions between Bob and I. Well, we agreed early on that the way we want to document that data, that information that is flowing between science and engineering, how do we document that besides putting it in a memo and then it sits on a shelf and maybe grows dust and people can't find it later is that we agreed that we would generate a set of schematics that are drawings that actually have the key parameters listed on them. This is an example of, say, an in drift configuration schematic that would list things like drift diameter, drift--I guess the drift diameter must be on here somewhere--the drift diameter, you see the maximum wall temperature. That would be a key parameter that either he would want me or I'd need from him in this case of, you know, what is the actual maximum wall temperature in the drift that they're going to allow for design.

Other examples would be ventilation. We have to give the range of the ventilations rate that we provide to cool the waste packages. Another example would be in-drift materials and what are we going to use for the invert ballast and what are the actual material specs on those things so that Science can incorporate that into their TSPA and their chemical analysis in the drift degradation models.

So this is an example where we work together, define the information, make sure it comes across at the right time, and then we document it in these drawings that go under configuration control. So that if I want to change a drift diameter, I have to go through, modify this drawing, Bob has to agree to it, so there's total configuration control, that I won't go off and wander off and do something that's out of synch with what Science is up to, or vice versa, with performance assessment.

Okay, so that's pretty much my presentation. If I can leave you with just two points. One, Science and Engineering have worked together jointly to develop a very detailed work plan for the License Application. And that work plan includes logic tied integrated schedules. And Peter will go into more detail in his presentation, but we believe that this plan does address all of the outstanding technical issues.

The second point I want to leave with you is that we develop processes and tools to manage the interfaces within that plan. So the key interfaces between engineering and science, whether it's through drawings or through these routine meetings or through the detailed schedules, we have those processes in place to manage those interfaces.

Any questions?

DR. NELSON: Thanks, Larry. Let me just ask one. If you are considering design changes that really precipitate things that ought to be included in performance confirmation, who identifies that, and how is that information conveyed to Ziegler, I guess, who's in charge of the LA?

MR. TRAUTNER: Well, the LA will have a performance confirmation program in that, and I presume that information will be transmitted to whoever is managing the performance confirmation program.

DR. NELSON: Right, but how does it get over there? Do you identify, is that one of your jobs, is to identify design aspects that there needs to be work included in PC?

MR. TRAUTNER: I don't know if we've got a process for defining what exactly is going to go into the performance confirmation program. I know John made a good presentation on that. Steve Brocoum is going to be working that in more detail, as is Mark Peters. Right now, Mark Peters is responsible for that performance confirmation program, or was until two weeks ago, and now Doug is.

You want to say something, Jack? Anyway.

DR. NELSON: Only if you tell us who you are.

MR. BAILEY: I'm Jack Bailey with BSC. Yes, we have a performance confirmation department that works on what are the needs for performance confirmation. They provide those needs to Larry, and he engineers in whatever it is they need in order to do the testing. And if Larry has things which he believes he needs to do for testing, that interaction occurs.

DR. NELSON: When you say "we" have one of those departments--

MR. BAILEY: The Project has such an organization.

DR. NELSON: It's under you in Projects?

MR. BAILEY: No, no, it's underneath--

MR. TRAUTNER: It's under Doug Weaver now.

MR. BAILEY: Yes, it's with Doug Weaver now.

MR. TRAUTNER: Yes. It was with Mark Peters before.

DR. NELSON: Doug Weaver is part of the Science and Engineering Testing Project, right?

MR. PETERS: Hold on a second, I can maybe help.

DR. NELSON: Okay, Mark.

MR. PETERS: Mark Peters, Los Alamos. In the old organization, where I ran testing, I owned the Performance Confirmation Plan and the Test Evaluation Plan. With me moving over to a new job, the PC Plan is now going to be owned by Peter Swift in PA's space, because really, the PC

Plan is driven by PA in the safety case.

DR. NELSON: Okay, we can hear about that from Peter after our break, when Peter comes up and gives a talk. Shall we do that, Peter? Is that okay?

MR. SWIFT: Sure.

DR. NELSON: A very fast one. Dan Bullen.

MR. TRAUTNER: Well, before we do that, let me answer your question, because I don't think we answered that.

DR. NELSON: Please. Thank you.

MR. TRAUTNER: If you go back to my Viewgraph Number--is it 5? Let me see here--yeah, 5. I didn't mention Production Teams Interface Meeting. Once a week the Science Organization and Engineering Organization production teams meet, and that includes the performance confirmation people, and we discuss all the main interfaces. The kind of thing you brought up, saying if something comes out of design that might impact performance confirmation, if it's not important enough to be on these interface drawings, then the first attempt would be, or the first, I guess, time it would show up would be in one of these meetings.

Second, we're going to have a performance confirmation information exchange drawing. So that also would be whatever is needed by us for performance confirmation, whatever performance confirmation needs from us will all be documented on these sets of drawings. So that would be another way to formalize anything that occurs in these meetings.

DR. NELSON: Okay. I guess just to close it, what triggered this all was you were charged to do some value engineering considerations. One of the things that's precipitated in that cost benefit trade-off is in some cases you need to do performance confirmation for certain aspects of a design change. And so to make sure that that gets considered right there as part of the value engineering would seem useful.

MR. TRAUTNER: Right.

DR. NELSON: Okay, my watch says 7 minutes before 3; does anybody have another time? That's close enough.

DR. BULLEN: You promised the Bullen Board one more little one, but that would be hard?

DR. NELSON: Okay.

DR. BULLEN: Actually, this may not be the key time.

DR. NELSON: Bullen, Board.

DR. BULLEN: Bullen, Board, quick question. You mentioned that only 30 percent of the design in the ballpark is going to be done. Is that the time that it's docketed, or is that now?

MR. TRAUTNER: That would be at the time that we had the cutoff for License Application, which would be about January '04.

DR. BULLEN: Okay.

MR. TRAUTNER: But it's almost 11 months before docket.

DR. BULLEN: Right. So the question then arises is that we need to know what the design is actually going to look like, and so I'm guessing it's going to look a lot like what Woody presented this morning; is that not correct?

MR. TRAUTNER: Woody presented it--

DR. BULLEN: Woody presented a 2-meter--

MR. TRAUTNER: Yes, oh, that--

DR. BULLEN: --spacing, 81-meter drifts, 5 1/2 meters in diameter.

MR. TRAUTNER: We're still studying that. You know, is it going to look like that?

DR. BULLEN: Okay. Because I guess at least--

MR. TRAUTNER: I'm not very ready to say that yet.

DR. BULLEN: The final question with respect to that 30 percent is that would I expect to see the whole footprint laid out or would I expect to see a detailed design of Panel 1 or--I guess I'm trying to get a fix on what that 30 percent is going to be.

MR. TRAUTNER: You would see the whole footprint laid out. Not to a detailed design level, but to a--

DR. BULLEN: No.

MR. TRAUTNER: --level enough that the NRC can be comfortable with the total project. I think one of the presentations this morning, I forget whose it was--or was it Joe's?--said we're going to license 100 percent of the facility.

DR. BULLEN: Right.

MR. TRAUTNER: So all of the panels will be licensed as part of the submittal for the License Application. All of the surface facilities will be licensed, and they'll all be in that same degree of completion.

DR. BULLEN: Okay.

MR. TRAUTNER: Even though we'll build them in a sequence, we're going to submit the 70,000 metric ton facility as part of the License Application.

DR. BULLEN: Okay. Now I'll also see a detailed waste package design. Will I see a detailed drip shield design with emplacement? Even though you don't have to build that for 50 years at the earliest, will I see that as part of the License Application since it's a key part of the safety case?

MR. TRAUTNER: Yes. And I say yes hesitantly because "detailed" is a very general term. Yes, there will be details in there for the drip shield. Will it be the same level of detail as the waste package? Maybe not, but there will be enough information, again, for NRC to be able to assess the performance of the drip shield.

DR. BULLEN: Thank you.

DR. NELSON: Okay, thank you very much, Larry.

Larry will come back and make himself available for Q and A after Peter's talk, which will take place after the break. Let us adjourn now and come back by 3:06.

(Whereupon, a break was taken.)

DR. NELSON: Okay, let us begin the next and final session, at which we will hear from Peter Swift and then from Steve Brocoum. I introduced Peter before, and he is the manager of the Performance Assessment Strategy and Scope Subproject. And now we know what that means because we've seen the org. chart. And Peter's going to introduce us to a couple of fairly complicated concepts here, so pay attention.

