UNITED STATES
NUCLEAR WASTE TECHNICAL REVIEW BOARD

SUMMER BOARD MEETING

June 26, 1997
Crowne Plaza Hotel
Las Vegas, Nevada

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I N D E X

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P R O C E E D I N G S

(8:00 a.m.)

COHON: Good morning. First, let me inform you of two minor agenda changes. First, Priscilla Nelson will be chairing the bulk of this morning's session, but not until after the first talk. The first talk is really the last talk of yesterday's session. So, Debra Knopman will continue as Chair, and she'll take over in one second.

The other is that Lake Barrett will be making brief remarks to the Board at the end of the published agenda; so, at approximately noon and just before the public comment period. And, indeed, there is another public comment period. If you wish to make remarks, please sign up with Helen. We welcome that.

And, finally, the all important, remember to talk into the microphone. This is being recorded, and if you don't do that, they can't hear you, they can't pick you up.

Thank you. Debra?

KNOPMAN: Thank you, Jerry.

Yesterday, we spent a fair amount of time talking about the unsaturated zone and remaining uncertainties and that part of the natural system. This morning, we're going to have just one talk on the saturated zone flow and transport. Our speaker is Dwight Hoxie. He is a hydrologist with the U.S. Geological Survey here in Las Vegas. He's been with USGS or he's been in Las Vegas, at least, since 1984. Dwight manages all the process models, the development and work with many of the investigators on behalf of the M&O.

Dwight, feel free to correct my remarks there if need be.

HOXIE: Let me put up a slide. First of all, I'd like to say that this being the morning of the second day of this meeting, I do have the opportunity to conduct empirical tests of two alternative conceptual models. The first alternative model is that--since it's very early in the morning, the panel and the audience, as well, are very fresh and eager to get going and will be very incisive in their remarks and pay attention. That's one conceptual model. The other is that, well, maybe some of you have fallen prey to the lures of the attractions of Las Vegas and spent a night on the town, perhaps until the wee hours of this morning. Maybe you're not quite as fresh and bright-eyed as you might like to be. In fact, you might even be wishing that I kind of speak softly and not make too many loud noises at this time of day.

These alternative conceptual models, of course, are very important to performance assessment; that is, your assessment of my performance this morning. The thing is that I am not going to test these models. Actually, I'm going to borrow from my colleagues in performance assessment, and I'm going to adopt the stance of reasonable conservatism and take the first alternative as my working hypothesis and get on with the presentation.

Okay. I am going to be talking about the saturated zone. I want to, first of all, just point out a little bit about the geography of the region and what it is that we are going to be talking about. Of course, the saturated zone comes into play once the engineered barrier systems are breached and we get radionuclide transport down through the underlying unsaturated zone to the top of the water table and fends out to the accessible environment by groundwater flow.

I want to show you this is just the boundaries of the regional groundwater flow system that encompasses Yucca Mountain. It's also the boundaries essentially of a regional groundwater flow model that we have constructed in order to provide boundary conditions for what we're calling the site-scale saturated zone flow and transport model. And, Yucca Mountain is located about right here. So, this is the area that I'm talking about. The regional model, again I say, provides boundary conditions for this rectangular box. So, when we talk about the saturated zone, we really do have to talk about a large area that encompasses a much smaller area of immediate concern. I'm going to leave that one up there so I'll have it for reference and I'll try not to get in the way of things.

One of the things that--at least, the agenda that I had said that we wanted to talk about today are what are the key uncertainties associated with saturated zone flow and transport. I was very fortunate in that there was a workshop that was conducted by the process modelers, the flow and transport modelers, along with performance assessment personnel that identified a set of key issues and uncertainties. This workshop was held in April here in--actually, in Denver and I will talk about those issues. These issues also were identified yesterday by Abe Van Luik. So, this talk follows naturally from his. And, I've done another performance assessment type approach and that--I think they came up with 14 specific issues in their workshop, and I've abstracted these and tried to group them into some larger scale issues. So, I'm going to be talking about essentially four major issues; the spatial distribution of advective flux--I'll define that in just a minute--alternative conceptual models, and effective transport properties, future climate change.

Under spatial distribution of advective flux, this is the moving groundwater that it's actually carrying the radionuclides or solutes or whatever. We have three sub-issues that we need to address and I'll talk about those individually. That's the regional recharge and discharge, channelization of flow, and vertical flow. Again, the significance of knowing something about the advective flux in the Yucca Mountain area is because it's groundwater moving beneath the site that we feel is going to be the principal transport medium for transporting radionuclides out to the accessible environment.

So, now, let me talk about these three issues individually, define them, and try to give you some indication of their significance with regards to performance assessment. Regional recharge and discharge, that has to do with the amount of water that's actually coming in to this groundwater flow basin and discharging from the groundwater flow basin. We can't measure recharge directly. The current technique is to estimate it using a method that was developed here in Nevada, so-called Maxey-Eakin method. It's been modified and made more sophisticated, but it's essentially a correlation of altitude with precipitation; the higher the altitude in the mountains, for example, the more precipitation you have and the more likelihood for recharge. So, down here in the Spring Mountains, the tall mountains outside of Las Vegas, we have a high potential for recharge. This is actually reflected in the potentiometric surface contours. You see we have large hydraulic gradients here because we have water being recharged in the mountains and moving down into the basins. And, similarly, you can see other places where we have potential for recharge.

Unlike recharge, if we talk about discharge, we have--in principle, can measure this particular entity. For example, we can measure discharge from springs. We can go out to playas and make some measurements that might give us a handle on evapotranspiration. We can monitor pumpage from wells, for example. The significance of knowing what the recharge and discharge distributions are is because these provide the boundary conditions for our regional groundwater flow model which, in turn, provides boundary conditions for our site-scale model.

Another thing that we're concerned about in talking about advective flux is the possibility of flow channelization. You heard a lot about that yesterday in terms of fracture flow within the unsaturated zone. We have a similar kind of problem with the saturated zone. That is the flow can be channelized as a result of intrinsic heterogeneity within the hydrogeologic framework. For example, the spatial distribution of hydraulic conductivity, the parameter that measures or quantifies the transmissive properties of our aquifer systems. So, that can channelize flow into discrete, more favorable aquifers, aquitards, confining beds, and so forth. We have to deal with large-scale structural features like faults which can act as conduits for flow or even as barriers for flow. Again, at Yucca Mountain, particularly where we're dealing with the volcanic aquifers that are highly fractured, we need to know something about fracture conductivity because this may also cause flow to be channelized. Why is this important? This is important because the channelization actually defines the flow pathways out to the accessible environment.

Another issue regarding advective flux is vertical flow and its likelihood. We have limited data at the site currently that we do have increasing hydraulic head with depth which indicates the potential anyway for upward flow, probably from the underlying carbonate rock aquifer system. We also have thermal data that indicates that we may have upwelling of groundwater along major structural features like Solitario Canyon Fault or the Paintbrush Canyon Fault to the east of Yucca Mountain. The importance is that if we do have vertical mixing at the site or down-gradient from the site, this would--mixing of waters would enhance increased dilution of any radionuclides that may be present.

Okay. Now, away from advective flux, but I'm talking now about alternative conceptual models that we tested this morning, for example, or we've talked about. We have a set of alternative conceptual models also for our saturated zone flow system. One is that right now we assume that the flow system is in steady-state equilibrium; that is it's not changing with time, the water coming in at the boundaries is being discharged, the same quantities of water being discharged at the outlets. This hypothesis certainly will not be true over time because we expect climate to change, recharge to change; so that we will have transients within this system. Of course, as we get down to smaller and smaller scales by our site-scale model, we may be more concerned about transient phenomena. Another conceptual model that we have, right now we're representing the flow numerically in our numerical models by the equivalent continuum hypothesis or representation. This was discussed yesterday very nicely by Bo. So, I don't really have to go into details there except to say that by using the equivalent continuum kind of formulation, we may not be able to represent the channelization of flow to the degree that it may be occurring.