MR. SWIFT: Okay, actually, I should probably start off by just answering the question about performance confirmation and the org. chart because that probably won't come up otherwise in my talk.

First of all, the org. charts, they're actually a formal management tool within BSC. They have to be signed off, they have to be approved by management. And we're right in the middle of rearranging them right now, which is why there's some confusion as to we didn't want to put ourselves in a position where we were making an org. chart here in public, we do things in internal management decisions.

The plan, indeed, is to have the PC, Performance Confirmation Plan, move into my subproject, however, that has not yet officially happened. That's why Mark and I were struggling a little bit. It is still in testing. We wanted to have it in my subproject because we wanted it closely linked to the licensing strategy, the licensing people, and Steve Cereghino's department, and we wanted it well informed by performance assessment. We're looking at PC Plan, the Performance Confirmation Plan, as something distinct from the larger Science and Technology Program. The PC Plan is a regulatory document, it's part of what we're going to docket with the NRC. It will meet the requirements of the PC portion of Part 63. So that's basically our strategy, is to make sure that that scope of work defined by the regulation is closely tied to the performance assessment and to the licensing group, and therefore we think it's going to stay in my subproject while the rest of the long-term science program goes into Mark Peters' group.

All right, actually, can I back up to the first slide? I'm sorry. The title slide. I wanted to just give a little credit here. Rob Howard, the deputy subproject manager of this group, did a whole lot of the work that I'm about to present, and a lot of conceptual design for it came from Karen Jenny (phonetic) at Geomatrix, and a great deal of the--well, you'll see the work done by Tim Neiman (phonetic), also with Geomatrix. I just wanted to make sure that they got due credit for this.

Next slide. I'm going to attempt here to give an overview of the planning for the next two years in the Performance Assessment Project. Mostly I'm going to be talking about the process by which we got there. I will say something about what's in it, but most of what I'm saying is the process, and you'll see when we get to the end here, I'm not the expert on every single thing that's in it, so I'll have to rely on others in the audience to help on that.

A little review here from the previous one. The PA Project includes natural systems, engineered systems, testing, and TSPA and this strategy and scope group that I manage. We went through a risk-informed prioritization, and that was the basis for the planning--a basis for the planning. That's much of what I'm going to talk about. And obviously our goal here was a defensible and sound basis for a License Application in December 2004.

Next slide, please.

Again, 2004 was not necessarily a given going in, but it was a target.

Our job was within the prioritization process, evaluate and prioritize work in performance assessment and science; focusing on necessary License Application work scope; identify and--it says "select" here, actually within my group our job was to recommend, not to select, select is a management decision, the overall scope of work balancing project management risks. Risk-informed here is more than just risk in terms of hypothetical dose to humans in the far future, it's risk to the project in a management sense. Are we spending our money wisely? Will we get what we need to get from it? Document that basis and ultimately submit it to the DOE.

The management decisions that we made needed input from the technical staff and the technical line management, from the Total System Performance Assessment team, from senior project management, and from the Project Control Office. These are the budget trackers, the people who manage that massive schedule that Larry Trautner described, which is really a remarkable thing. And all those groups had to help inform the decision.

Next slide, please. We asked the department managers--and here I mean the Technical Department managers, people the Board is very familiar with, the people managing the Saturated Zone, Unsaturated Zone, Waste Package, and so on, Departments--to redefine their work scope, organizing it by TSPA model components. The reason for choosing the TSPA model components, that is where we can get the most insight from the existing TSPA models. For each work area, each work component, we asked them to define three alternative work scopes, Levels 1, 2 and 3. You know, basically what we're headed for here is a utility analysis where we're going to decide which level of scope of work we need to do.

Level 1, the lowest level, we presumed but did not insist that it also have the lowest cost, would be the work required to meet our own internal quality assurance requirements and model validation as defined by our own internal reviews. And this would have been for the models we used in the Supplementary Science Performance Analyses last spring, the SSPA, and in the Final Environmental Impact Analyses done in the fall. So what we're doing here is bringing our current TSPA models up to a QA level where they could be used during application.

Level 2 Scope, assumed to be a larger scope of work, didn't have to be, though, the goal here was to take a risk-informed path to resolving particularly the key technical issue agreements with the NRC but also other outstanding concerns. By risk-informed, I mean taking into account the importance of that area overall on repository performance. So if it was an important area, more work might be required. If not, less work might be acceptable.

Level 3 Scope would be adding the additional technical basis. This essentially could be looked at as doing all the science without looking to see which mattered with respect to importance on performance. "All" was too strong a word, but Level 3, anyway, was a larger body of science than that proposed for Level 2.

We identified attributes. We're going to end up here doing a multi-attribute utility analysis. We identified the attributes against which we wanted to evaluate each of these work scopes.

And we wanted the technical staff to provide primary input. Not the TSPA staff at first and certainly not the management at first, because the people who are the experts on the technical work are the ones doing it. So we sent out a questionnaire.

Next slide, please. Oh, I forgotten this one was in here. This is simply a list of the model components that we broke the work up into. And actually, that list, I realized going over it on the airplane, is missing a couple. There was a UZ climate change and a waste form colloid one that's missing from that list.

Next slide, please. Here are the attributes that were in our questionnaire that we asked each of the Science Department managers to work with their staff to evaluate their work components against these. And I'll say more about what that means in a second here.

First, they can be grouped qualitatively into three main groups here. Russ Dyer mentioned these Monday morning. In fact, they aren't grouped, this is a 16-dimensional utility analysis, but conceptually it does help to group them that way. Some of them relate to the quantitative performance measures, the things you can actually calculate and compare to a firm standard. There are only three of them: change in 10,000-year mean annual dose--that's total mean annual dose that is driven by the probability of weighted volcanic dose; change in groundwater concentration--that's for undisturbed performance, that does not include the volcanic disruption; and change in the human intrusion scenario.

Then a group related to regulatory defensibility and acceptability with respect to the docketing of a license application; inclusion of credible FEP's and exclusion of those FEP's that can be excluded; multiple barriers, can we identify and describe the capability of our multiple barriers and can we meet our KTI, Key Technical Issue Agreements--I'll come back to those in a second.

Over here a long list of qualitative acceptability and internal/external defensibility things. These are things we know matter. And I think, Dan Bullen, I think you asked how do we quantify external acceptability. Well, we can't. We can't quantify whether or not you will accept our work. As a proxy, we can estimate what we think is likely to lead to acceptability, but ultimately acceptability is in the eyes of the NRC and the Board, other external--you know, we can't actually determine external defensibility, we can only estimate it.

Now some things here that matter, then, in this column. Impact on confidence of internal reviewers, external reviewers. We wanted to catch the internal reviewers. That's an important point. If we haven't got the buy-in from our own side, we're not there.

Quantitative metrics that we can calculate using the TSPA tools but which are not required by the regulation: change in the time that we first start to show 15 mrems per year--that needs a "per year" on it--sort of when does the steep climb in dose start to occur for undisturbed performance; change in uncertainty in the system performance, what's the range of results we're getting around the mean that is a regulatory limit; 10,000-year dose, if we condition it on early waste package failures and take out the volcano; change in peak dose out at several hundred thousand years; consequences associated with the conditional igneous--that should say disruption, not intrusion, it's both eruption and intrusion. And it's conditional is the point we're trying to get at there. If it happens, what effect does it have on that.

And two here which actually can be tied to the regulation, uncertainty in the parameters used in the model, and uncertainty in conceptual models.

Go on to the next slide. Thank you.

So for each of these attributes we need to get information from various different people. The information is necessarily qualitative. I mean you can call it semi-quantitative if you want, because we did try to quantify it, but these are subjective human judgments with a very few that can actually be calculated by the TSPA models. Most of what we're talking about here is human judgment from hopefully the right people.

First question, how likely is it that this scope of work--i.e. your Level 1, 2 or 3 work, let's say you're the Waste Package Department manager and you're being asked about your degradation testing program--how likely is it that this scope of work will result in a change with respect to whatever attribute it is you're evaluating here? If you do this work, is it likely to change understanding of, let's say, peak dose, is it likely to change the likelihood that this will be acceptable to external reviewers? Is it likely to lead to resolution of KTI Agreements? And so on. And the possible answers there were: very unlikely, unlikely, neutral, likely, and very likely, which translate to I think --I'll try to convert it into percentages--5 percent, 25 percent, 50 percent, 75 percent. I think that was how it went.