Another persisting difficulty for us is that if you just look to the north of Yucca Mountain, you see a large--in the potentiometric contours, we have a large hydraulic gradient essentially in this region. It's not a recharge region that we think anyway, but we don't have any good, firm explanations for this particular feature. We have something on the order of five alternative conceptual models and, although we don't think it will have any impact on the performance of the potential repository system, nevertheless, it sticks in our craw because we don't have a good explanation for this phenomena at this point in time. And, what am I really saying? Well, I'm saying that if we have alternative conceptual models, then this is representing our uncertainty and our understanding of the flow and transport processes.

Now, I'd like to get to transport issues themselves, and I'm just going to be talking and categorize these into three areas. The first thing is something called dispersivity which is a parameter that goes into our numerical models. I would also argue that it is in some sense a fudge factor, but it's a parameter that attempts to quantify the fact that if you dump a solute into a groundwater flow system, not only will it be carried along with the moving groundwater, but it will tend to spread both longitudinally and transversely. So, this parameter is a parameter that measures that tendency to spread and, therefore, can create a solute plume. We don't have good handles on that. I'll talk a little bit more about that in just a moment.

Matrix diffusion, if we have the groundwater containing a solute that is moving in the fracture system, the water in the fractures containing the solute will have a --there will be a concentration gradient from the fracture into the adjoining adjacent rock matrix and so there will be a tendency for solute to move into the rock matrix as a result of the molecular diffusion. So, this is what we call by matrix diffusion, and in our equivalent continuum model, we actually represent this by another parameter called effective porosity for which we do not have good numbers again.

Then, the other issue an important to transport is a process that I'm just labeling it here as sorption. This is the idea that a radionuclide or a solute of contaminant could interact chemically with the surrounding rock mass through which it is moving. So, I'm just calling this the sorption process.

And, the significance of these three different transport quantities, entities, issues is that, of course--they're two-fold, actually. First of all, they will reduce downstream radionuclide concentrations. That's what we're concerned about especially with a dose based standard, and they will delay arrival times to the accessible environment.

Just briefly now, the last issue is future climate change. Again, another area of uncertainty, as I think we're all aware with the prospect of global warming and what that's going to do to us over time, we know--I think we can be fairly secure in predicting that sometime in the next 10 to 100,000 years the climate is going to change. It has done so in the past. We've had glacial ages. We can anticipate that we will have glacial ages once again. Accompanying the return to glacial ages or glacial episodes, we will probably have wetter periods, pluvial episodes, in which we could expect to have higher recharge in our recharge areas, increased discharge from the system, and its consequences.

So, the significance of future climate change, first of all, it could lead to potential water table rise beneath the Yucca Mountain site. We know that inferences based on limited data again that the water table probably in the past has been as high as 100 meters or so above the present water table at altitude at Yucca Mountain as a result presumably of past climate change. So, this gives us some idea of what the potential groundwater rise might be under climate change. The other thing is that we have groundwater rise and increased gradients perhaps. We can have higher effective transport velocities that might impact us. The good news is that it's also possible that by having more water moving through the system, we could lead to a state where we would have increased enhanced dilution of the concentrations of radionuclides. So, climate change may not all be bad.

Okay. How do we address uncertainties? What are we doing about addressing uncertainties? Well, there's good news and bad news. I think a lot of people recognize that in some sense the saturated zone has been the forlorn, abandoned child of the Yucca Mountain Project. The reason for this, I believe anyway, we have not conducted a lot of saturated zone studies. For one reason, it's very deep beneath Yucca

Mountain so it's not easily accessible. But, in 1987 when the Yucca Mountain site was mandated by Congress to be the candidate site for site characterization to determine whether or not it might be suitable as a repository site, the standard at that time to which we were working was promulgated under 40 CFR 191 from the EPA and was a cumulative release standard at a distance of five kilometers from the potential repository. That is a mass release, not a concentration or dose kind of standard; although there was a dose component to that standard, but the important thing was we were really concerned about mass releases. Now that it looks like we are going to be given a new standard that's going to be dose based, we're now concerned about concentrations and now the saturated zone probably is going to play a much more prominent role. And, in fact, we're talking about doses to individuals perhaps as far as 25 or 30 kilometers south of--or down-gradient/downstream from the Yucca Mountain--potentially, Yucca Mountain Repository. So, the only thing that I know of right now going on testing-wise in the saturated zone is we are still continuing to periodically monitor the water wells in some wells and we are just finishing up the sequence of testing at the C-Holes complex, tracer testing, hydraulic testing, about which you heard in your January meeting. And, we're planning--well, let me get on to that; wait.