Then after we had that elicited from the technical staff who knew their own work best, we went to the TSPA Department and said, "All right, here's what they want to do in this scope of work, is it going to change--in this case it's the ones that are quantified--but will it change dose, will it change peak dose, and so on?" And so responding to this question would be the TSPA modelers.

These first two we actually did in a cooperative workshop with all the right people in the room at once, so that there was no secrets, the TSPA team knew what the science groups were saying, and vice versa. And it was about as close to a consensus of opinion as I've seen on the Project.

The bottom two are independent, and this is important. These are management decisions down here, and you don't want technical staff making this sort of decision. What weight does the project assign to the attribute, i.e. how important is it? Is this a strategic decision? Does the Department want to put all of its eggs in the basket of simply meeting the quantitative requirements? We can do that, assign a weight of 1 to total dose, give everything else a 0. We didn't do that, obviously, but that is a management decision that's separate from the technical staff's understanding of what the work actually does.

And value, what value does the project assign to possible impacts? This again only applies to those things which had quantitative TSPA possible answers. But would the project be more interested if a result caused dose to go up or dose to go down?

So these last two things were elicited from the management team. I'll say more about that in a minute if I need to.

This is an example of a spreadsheet. During our interactive workshop with the science departments, this was up on the screen the whole time. Here are the questions down on the left, and the possible answers. And ignore the cost numbers there, those were preliminary, but you know, they're real, we're thinking of cost. I'm not going to try and walk through that, just to show you the example of what we had there, that we worked through every single possible answer for each of the work scopes at three different levels.

Next slide, please. And now what's a multi-attribute utility analysis? Well, those were the attributes, the 16 things a few slides back, or on the questionnaire there. The utility that we're interested in is simply the sum of three terms here, the likelihood that it will change our scoring with respect to the attribute--this is the number that the scientists provide, if you want to think of it that way--the impact, and the weight--these are the management numbers.

So the technical staff define the likelihood of an impact, they define--I'm sorry, I said that wrong. The technical staff, i.e. the TSPA staff, define the magnitude of the impact, management assigns a weight to that magnitude and a weight to the entire attribute, and you multiply and sum.

Next slide, please. For each work package you end up with a summed total utility. It's a dimensionalist number. What it means, basically, is how much is each thing you're measuring, the work scope, how much does it contribute in sum to weighted value for each of the attributes. The weight comes from management, the value comes from the technical staff.

There's nothing particularly unusual in this technique here of a multi-attribute utility analysis, I think it's a fairly straightforward thing. It's important to realize, though, that it does use informed subjective human judgment. Ask the right people the right questions, get the technical staff describing the technical value of their work, get the management team thinking hard about what work is it we really need.

Can we go on to the next slide? Get results that look like this for engineered barrier system flow and transport. The column here (indicating) shows total utility for three different levels of work. And the first thing that at least jumps out at my eye off this is that if you go from Level 2 to Level 3 you get no more total utility. As a decision maker, since you already know that Level 3 costs more than Level 2 and takes longer, it's not buying you anything more in respect to the 16 things shown here in that column.

You can also take this graph apart in more detail if you had it in color. I don't think you do. Each one of these colors maps over here (indicating), you can see what it is that's doing things. For example, the big blue one here is "Resolution and closure of KTI's," I believe. Obviously somebody felt that--the EBS technical experts felt that they had to go to the Level 2 scope to achieve a greater level of confidence that they would satisfy the KTI agreements.

Next slide. Just a different example. This is unsaturated zone flow. And again, each one of these scopes of work has a written description, many pages written describing what work would be done in Level 1, what work would be done in Level 2, Level 3. And these are the weighted scores associated with how well that work would address each of these attributes, what impact it would have on each of these attributes.

Next slide, please. This is an example, then--this is all done in an Excel spreadsheet that was built by Tim Neiman from Geomatrix, and we ran it in real-time for both staff audiences and for management audiences--this is just one example of the sort of result you can get out of it. Incremental utility here.

Can we just back up one slide?

Incremental utility is the difference between one level and the next. Next slide. In this case, this is the incremental utility that you get from going from Level 1 to Level 2 ranked from those work packages that essentially bought us the most utility to those that bought us the least. Don't pay a lot of attention here because this is only an example, but it's a good one. Doing extra work in this example in igneous activity showed the highest utility. It's dimensionalist number, it's only valuable relative to each other.

We actually had a negative utility because our cladding team boldly said, "Well, if you really want the cheapest, simplest expert cladding, stop taking credit for it and you don't have to pay us." And so we had a negative utility for Level 2 in cladding. We actually got less benefit out of it, but it was cheap.

Next slide, please. Now, how do we use this information in forming the management review and decisions? First of all, we put together many charts of incremental utility values, like the one you just saw, from Level 1 to Level 2, Level 2 to Level 3, and so on. We looked at the sensitivity of our utility values to the management weighting, and we did this by we actually elicited a different set of weights from that oversight board I described a little while ago. We got them in the room, we explained the whole process to them, it took half a day, we went through a semiformal elicitation where they indicated what attributes they thought were important, we put their weights in, combined with the technical staff's value judgments, and we were able to show our own management team that actually their weightings weren't that different from the weightings that we had already presented to them. Which, for example, on the previous slide, the management weightings were on average Bob Andrews and myself. Well, we compared that to management weightings from those names in Nancy's Oversight Board that I went through earlier.

And then we put cost into the function, we showed the board utility cost ratios, which of course if you're doing a formal cost benefit analysis, cost is a big factor here. And we do want to look at cost, that's one of the things as a--we want to be responsible here about how we spend the DOE's money. The goal was not to simply spend it all until it's gone, the goal is to use it wisely.

So my team presented an initial prioritization, our recommendation based on this sort of information, to the Management Oversight Board in January, and we had then a three-day meeting with that Oversight Board where they took our work and reviewed it in great detail and tore it up and informed themselves.

Next slide, please. All right, we then brought our recommendation and our spreadsheet and all of our insights gained from this process to the Project Oversight Board. That was, you saw the names there, Licensing, National Laboratories, USGS, and Project Management itself in the form of Nancy Williams, Jack Bailey, Don Beckman. And that group spent probably two full days going through the work scope descriptions in detail and adjusting the recommendation we had made to them, adjusting the work scope descriptions themselves, calling in the department managers who had made them, and eventually the board came out with a decision that was based on utility, as we'd done the utility analysis, and yes, it was based on cost--I'll say a little more about that in a second--and it was based on schedule. We didn't go in predetermining we could make the schedule. We wanted to see if we could make a schedule with a defensible product and the cost that we had available. We concluded we did.

One of the things that the Oversight Board was able to do was use an informed management that we had not put into the analysis. Basically--and here's the best example--the Oversight Board immediately placed a high value on continuing ongoing testing. This was not something we could score ourselves going in. The management team looked at it and said, "There's got to be some value attached to continuing work already in progress, you don't just shut things off."

Cost, I just want to--we've had I guess twice now the concern that the budget--one of the outcomes of this was a drastic cut in the science budget. That's actually not true. The budget that we actually submitted to the DOE and the DOE has now accepted--we submitted it March 1st--has essentially the same amount of money for FY02 in Bob Andrews' performance assessment project as we did going in. We didn't come in here planning to talk money, but--and it's within $500,000 of where it was going in. Things have been rearranged considerably. That's to be expected. Certainly it is absolutely true that the management team would have been pleased if we'd discovered we could get on schedule to 2004 for less money, that would have been a great outcome. We didn't do it. The recommendation that my team made would have produced considerable savings, but when we looked at things like this, the decision was to go ahead and spend the money.

So, next slide. This is, yes, management decisions. Generally, the Level 1 work scope, that minimum level, is what we came up with as being sufficient to support a docketable LA. That was our goal. And that puts the emphasis on validating the models that are already available. However, we then--and this is where we end up spending essentially the same amount of money we had coming in--we took specific activities out of the Level 2 and Level 3 work scope and brought them back into the planning portfolio on a case-by-case basis. The Oversight Board went directly into the work scope descriptions from where the department managers had described their Level 2 and Level 3 work scope and said, "This activity has got to be done, got to be in the package, this one can be deferred."

So what we ended up with, basically a bias towards continuing ongoing testing and validation studies, regardless of where in the prioritization process they fell. And there were several activities that we also felt we could move forward to accelerate them, literally put more money into them, from where they had been planned originally in order to make the '04 date.

For example, on the work in the igneous disruption consequence area, basically the work will be done even more rapidly than it had been proposed, and that adds a cost.

DR. NELSON: Peter?

MR. SWIFT: Yes? Oh, you want me to wrap up here?

DR. NELSON: Five minutes.

MR. SWIFT: Thank you. Next slide, please. March 1st, BSC, we gave detailed work packages to the DOE. DOE has accepted that proposal and the plan is being implemented. Obviously there are--oh, there's a lot of activities behind those simple words, "being implemented".

All right, and now this is perhaps what the Board was really interested in. I'm sorry if it came out in the last five minutes. How does this planned scope of work address uncertainties?

First point here is that the DOE is committed to supporting a license application that meets the NRC requirements. This shouldn't have to be said, but it is being said. We will meet the NRC's requirements regarding uncertainty, and here are some key ones from the rule: the DOE will not exclude important parameters simply because they're difficult to quantify. DOE will focus on the full range of defensible and reasonable parameter distributions. DOE will consider alternative conceptual models consistent with available information. And we will document the impact of that uncertainty in the LA.

Next, please.

That is not necessarily the same as committing to reduce uncertainty, that's documenting the impact of it, which is what the requirement was for.

So our testing and research focuses, then--and actually there's a bullet missing here--first it focuses on validating the models we're going forward with, that should have been said--but quantifying the uncertainty in those models and the input parameters in them, evaluating the impact of that uncertainty on system performance, and identifying those areas where the existing uncertainty has a large impact from a licensing perspective. And those are the areas where focus from a licensing point of view needs to be on reducing uncertainty.

Performance confirmation work, which I described briefly as we're defining it as the scope of work that meets the regulatory requirements for performance confirmation, and other long-term research and development, science and technology work will further reduce that uncertainty. That's a confidence building exercise that Steve will talk about and which is not on the--deliberately not tied for the critical path for license application except indeed to make sure that we have a plan for performance confirmation as required.

Three or four slides here, just to give you a sense of what types of things are in the plan. I mean, the Board is just concerned about what's in the plan, what are we doing. There isn't time to go through all of these, I knew this going in there wouldn't be, and I'm not disappointed by that. We could have spent an hour on each one of these productively if that were the intent, but the intent here, rather, is just to give the Board a feel for hopefully some sense of comfort that in fact the work selected for the License Application plan is a good comprehensive piece of work.

I'll run through these slides because I've got them here, but within the Unsaturated Zone, testing in Alcove 8/Niche 3 as validation work for the active fracture model, Niche 5 seepage testing, the Cross Drift bulkhead testing, drift scale test, Chlorine 36 work is continuing, field studies at Peña Blanca are continuing.

Then the Engineered Barrier System here. I could read them.

The next slide, please.

If we have questions on specifics here, this would be an appropriate time to ask during, you know, the Q and A. Again, I'm not going to try and walk through them all because I can't do them all justice.

Next slide, please. One point here from the Saturated Zone, a point worth making which I think is probably not news to this group, the Alluvial Testing Complex here, we had hoped for multi-well testing there also. That is on hold indefinitely right now due to permitting issues with the state. Therefore, we are looking at--this is work going on in real-time back in Las Vegas--looking at alternative ways to gather information to help support the Saturated Zone flow and transport models.

Igneous activity, a point worth making here that we will be conducting an independent peer review starting up in just a few weeks on that. That is one of the ways that we believe we can accelerate the schedule in igneous activity. And Mark Board I think had already talked some about seismic activity.

So a summary here. Planning decisions were informed by the multi-attribute utility analysis and utility/cost schedule. Cost, as I said, definitely it was a factor, it's a responsible thing to do, but in fact there has not been a catastrophic cut in funding for science. There has been money moved around from one activity to another.

And our emphasis here, then, is on qualification and validation of current models, treatment of uncertainty for license application, and we have knowingly and deliberately biased the outcome in favor of continuing ongoing testing.

DR. NELSON: Great. Okay, thanks, Peter.

In deference, I will let Dan Bullen say something if he wants to. Do you have any questions, Dan? Since I slighted you in the past.

DR. BULLEN: Point of order, Madam Chairwoman, are we allowed to ask questions of any of the speakers, including Mr. Trautner, who is sitting in the audience, or--

DR. NELSON: That's wonderful. Larry, would you join us, maybe, up here. Maybe you could take the podium in case you need to chime in.

DR. BULLEN: My question is specifically for Larry because you were doing the value engineering, the cost studies, and I guess Carl Di Bella pointed out to me that I've been dancing around the issue the entire day, and I raised it with respect to the 2-meter waste package spacing and Jeff Wong actually asked me the question about the 81-meter drift spacing. And the question that I have here is that if you're doing a cost analysis and you don't change the 81-meter drift spacing, doesn't that unfairly bias your analysis against the low-temperature design? Because you don't have to go 81 meters apart for low temperature.

MR. TRAUTNER: The 81 meters, I don't believe that would be the case because the drift--you're talking about the actual 81-meter spacing--

DR. BULLEN: Right, because I'd have to drill a lot less perimeter drifts, right?

MR. TRAUTNER: That's all you do is drill less perimeter drifts, that's correct. That wouldn't be a significant factor compared to the overall cost.

DR. BULLEN: But that's the whole reason that you get mad at the low-temperature design, because you have to drill those extra drifts, and then you have to drill more drifts because they're spaced farther apart. Is there not a trade-off there in that I gain a couple meters every time? I mean this would make it look more like a wash to me.

MR. TRAUTNER: I'm not sure what you say when you say "get mad at the low temperature".

DR. BULLEN: I know, I know. It's been a long meeting and-- But I guess the question is, I would sure like to see you do that analysis where you take a look at the 81-meter drift spacing as it reflects the true value of what the changes might be and justify why you can't or can change that spacing for the low-temperature design.

MR. TRAUTNER: We could change that spacing for the low-temperature design, however, that would violate our goal of being flexible. We could not go back and do the hot-temperature design, as I understand it, because 81 meters was essentially the minimum spacing that we've concluded that you go for the hot temperature to keep 50 percent of the drift in between to be below boiling. So if at this point we make the decision to move the drifts closer together and we went and constructed that way, we would not be able to go back and go to a hot temperature operating mode.

Is that fairly stated, Mark?

DR. BULLEN: Fair enough. That's probably true.

MR. TRAUTNER: Woody, you still here to help me? I think that's where we're going.

DR. BULLEN: That's fair enough, that you couldn't--you couldn't make it hot--

MR. TRAUTNER: Couldn't make it hot.

DR. BULLEN: --unless you made the waste packages bigger or changed something else.

MR. TRAUTNER: Right.

DR. BULLEN: I mean, in the static case that you have, I mean you could make it hot, I mean we could figure out a way to do that if they were closer together, but you couldn't let it shed or--

MR. TRAUTNER: I think it would be difficult to make it hot if you went closer together because you would have difficulty. Some of our waste packages are hot, but, you know, not all of them. We're going to have some cold waste.

DR. BULLEN: Right. Thank you, Madam Chairman, that's all I had.

DR. NELSON: My pleasure, Dr. Bullen.

Debra Knopman.

DR. KNOPMAN: Knopman, Board. Peter, this was really interesting to see how you organized your kind of a systematic view of what needed to be done, and I think your team should be commended for working their way through it. That's the good news, it's really interesting how you went about it. Love to see the weights and will hope that you provide the Board with the various weights. You don't have to put names on the weighting, but--

MR. SWIFT: We had a session with some Board members in March in Las Vegas, and I think we actually did put the names up on the screen for you, didn't we, so you could see who said what?

DR. KNOPMAN: Okay, well, I didn't see that. But what I thought was so interesting was where you ended up. And if we go to Slide 16, after all the work that you did, you essentially came back to the status quo, or so it seems. That is, you're working with those models that you've got already available as opposed to reaching out to something else if there was justification for that, I don't know. You know, the continuation of the ongoing, at least selected ongoing testing. So, you know, it would be interesting to know, I think, where there were significant substantive differences in what your team had gone in recommending and where you ended up. And I think it would be revealing to us. First of all, it just shows this is what happens with multi-attribute utility analysis, it all comes down to the subjective weighting after you've done all the work on the technical analysis and you can trigger the numbers however you want. So that's sort of Question Number 1.