Addressing key uncertainties, we do have plans, however--that's the good news--to continue studies and do more studies. We are continuing with laboratory studies and planning to do more studies to get handles on some of the transport properties themselves and also solubilities of various radionuclides. And, we're also measuring hydrologic properties of the various aquifer materials. We also are planning to do more field testing. At the C-Holes complex, we want to move up the borehole and start testing in a zone closer to the top of the water table, for example. We have plans and actually have the funding to do that study. We are just finishing up the Fortymile Wash recharge study. Fortymile Wash is a drainage that runs along just east of Yucca Mountain and there is a potential there that water--ephemeral flows coming down the wash may recharge the system locally. That would be a transient kind of flow problem, for example.

We are planning to drill a borehole called WT-24 that will penetrate the large hydraulic gradient that's a little problem for us up here to the north of the site to try to get a better handle on the configuration of the water table at that location and perhaps some idea of what's causing the feature. We are planning to do hydraulic and hydrochemical testing in boreholes that have not been accessed previously. We have an existing borehole, WT-17, in which we want to do some Eh measurements to try to get some understanding of oxidation potentials in the groundwater system itself and we're planning to drill four--excuse me, three new boreholes to the water table essentially in the repository block itself or just to the north and south of it. We also have plans to develop a second SZ testing complex somewhere down-gradient from the potential repository, and we are continuing with paleo discharge studies to et a handle on how climate change in the past has impacted the hydrologic system.

We're doing modeling studies. The kinds of modeling studies that we're doing actually have come out of the workshop that I told you about previously that identified these key uncertainties and issues. Now, we are doing sensitivity analyses to try to determine the importance of these various parameters and issues to performance assessment and to the flow and transport process models. And, I might just mention that we have completed some future climate modeling that was done on our behalf by--and in order to try to bound what we think may be potential future climate states, fold that in to try to get estimates of what the regional recharge might be under changed climatic conditions.

And, we are doing what you just heard about in great detail yesterday. Now, we're doing an SZ, saturated zone, expert elicitation on flow and transport; very similar to the expert elicitation that we did for the unsaturated zone about which you heard yesterday. We've convened our panel. The panel members are listed here. You might recognize some of those names. We have had our first workshop and are planning to have our second workshop in July. So, it's going to be the same kind of structure that Kevin Coppersmith told you about yesterday. Many of the same people are involved. I'm very pleased that Shlomo enjoyed his tenure on the unsaturated zone expert elicitation to join us on this one. And, of course, Don Langmuir, I think, perhaps some of you--that's a name, I think, you probably recognize as a former Board member and, therefore, he's our internal sort of Yucca Mountain expert, if you will.

What I have done here, you can't read this from up here, but it's in your handout. What I tried to do is all of the issues that I've addressed in this talk are listed over here in this column and all of the, I think, testing that I've been talking about that we plan to do or perhaps are doing currently are listed over here so you can get a crosswalk between what testing addresses what issues. This is my subjective or objective or whatever assessment. So, I just want to let you have that so that you know we are trying to address these things.

I'm going to go out on a limb. This is my conclusion. I think that by the time that we get to viability assessment in 1998, I think that we will be able to have quantified bounds on our key parameter and model uncertainties. I think that with our testing program that we have planned and currently laid out that by the time we get to a license application, if we do get there, we find the site is suitable, I think that we will be able to reduce these uncertainties significantly.

With that, I thank you and will entertain questions.

KNOPMAN: Thank you very much, Dwight; very good and crisp presentation.

I'd like to entertain some questions now from the Board members. Dick Parizek?

PARIZEK: Yeah, Parizek, Board. I didn't see in the data table and testing program any specific reference to geochemistry, the regional geochemistry, for both characterizing the patterns of flow and to help validate or verify your transport models. I see the Eh/pH discussion with specific wells which we understand why you're doing that. What's the status of the regional geochemistry program?