If I can just put on the table a second question. The organizational chart as well as the way you've described this whole analysis and exercise all is PA oriented so that it is sort of self-referential. If something shows up as significant in PA, then it kind of keeps going in the process. If something in PA itself is not sensitive to a particular phenomenon, oh, let's just say thermal processes or hydrothermal processes, it's not going to show up as a particularly significant feature in this kind of analysis.

And then the next step with that is all of this is PA-oriented, what about the rest of the safety case that the

NRC is asking you for that has to do with multiple lines of evidence and everything else? So it seems like you took a very narrow view in the end, even though you sort of started off with the structure of doing a much more expansive, in some ways clean slate look at what you needed to do, you kind of didn't end up there.

MR. SWIFT: Let me start with how I thought I was going to answer the first question. There's a report that--relatively thin report, 50 or 60 pages, that summarizes the exercise that has at the end of it--well, as you work your way through it, you'll find the recommendations that my team made to the Project Oversight Board, and then you will also find in an appendix at the end a line-by-line description of what ultimately was in, what was out. And the listings of what is out will be very, I think, useful for you to see what activities were not carried forward. And I think that would show you that we didn't simply end up with a status quo, we actually ended up with a realignment of work that supports a common goal.

Now, yes, the decision that will go forward to licensing with the models that we used in the work you saw last summer, that is correct, to that extent that does look like the status quo. We felt that was the best strategy we had for the License Application that was defensible in 2004.

With respect to the question of it being too narrowly focused on performance assessment, there is some confusion over the term, or the words, "performance assessment" as distinct from TSPA. And I mean I caught some of that in Claudio's talk yesterday, for example, where he uses performance assessment in a broader sense, I believe anyway, that it almost is synonymous with the safety case.

From the NRC's point of view, things like multiple barriers are a part of the performance assessment. The TSPA, the calculation, is the quantitative part. But I do consider things like demonstration in multiple barriers and their capabilities to be part of the performance assessment. And that was the intent in renaming the Science and Analyses Project Performance Assessment Project. It wasn't to exclude science from performance assessment, it was to bring them together, rather than apart.

The way the multi-attribute utility analysis was set up, no, it was not biased against things that PA was--TSPA, sorry, was insensitive to, and there were things that--because we had attributes that spanned the qualitative and external defensibility confidence types of, well, attributes, activities that would have no impact, I believe, on calculated dose. Things like a criticality event, for example, I have a darned hard time seeing how that's going to affect dose. And yet it certainly affects external reviewer confidence, it affects--we have KTI agreements with the NRC over it. Criticality issues scored relatively well in this analysis despite the fact that they aren't going to change dose. You know, no one felt that was a likely outcome. So there was less of a narrow TSPA bias in this, I think, than you perceive, much less.

DR. NELSON: Dr. Cohon.

DR. COHON: Thank you. Could we look at Number 19 for just a second? You talked about, and as the slide shows, quantifying uncertainty and evaluating the impact of uncertainty on system performance. Now if we go to Number 6. I was struck by the fact--and even more so in light of Number 19--that none of the potential quantifiers of uncertainty, or estimates of uncertainty, or criteria associated with uncertainty, are part of quantitative performance. They're all part of acceptability and defensibility. And as the exercise was intended, everything that's not under quantitative performance is specifically not quantitative, right, it was not intended to be. So isn't this a disconnect--

MR. SWIFT: No. I'm sorry, I interrupted you.

DR. COHON: No, if you're ready to answer, go right ahead.

MR. SWIFT: The quantitative performance was limited to those things for which there is a quantitative limit in NRC's rule. These are things over here that can be quantified but cannot be compared to--some of them can be quantified--but they can't be compared to a regulatory limit. So that was--grouping this group over here (indicating) highlights the idea--and it's a wrong idea--that one way to approach the problem would be simply to keep the doses below that 15 mrem per year limit, and if we did that, we'd be done. Keep the average doses. That's the first one there.

The impact on representation of uncertainty at the parameter level is something that needs to be quantified. This is the step at which on that Slide 19 or 18 we were just on, where we need to make sure that we've got uncertainty quantified in a way that can be promulgated through our models.

DR. COHON: What's the purpose of quantifying uncertainty, why does it need to be quantified?

MR. SWIFT: Well, one answer is that the regulation actually does call for it.

DR. COHON: Well, let me interrupt you.

MR. SWIFT: Yes?

DR. COHON: You just said that you only made it to the quantitative performance group if there was some regulatory standard or limit to which you could compare the number. So you just said the regulation requires you to quantify.

MR. SWIFT: The regulation requires many things that are qualitative, not quantitative.

DR. COHON: But you just said--we were just talking about quantifying. My question was, why would you quantify uncertainties, and you said because the regulation says we have to.

MR. SWIFT: It says we have to, but it doesn't set a limit on it.

DR. COHON: So there's nothing to compare it to, and that's why it doesn't make it to that category?

MR. SWIFT: Yes.

DR. COHON: What do you intend to do with quantified uncertainty? I mean is there some internal sort of house limit on--

MR. SWIFT: No.

DR. COHON: --quantified uncertainty?

MR. SWIFT: No. The uncertainty that I think we want to make sure that decision makers--in this case, decision makers would be, in the context of a license application, it would be a licensing board--we want to make sure that they have access to our best estimate of the uncertainty associated with our results. We show them--let's say, a .01 average mean annual mrem per year dose, and we have some uncertainty band around that. We need to show them that as information that they need in their decision-making process. That's our job, we must show them that, and this Board also.

DR. COHON: I'm really pleased to hear you say that, because you sure didn't do it for the SR. The Secretary's Report not only doesn't communicate the quantification of uncertainty, it does just the opposite in my view.

With regard to external defensibility, did you reject the idea of asking external bodies for their views on attributes, their subjective evaluation, etc.?

MR. SWIFT: We actually considered it for weighting, although not for scoring. And we actually asked a couple members of this Board if they'd be willing to participate in a weighting exercise, and I believe they wisely said no. But for the scoring, basically the technical input from our own experts, no. We relied on the people most familiar with the very specific piece of work and we believed they were the people doing it.

DR. COHON: Thank you.

DR. NELSON: Okay, Don Runnells.

DR. RUNNELLS: Runnells, Board. I'm curious, Peter, about linkages among these various topics. Let's see, what's the word we use for--let's go to Slide 13, that's a better way to ask the question. I'm curious about the linkages among the listed items up there. What do you call those things?

MR. SWIFT: We call them components.

DR. RUNNELLS: Components. If I look at the components there, I see four that are UZ related: UZ Coupled Effects, UZ Flow, UZ radionuclide Transport, and UZ Seepage. And in my mind at least, those are physically and chemically very closely related to each other. They're not independent, they are coupled. How was that handled in terms of independence of components, or interdependence of components? And then the second part of that question is--hopefully the answer is no--hopefully these do not correspond to project titles managed by individuals. I mean--okay, I'll stop.

MR. SWIFT: Some of them do, in answer to your second question.

DR. RUNNELLS: But only some, okay?

MR. SWIFT: Only some.

DR. RUNNELLS: All right.

MR. SWIFT: The rearranging of work scope by model component, or system component, did break some institutional barriers and reinforced others. In answer to your first question, the important one, is we did not have a systematic way to ensure that linkages were properly captured going in, and we saw this when we went through the workshop in early January with all the science department managers present with our team. And our defense here is that we fixed them on the spot when we found them. We sort of called our managers on it, we said, "Look, over here let's take a hypothetical example in UZ flow and seepage over here. You said this piece of work was absolutely needed over at Level 2 in flow, but you can't do Level 1 work in seepage unless you did Level 2 work in flow. What's wrong here?" You know, moving back left to right so that they're aligned properly.

This piece of work was done in two months. I think it's a good piece of work for and it's appropriate level of effort for the value we're getting from it. But a systematic elimination of that type of linkage problems would have had to have been built in from the front, and we didn't do it.

DR. RUNNELLS: I'm wondering, though, if a different choice of components had been made that recognize that linkage, if the bang for the buck would have been greater. If you see what I mean.

MR. SWIFT: Yes.

DR. RUNNELLS: If I were to link, for example, UZ Flow and UZ Radionuclide Transport under some other name, I'm wondering if my incremental utility would have been significantly greater. I think it might have.