HOXIE: That's probably a very good question. We do have quite a bit of data and some data are still being collected not as part of the Yucca Mountain Project--well, as part of the environmental program at the Yucca Mountain

Project. Let's see, we have a large data set that has been compiled. We have a large data set from NTS. We have not pulled it all together and that's probably the thing that really needs to be done. There's a lot of data and, you're right, I probably should have listed in the testing program there is a proposal for FY-98, in fact, to try to pull all of that together.

PARIZEK: Yeah, a simulation, an integration of that--

HOXIE: Yes.

PARIZEK: I think if you don't put it in--probably not doing it.

HOXIE: Right.

PARIZEK: But, if you intend to do it, it ought to be shown.

HOXIE: Right. It should be shown in my table. I probably didn't have a little good place to--an issue there that that would address--well, flow paths probably.

PARIZEK: On the regional model simulations that have been conducted, thus far, you put Yucca Mountain in there as part of the regional domain that you're considering.

HOXIE: Of course.

PARIZEK: In order to have the model do anything reasonable, do you get a Shlomo Neuman percolation values or do you get--what sort of values seem to fit on a regional scale? Again, there's some difficulties with this, but--

HOXIE: Okay. You mean in terms of recharge?

PARIZEK: Yeah, recharge.

HOXIE: Well, of course, we've always felt that recharge at Yucca Mountain is probably insignificant; maybe five millimeters--best estimate right now for percolation flux, say, at or below the potential repository horizon is like five millimeters a year. Now, I don't know if that's significant as a recharge. We know further to the north, for example, on Rainier Mesa, we're probably talking more on the order of 25 or 30 millimeters per year. So, that may be contributing something. In the Spring Mountains, for example, you're probably talking 200 millimeters per year or more. So, I'm not sure I'm answering your question, but we don't see a groundwater amount beneath Yucca Mountain that we can attribute to recharge.

KNOPMAN: Dwight, I'll ask a question. I'd like you to elaborate a little bit more on the kind of field testing you're doing to test your hypothesis about the steep hydraulic gradient north of the site. What precisely are you planning to do and what do you think you're going to be able to gain out of the additional field tests?

HOXIE: Okay. Let me just back up a little bit. We have one borehole that penetrates the large hydraulic gradient and that's the one we call G-2. It was originally drilled as a geologic borehole, not a hydrologic borehole.

It was to get geologic information. That's what led us to identify, in part, the large hydraulic gradient in the first place. We have done some limited testing in there, but the test results, I think, are inconclusive in terms of discriminating among the various alternative hypotheses. Some of them involve water going down and into the carbonate aquifer beneath and then moving beneath Yucca Mountain and coming back up to the south along some kind of structural feature or buried feature that may not be visible at the surface. Another hypothesis is that it's a perched water body. We thought that maybe the testing that we had done at G-2 would allow us to determine that, but I don't think we've got a conclusive result there either.

So, the plan right now and it's the only plan that I know of is to drill WT-24 which would be--I'm not even quite sure--let's see, it's going to be southwest of G-2, I believe. That would also give us just a handle on the configuration of the water table there. It would allow us to do some testing that perhaps could at least eliminate the first water hypothesis if that is not viable.

KNOPMAN: Testing like what?

HOXIE: Oh, hydraulic testing. I'm sorry, yeah, aquifer testing. I'm sorry. But, these single hole tests. But that's the kind of thing that we would do.

KNOPMAN: Okay. And, can you give an estimate of how long that might--you know, what might be the duration of the pump test of that sort?

HOXIE: I can't, no. I really can't because I haven't really been planning it. But, I'm sure that if it's going to behave anything like it did at G-2, we're talking about long pumping times and long recovery times.

CHRISTENSEN: Christensen, panel. This is a potentially naive question, but one of the issues that the panel has been confronted with and the project confronted with is the issues of sort of long-term human intrusion. It strikes me that one of the most likely violations of your equilibrium hypothesis may have more to do with discharge related to human water use in this area in the future. Could you comment on how that might fit in and whether that's a significant issue?