MR. SWIFT: Yes. And in other presentations I've made on this we've had a list of caveats that we certainly were very careful to inform our management team about. Yes. Less than the linkage problem, we had a problem with defining the --particularly when we got to the utility/cost ratios, people who coarsely aggregated their work had a large cost associated with a single utility. People who finely divided it--you'll notice that the waste form people broke there's up in as fine a set of components as they could--they got very small costs associated with their things, so utility/cost ratios went up. That was the sort of thing we had to filter back out using human judgment afterwards.

DR. RUNNELLS: Okay, thank you.

DR. NELSON: One last question from Paul Craig.

DR. CRAIG: Yes, Number 10 first of all, please. I believe we've talked about the various publics at various points, and this utility approach that you've got here really does look like the sort of thing that would be very interesting to a lot of publics. It might be quite interesting, I'd be intrigued, for example, how Steve Frishman would fill out such a thing, or how the folks from Nye County would do it. And you have the potential for a tool here that could be quite interesting.

Your focus is clearly on regulatory compliance, and maybe that's why if you go to Number 13 and I look down the list there, there's nothing about corrosion of C22 in there on the list that I could see, although maybe I'm not reading it properly. There is something on waste package drip shield performance for some reason. And I guess from your--

MR. SWIFT: I sure hope there's a waste package degradation.

UNIDENTIFIED SPEAKER: It says, "Waste Package Performance".

MR. SWIFT: Yes. I'm sure it was up there.

DR. CRAIG: What?

MR. SWIFT: There is a Waste Package Performance box there.

DR. CRAIG: Oh, there is? Okay.

MR. SWIFT: Yes.

DR. CRAIG: Okay. I missed that one. But anyway, the way in which you would place your weight on these things might very well differ a lot if you were interested in regulatory compliance versus whether you're interested in how the thing would hold up over the long haul and whether you might expect surprises and want to do something about surprises. And the type of questions that you might ask could be quite different, and I suspect in many cases would be quite different. So it seems to me that you--that you have a potential for a nice tool but you've exercised it very narrowly, and perhaps this is the reason why you're coming up with the kind of answers that Debra referred to rather than answers that might broaden the discourse a bit.

MR. SWIFT: I accept the comment. One of the things that, when we asked Karen Jenny, who advised us in putting us together, one of the first points she raised was that before you design the analysis, know what question it is, what decision is it you're trying to inform, where are you headed with this, what is it you're trying to support. And in this case, the decision of our team going in was that we were trying to inform our management team on scope of work necessary to support a docketable License Application. So, yes, you know, go back to the first slide. If instead our goal had been broader and longer, the questions we asked might have been somewhat different, and also the weights that the management team applied to different things might have been different.

DR. NELSON: Okay, thank you very much, Larry and Peter, thanks for being willing to reorganize the schedule and to help us.

And our final speaker for the day is Stephan Brocoum. We've known Steve for a long time, it seems. His title is Senior Policy Advisor, and his background is in geology, ultimately with a PhD from earth sciences at Columbia University. And he's been involved in licensing and regulatory activities for much of his professional life. He's going to speak to us on the subject of "Enhancing Confidence, Technology, and Efficiency for Radioactive Waste Management".

MR. BROCOUM: That's correct. Next viewgraph. We're going to present an overview of the proposed science and technology program, we're going to talk about the relation between the proposed science and technology program and performance confirmation. They are separate. This is a task force, so we're going to talk about the task force scope of work, we're going to talk about some examples at a very conceptual level, and a summary.

Next viewgraph. The top bullet, basically, is what we've been talking about up to now. Peter went into a lot of detail of how we developed our detailed work plan to get us to potential License Application in 2004. And you heard yesterday Under Secretary Card and you heard Margaret Chu give their vision of what continued scientific investigations would be and how the Department might go about doing them. You heard Russ Dyer state that he's set up a task force and he asked you to head that task force to actually implement this continued scientific--or come up with a plan to implement this to continue scientific investigations.

So I want to tell you who's on the task force. I'm on the task force, Dennis Williams is on the task force, April Gill, we're all detail to the Project Manager's Office. In addition, we have Steve Hanauer and Abe Van Luik. We interface with BSC through Mark Peters and through the Chief Science Office, Mike Voegele and Jean Younker. We've also been helped with a little bit of work we've done to date by Claudia Newberry and Bill Boyle. The task force is actually official on April 21st, so it's a relatively new task force.

Basically, consistent with DOE's objective of long-term stewardship, we've set up the task force to develop this proposed science technology program with the intent of increasing confidence in projections of performance and understanding the repository system, improving existing technologies used in the waste management system, and perhaps promoting efficiencies in the long range in the repository system since it's such a long program that goes for perhaps hundreds of years.

We plan to make recommendations to our management on the possible science and technology strategies and work scope. Margaret committed to the Board to have to come back in September, so I guess we have to make our recommendations to Margaret and Russ Dyer in the August time frame, and we're going to work to that.

It's very important, and Under Secretary Card made this point, that, you know, the main focus and objective of this program is a successful or viable License Application. He said that the first book that will be full by money is that LA line. And so these activities that we are planning supplement but are not on critical path. They're not in line, or on the line, going to License Application. So we will not impact the resources necessary to complete the LA.

Now a couple of words about performance confirmation since this is a performance confirmation session. You know, performance confirmation is required by the NRC, 10 CFR 63, Subpart F. Now, I really like the definition that John Kessler used today on his Slide/Viewgraph Number 8, "Activities are specifically designed to evaluate the technical basis for the license position."

Those are truly part of the critical--you know, defining the performance confirmation is truly part of the critical path to getting to an LA. And those would be developed by the licensing group here under Joe Ziegler.

The PC Plan that we develop will be part of the LA, and the current plan will be revised to reflect the current and final 10 CFR 63.

The science and technology program will be broader than the PC program. It will look at it in holistic approach towards all the issues related to geologic disposal. It will address issues and alternatives beyond the basis, direct basis, for the safety case.

Finally, the last point is, you know, once site characterization was over--it's essentially over--the PC program began collecting information and many of the ongoing tests now could be considered part of the PC program.

Our scope of work. Well, we're going to identify potential work that will contribute to our long-term objectives and goals, our long-term stewardship. That's basically to increase our understanding of a natural engineered systems and the projection of long-term performance.

We've already started to assemble comments that have been made by the Board, by the Waste Package Peer Review, by the IAEA, the Peer Review on the TSPA, by the Biosphere Peer Review. We want to make sure as we develop this plan that we're informed by the comments the external oversight bodies made. So we're going to very carefully pull together all the comments when we're doing that and make sure we can see if we can address them all in coming up with this recommendations to management.

Also, we're going to coordinate with other DOE offices--this is, you know, other offices in DOE--universities, international programs, and other scientific organizations. I mean, science, in a sense, can be done in three places. It can be done within the program based on resources we have, it can be done through the university system--we're already spending about $10 million a year on the University of Nevada system through the cooperative program--and it can be done through international cooperation, international programs.

We had a major international program from '89 to about '95. It was cut back at that time, but I think Margaret has made several comments she would like to have a stronger international program, and that will be part of the mix of doing the science. So it will have at least those three components.

So we will identify plans and tests and develop models, and perhaps perform analyses to contribute to our understanding. Those can be done, again, in the program, perhaps in international program. For example, Dennis Williams is going to Switzerland on May 20th to discuss with the Swiss the potential use of our non-radionuclide tracers in one of their experiments so we can see how they correlate to radionuclide tracers.

Next viewgraph. Even though we're not on critical path for License Application, we still need to have milestones and, you know, have to be able to report progress. Another goal is to foster excellence in the Project by encouraging publication in peer-reviewed journals. We are updating our policy on publication to encourage our people to publish. And very important point that Margaret has made, and Card, is that look at new "out-of-the-box" concepts and emerging technologies to see how they can improve the waste management system. And I fought with the third one today from the State of Nevada on having a low-temperature repository.

Now, some examples. You heard Peter spent quite a bit of time on how we developed our plan. And on his Viewgraph Number 4, he had the three scopes showed, and the Level 3 Scope was the most scope of work, largest scope of work, and had some additional technical basis. You know, we want to start with what Peter has done, and his group has done, and build from that. So we will be looking at these Level 3 activities and see which would be appropriate to bring in the Program or to do as long-term research and development. Then, you know, Margaret went over this yesterday. She's very interested in technical issues, comments on all repository programs, and these kinds of issues might be very amenable to an instance they are common with other repository programs, be amenable to the international program, for example.