HOXIE: All right. Let me put this back up. Okay. I think the most significant thing, first of all, is that you don't see the boundaries on here, but of course, we have the Nevada Test Site sitting right over here, we have Nellis Air Force Base sitting up here, and BLM land all located in this area. So, much of the immediate area currently is Federal land. So, we presumably have some control over withdrawals there. Down in this area right--I might point out that the southern boundary of our site-scale flow and transport model actually is in an agriculture area where they are withdrawing water for irrigation currently and this gives us some control for hydraulic heads along this lower boundary because we have wells. But, this area is being irrigated. Water is being pumped. It's probably not significant quantities currently compared to the total amount of water moving through the system, but certainly there is the potential of increased development out here. Certainly, I think we know that Las Vegas is, for example, looking for underground water supplies to augment their own.

So, I mean, I think that you're absolutely right that we need to bear that in mind or we could have--it's not a human intrusion issue directly, but indirectly, it certainly could change the whole system.

KNOPMAN: Dwight, I have another question and it has to do with the water budget for both the regional scale model and the site-scale model. Can you give us some--do you have any rough numbers, or perhaps if you don't have them off the top of your head, you could supply them to the Board when you can get your hands on them. How much water is moving through this system in the saturated zone?

HOXIE: I can do that. I do not have it off the top of my head, though. I'm sorry.

KNOPMAN: Okay.

HOXIE: I might just point out what are some of the important discharge areas naturally occurring and the significant one is over here in Death Valley. That's probably a base level for our systems since it's below sea level. There's another area--let's see, I have to think of where I--I get lost on these maps. Right along in here, there is a spring line called Ash Meadows. Maybe on field trips, you've had a chance to go out there. These are a series of springs that I--again, I don't know the numbers, the quantities of water that are being discharged, but the thought currently is that this is water that is coming off the Spring Mountains located right here. Las Vegas is right over in here. So, the water that's coming out of the Ash Meadows spring line may not be water that is coming beneath Yucca Mountain, for example. We think that the major discharge for Yucca Mountain--I'm probably going to get lost down here--is down here at Franklin Lake Playa which is an evapotranspiration site, but I can get you the numbers. They have been estimated. There is a water budget that has been compiled. I just don't have it off the top of my head.

KNOPMAN: Okay. Priscilla?

NELSON: Nelson, Board. Just to follow up on Norm Christensen's question, do you plan on doing a model for the development of changing withdrawal because of land development in the area to the south and east?

HOXIE: I think we could do that. We would have to--that's a socioeconomic kind of problem. I don't think we've addressed that as part of the site program because we don't know what the well development might be, but we could probably hypothesize something. But, we don't have any plans to do it that I know of anyway right now, unless it might be done as part of an Environmental Impact Statement.

PARIZEK: Dick Parizek, Board. On the model, the main thing that you can measure perhaps is the discharge.

HOXIE: Yes.

PARIZEK: --come back and see what the recharge might be like.

HOXIE: Right.

PARIZEK: We were appraised of some of the ongoing efforts to do this. By your evapotranspiration calculations, you're fine. It seemed like the Death Valley discharge and the Oasis Valley discharge program was going to take a while to do that. Is that still in the plans? Is it likely that that will be done by the '98 deadline?

HOXIE: It's not--I don't think we have plans to do any more currently. I think there is some work that's being done independently of us, however, at Death Valley on the salt pans out there. That is probably something that we would like to get a better handle on, but I don't think we have a plan right now to do that.

PARIZEK: But, that's something that might be available by license application time?

HOXIE: Perhaps, yes.

PARIZEK: But, the other model which is the transient model is not now being done by anybody that I'm aware of and that's a whole new problem to do a--

HOXIE: Yes, correct.

PARIZEK: --do a calibrated transient model and that would then allow you to talk about climate change in some sort of a time frame, as well as the consequence of withdrawal, and that could be extremely useful if you say, well, how long will it take to raise the water table 100 meters? You could buy a lot of time doing that, as an example, or maybe you can't buy very much time.

HOXIE: But, you're right.

KNOPMAN: Okay. Let me ask you one of those questions you'll groan at. Your chart is very, very useful in the back of the handouts here by giving us a good idea of what you're planning to do in the way of laboratory and field testing and modeling studies for each of the issues. Of all of these remaining issues, which ones would you say present the most formidable hurdles in data collection and in reducing uncertainty?