So in summary, you know, we are developing a program, and it's actually a plan for management to consider, we will get out the proposal in the August time frame to Russ and Margaret for their consideration. That plan will not only consider work that the Project can do but work that can be done in the international community and work that can be done in university system. And we encourage--we would like to somehow interface with the Board as we develop this plan. Right now it's very conceptual, we've just started thinking about it, but as we progress, we would like to interface with the Board and get your input as we develop a plan. So if we have a plan developed, the Board will have had chance to give us comments before we finalize it.

Thank you.

DR. NELSON: Thanks, Steve.

Since the task force was created, what, three weeks ago?

MR. BROCOUM: Yes.

DR. NELSON: What was the first step?

MR. BROCOUM: Start assembling information. For example, we pull together all the comments that I said that you have made and various peer reviews have made, and so on.

Second thing is, we try to pull together all the activities that Peter talked about that didn't get put in the program. We call them "on the cutting room floor". There's about 70 of those activities, and we have those pull together. And we also start thinking how we could build on Peter's process to kind of screen ideas that people come up with and decide, you know, how to weight them, how to put them in the program. And we've done a lot of brainstorming, because the "out-of-the-box" is where we haven't really thought enough yet, and we need to do some thinking there.

DR. NELSON: Are you going to do this both from an experimental and analytical perspective so if you start thinking about developing new models, different kinds of models, in addition to the experimental?

MR. BROCOUM: I wouldn't exclude that, that's possible. We're trying not--I mean I've heard some very good comments today about the process that Peter Swift and his people use, and we'll take those to heart. We took some notes as questions were being asked.

DR. NELSON: Okay. Bullen.

DR. BULLEN: Bullen, Board. Actually, this is a good viewgraph to start with, because I would hope, and I probably should have asked Under Secretary Card this question yesterday, but he didn't have a viewgraph that said it, although I'm pretty sure he did say it in his presentation to us, that he wanted the development of technologies to improve long-term performance and reduce repository costs. Sure would like a semantic change in there that says "and/or reduce repository costs," because I'd love to be able to see you develop--this is the diamond underneath of the first indent there.

MR. BROCOUM: Oh, okay, I see, yes.

DR. BULLEN: And so if you have "and/or" there, that means you could develop something that would improve long-term performance--

MR. BROCOUM: Yes.

DR. BULLEN: --whether or not it reduced cost--

MR. BROCOUM: That's correct.

DR. BULLEN: --or it could reduce cost and not improve performance. I mean those are the things that would all tie in together. So it doesn't necessarily have to do both of those things to identify as an attribute that the Science

Program would want to carry on.

MR. BROCOUM: No, I think on my earlier viewgraph there were three. Those were separate things.

DR. BULLEN: Oh, okay.

MR. BROCOUM: Okay? So--

DR. BULLEN: Okay. Actually, I kind of wanted to go back to I think it's 10, you want to go back to the previous one there? Whoop, almost.

MR. BROCOUM: 10?

DR. BULLEN: Yes. I'm sorry, 10, not 2. Back one.

MR. BROCOUM: Yes.

DR. BULLEN: Let's see, and what was I going to--this may not be it. The one that was basically going to--oh, "Reduce toxicity and waste volume". I guess the question I have there is, when you're thinking out of the box, and you're thinking of what's required by law to go to Yucca Mountain--and the one thing that jumps off the page at you is the greater than Class C waste that's like, wow, you have to put those in expensive cans and bury it--is it your group's purview to take a look at the science that maybe does a cost analysis and says, "Look, we're paying a whole lot of money to take this greater than Class C waste," which just doesn't qualify under Part 61 as low-level waste that can be disposed of, or is that--I mean is this not quite the avenue to do that?

MR. BROCOUM: Well, this is kind of--you know, it's always been hanging out here and never a clear position about where it was going to go, and I think it's something we have to discuss internally within the Department as well as with external parties. I don't have an answer for you. But it's always been something on the side here. So that's all I can say right now.

DR. BULLEN: Okay. Just one last comment, is that I am very heartened by Margaret Chu's comment that she wants to get a fraction of the budget to stay for science, and I wish you all the best of luck in maintaining that fraction, whatever the budget profile might be. And I think the Board has always been in favor of a very strong and consistent science program in support of all the licensing activities. So I just want to go on record, at least as Bullen, Board, as saying that I think that this is a good program to continue.

MR. BROCOUM: Okay. Thank you.

DR. NELSON: Any other questions or comments? Dave Diodato.

DR. DIODATO: Diodato, Staff. Steve, on your Slide 6, just on performance confirmation there, kind of the last bullet makes a statement that the "completion of site characterization" is the concluding phrase there. So what does that mean, is site characterization complete at this point? Do we know everything we need to know about the site?

Is it all understood?

MR. BROCOUM: If you look in the Nuclear Waste Policies Act, it says, "Upon completion of site characterization, the Secretary will--" So, you know, the Act says the Secretary could recommend after the completion, so one could argue that site characterization is completed. I think our lawyers have taken a position site characterization goes on until the site is designated. That's why I was a little vague as to whether site characterization is completed.

Also, Part 63 requires performance confirmation program to start during site characterization, so that's why I said some of the ongoing tests today, as site characterization completes, will become--for example, the large scale heater test, you know, that will go on for four more years or whatever, so that will--obviously performance confirmation, assuming the site's designated.

DR. DIODATO: Thank you.

DR. NELSON: Okay, thanks, Steve.

I think we have a question, since we have a little bit of time, Dr. Parizek would like to ask a question that Peter might be the one to respond to.

DR. PARIZEK: Parizek, Board. I was looking at prioritization, and it's Revision 1, it's March 2002, and there are certain activities that are listed under just a variety of areas of scope reductions at work for certain work periods, like natural analogues and other categories. And I didn't know if some of these are the ones that dropped out based on the screening process that was used that you described for us. And then I was just wondering if that's something that Steve's program would then pick up and put in his list of things to worry about for the future. Because there's quite a number of things on this list that would seem to be important to performance.

MR. SWIFT: Peter Swift, BSC, Sandia National Labs. You're looking at this report here (indicating)?

DR. PARIZEK: I believe. It's Revision 1, March 2002. It's PA 6.4, Section 6.4, PA Prioritization.

DR. NELSON: It lists Plan B scope activities and indicates which ones are scope reductions.

MR. SWIFT: The short answer to your question is that, yes, if that's the document that I've got here, those are, as listed, the ones that were not carried forward into the current plan. And yes, those are candidates for Steve Brocoum's group.

DR. PARIZEK: And Plan B really is what you had for December 2004 activities.

MR. SWIFT: Yes.

DR. PARIZEK: I mean, you didn't actually identify it in your Slide 2, so it was a little hard to know where that came from. Okay, thank you.

DR. NELSON: Thank you. Well, I"d like to thank all of our speakers this afternoon for making such clear presentations. I'd also like to extend a thanks to John Pye, who's been spending the last couple weeks, months organizing this meeting and has done a super job.

And since there are no more questions at the moment, I turn it back over to Dr. Cohon.

DR. COHON: Dr. Chu has something she'd like to say.

DR. CHU: I just want to make a small announcement. The House just voted on Yucca Mountain, it's 306 counts to 117.

DR. COHON: Thank you.

DR. CHU: Thought I'd let you know.

DR. COHON: We also received word that the party affiliation breakdown is also interesting. Republicans voted 203 yes, 13 no; and Democrats voted 102 yes, 103 no; and there's 1 independent, who voted no.

I want to add my thanks to all of the speakers today, and certainly to John Pye for organizing this meeting, and to our wonderful administrative staff for pulling if off so well.

We have three people who have signed up for public comment, but I believe George Danko has already departed. George, are you still here?

UNIDENTIFIED SPEAKER: He's on an airplane.

DR. COHON: He's on an airplane. So we have Don

Shettel. Don, would you like to go first? Is he still here? There he is.

MR. SHETTEL: I'm going to yield my place in the queue to Judy Treichel. I have to catch a plane.

DR. COHON: Okay. Judy Treichel.

MS. TREICHEL: Well, thank you. Judy Treichel, Nevada Nuclear Waste Task Force. I have to say something about the staging, and I don't have a copy of Charles' presentation, so I'll pick it up on the way out. But one of the slides that he had was one that took Todd Laporte's criterion for a staging program, and the first things were to everybody buy in on a concept and to get public approval for that. And there were a couple of things that are completely off the scope and could never happen here. But one of the things that was very clear when Charles was talking about what staging actually is, and what we see staging in other countries, is that you get to a certain point, everything gets evaluated, everybody likes what's there, and then it goes on from there.

This is being done, or it's being fit in, in exactly the opposite way, where you sort of agree to go into Never Never Land and do a stage that is supposed to have been done already or that you would give some sort of confidence to. And it really just doesn't work that way. It's sort of in Las Vegas it would be called "betting on the come". And that's not the way a stage repository, in anybody's mind, I don't think, was supposed to work. So I hope that the Department of Energy isn't allowed to just fit themselves in and use the word "staging".

I think it's also incredible what we've seen today about the fact that there's a reorganization going on, there is a brand-new repository footprint that none of us have ever seen today, the EIS is already out with another design, those people who just voted on Capitol Hill hadn't seen what they probably were voting on. So it's very weird that you would have--one of the reasons that you lack confidence is that everything changes all the time. And if you had--another thing you'd need for staging would be that that stage that you had just finished stayed the same and it was there, whereas this keeps changing all the time. And so everything that you've done before is sort of out the door and not being built upon.

I kept thinking as I was sitting there, particularly during Peter's presentation, I would love to have you bring the finished program, the entire program, here because they could sit in two rows right there, and they're dealing with exactly the same stuff. And either it's going to be really dangerous and kill a whole lot of people, but it doesn't seem like that's the case, because as Claudio was saying, there was tremendous confidence and that people were going along with this. But when you see the sort of structure and this craziness and the teams here and the teams there and the number of levels to do essentially the same thing, unless I'm really missing something here, it would be really interesting to see what this program would look like on the finished model. And maybe then it would have some confidence because you'd really know what it was, and so would--you wouldn't have to each time you had a question get the different person up because he was talking about the people were even interchangeable and they even knew the whole program, like you're being expected to do. So I think that's a very interesting thing.

Just to finish up, there was a lot said today about reversibility, and many times that's interchangeable with retrievability. And that's going to be the big trust item, because it's so easily thrown out, "Oh, yeah, well, we just go back in and get it." And there's an awful lot of people, and I'm one of them, that just doesn't think that can happen like that, or that if you had a real problem you could just stash it out there on the desert, or get it out at all.

So thank you.

DR. COHON: Thank you, Judy.

Are there any other people who wish to comment? Don, do you want to comment now?

MR. SHETTEL: Don Shettel of GMI for the State of

Nevada. Today my comments will be limited to ventilation modeling.

A lot of computer horsepower has been applied to some of the ventilation models that we've seen today, some more than others, especially the MULTIFLUX's run on the Cray. These models partially rely on evaporative cooling of water to dry the mountain and to dry out the mountain. And however, and you knew this was coming, a fairly simple phenomena has been overlooked or ignored in these models. And that is, when you evaporate water, you precipitate salts and minerals and leave those behind.

An analogy, for those of you that live in the west and have some experience with a swamp cooler, or evaporative cooler, you know that the efficiency over time of that--it's essentially an air conditioner but uses humid air--but the efficiency goes down over time because the salt builds up on the pads and the solution in the bottom of the pan gets very salty and briny and eventually you have to change out everything.

However, in this case, in the case of Yucca Mountain, the precipitates will build up in the fractures, initially a few meters into the wall rack, and I suppose this has something to do with the influx of water coming towards the drift as ventilation proceeds versus the diffusion of gas vapor actually into the drift. These precipitates will greatly reduce, if not eliminate, the evaporation of water and flow of air into the ventilation drifts, and this renders the modeling essentially nonconservative.

By selection of reasonable values of parameters, such as fracture porosity, infiltration, skin thickness in the wall rock, water compositions, etc., I have calculated that this plugging might occur in the order of a few years, if not less, depending on ranges of parameters that you might select as being reasonable. We don't know exactly what these might be yet during ventilation.

I'm preparing a manuscript on this that should be finished in a few weeks. I will forward that to the Board.

But there's another disturbing aspect to this, and that's that some of these models are going to be used by people to validate against each other, and if they both are essentially incorrect by ignoring evaporation and precipitation of salts, they may both validate each other, but they are conceptually wrong.

Thank you.

DR. COHON: Thank you. Is there anybody else who would care to comment or to ask a question? Yes, Englebrecht, please--Parvis, you can--actually, Parvis, you're probably going to talk about ventilation, yes? Englebrecht, if you don't mind, could we have Parvis next? Thank you. Since it's obviously relevant to Don's--

MR. MONTAZER: I just wanted to make a quick comment. In none of my simulations did I take credit for fractual flow. In all the simulations that are presented today, it's all matrix flow, there's no fracture involved in any of them.

DR. COHON: Don, Don, Don, to the mike. Don't go too far away, Parvis.

MR. SHETTEL: You're still taking credit for the evaporation of water going from liquid phase to the vapor phase, and that imparts endothermic reaction and uses up heat and cools.

MR. MONTAZER: In the first place simulations on the overall simulation of the waste emplacement boreholes, that does not affect, because I'm not taking credit for the evaporation in that particular case. In the case of when I have the 20 or the 60 different waste emplacement boreholes. In the case of--in the other two cases when I'm trying to show the first 300-year cooling effect, I do take credit for some of the evaporation. But in the matrix flow, if you consider the amount of solids that could be possibly deposited is just inconsequential as far as the evaporation is concerned. If you include the fractures, yes, you get a tremendous amount of extra cooling. But in none of these simulations am I taking credit for that.

DR. COHON: You want the last word, Don?

MR. SHETTEL: It's an unrealistic model to use a matrix flow for ventilation. The fracture flow is the most important thing we've seen from infiltration studies, and to say that that's not going to be important in ventilation I think is a mistake.

DR. COHON: Thank you. Englebrecht. Sorry about that before. And please identify yourself for our recorder.

MR. VON TIESENHAUSEN: Englebrecht Von Tiesenhausen, I'm with Clark County, and I'm happy to say my comments do not concern ventilation. I want to address performance confirmation just very shortly, more as a parking lot issue, because there are no finite plans to assess. The container lifetime and corrosion processes are probably the most critical issues under the current performance assessment regime, and I have serious concerns that any critical data will be obtained on those issues during performance confirmation, especially if the time period ends at time of closure. Using waste packages and some other issues like that would probably help, but it fails to address cumulative issues that could happen in a real waste package. So even though the ideology of geologic disposal is you seal it and you forget it, I would opt for the fact that maybe some postclosure monitoring could be considered and that be made part of a License Application.

Thank you.

DR. COHON: Thank you. Any other comments or questions?

Yes, Dr. McCombie.

DR. MCCOMBIE: Charles McCombie, Switzerland. I just wanted to come back to the issue of the science program that was mentioned from the very beginning to the very end, I think it was the first and last thing. Because it's very good that it's going to happen and I like the elements in it, and so on. The point that kind of disturbed me was the assumption, or even the suggestion that the scale of the program should somehow be directly correlated, proportional to the project costs. I think there's no rationale for that. It's not just a good thing. If the project has a low, than a long-term program doesn't want to suffer from that. If the project has a high, if you suddenly start building massive engineering things and the costs go up, there's no good scientific reason to have the scientific program scale with it.

So I think the real thing is to get a reasonably dimensioned, in an absolute scale and scientific program. Bob Card mentioned a few tens of millions, I think, and I was a little bit perturbed at the assumption that seemed to go around the table in particular from Don that ought to be a scale factor. I think that's scientifically not a justifiable approach.

DR. COHON: Thank you. Dan?

DR. BULLEN: Bullen, Board. Actually, Charles, I agree completely. What I was hoping for was that minimum threshold, that it never went away. And our concern was that, you know, basically we've seen in the case of the cut down to $250 million from 400 million, a lot of things absolutely stopped. And so our Board has always considered the long-term and, you know, the long horizon. And so a minimum is exactly--I completely agree with you, let me put it that way.

DR. COHON: Tim?

MR. MCCARTIN: Tim McCartin, NRC. Englebrecht, the regulations do require a program for post permanent closure monitoring. It's not elaborated on, because obviously that's something if the decision is to move forward, it's maybe as much as 100 years from now. But 63.51, the amendment for permanent closure, does require a program for post permanent monitoring.

DR. COHON: Thank you. Any other comments or questions?

(No response.)

DR. COHON: Thank you again. We hope you'll join us at our next meeting, which is scheduled for September 10th at 11 in Las Vegas. We are adjourned.

(Whereupon, at 4:39 p.m., the meeting was adjourned.)