HOXIE: I may have to defer to Shlomo, but actually I would probably argue that probably the transport parameters. That's my feeling. I think this is where we have the greatest uncertainty and the greatest challenge of trying to come up with reasonable numbers. I think we can get a pretty good handle on the hydraulics and infer that, but I think trying to get a handle on the transport and what is actually going to happen to radionuclides that are complex chemical entities and how they're going to move through the system. I think that's a very formidable challenge.

KNOPMAN: Okay. Any further questions from the panel or staff?

(No response.)

KNOPMAN: Thank you very much, Dwight.

NELSON: Good morning. I'm Priscilla Nelson, one of the new Board members. I would like to just make a few introductory comments about the rest of the sessions planned for today.

There are four deliverables that are planned for VA. In the past sessions, you've heard about the design concept for the repository and waste packages, and you've heard about TSPA. Both of these are rapidly moving forward. Today, what you're going to hear about in three talks that immediately follow my comments you'll hear about plan and cost estimates for license application, cost estimates to construct and operate, and also about performance confirmation plans. Some of these are fairly newly starting activities and they certainly are moving very fast in terms of the amount of attention the M&O and DOE has given to them. The Board will be maintaining an interest throughout the year up to the time of VA in the evolution of these tasks, all four of them, in fact. We'll have a break following the cost estimate talk and then move into a second area that deals with the site characterization that's going to be continuing and focusing on the east-west tunnel and on ongoing scientific activities. So, that's the plan for the session this morning.

I'd like to introduce the first speaker or reintroduce Jean Younker who is a geologist by background and her crew has been evidence of the versatility of geologists in this world. She is operations manager of suitability and licensing with TRW for the M&O. I'd like to invite her to come up and begin her presentation.

YOUNKER: Thank you, Dr. Nelson, for that nice introduction.

What we're going to talk about in this presentation very briefly is the plans we have and the plans we have to lay out good plans for the work through license application. So, we're now stepping out after viability assessment and looking ahead to license application in 2002. I might mention that my organization basically is kind of the focal point for getting that LA, what's called the one product of the viability assessment called the license application plan, together. So, that's why I think I was asked to stand up and present this. But, certainly, there are a lot of people involved in developing the plans that I'm talking about here.

What we'll do quickly is just an overview of those products, the information available at viability assessment, additional work supporting the license application. Very briefly, you heard some really good information from Dwight Hoxie already about the kinds of testing that we'll be trying to do. You heard already a little bit from Dave Stahl yesterday and Dick Snell about the waste package repository design plans, total system performance assessment. I'll make a couple comments about what we expect to do between VA and LA and then talk about the regulatory activities which really start to ramp up at that time as we try to make sure we get the documentation in place for interactions with the Nuclear Regulatory Commission so that they can become confident enough to grant us a construction authorization.

All right. The information available at VA, I've kind of stepped outside now of what you've been listening to and tried to give you a sense for where we believe we'll be at the time of viability assessment. I guess a basic understanding of site processes is a kind of broad way to say that we certainly feel like we have a good handle on the geologic framework major deliverables this year and last year, have put down on paper what we believe that framework is. It gives us the basis for the kinds of two and three dimensional modeling that we do in performance assessment.

So, we have a good foundation of the framework, I think.

The hydrologic flow, I'm not sure I can convince you we have a basic understanding given some of the discussions that you heard yesterday on our expert elicitation on the unsaturated zone system. However, I think I have some kind of confidence that a lot of that is going to come together over the next six months to a year because we have, I think, some of the best people in the country, probably in the world, focusing on looking at the information that we have, trying to kind of pull that information together, and help us understand what it means about the hydrologic systems. So, I think, you know, this one probably--this may be a reach, but I believe that we will have a good enough understanding to bound the flow system in our performance assessment models in a credible way.

Geochemical environment is another one where I think you heard Dwight Hoxie answer a question that--what kind of sorption, what kind of dispersion processes or dilution we'll be able to take credit for along that saturated zone flow system. It's probably one of the key areas where we'll be in a bounding situation probably at the time of viability assessment, as I think Dwight probably acknowledged. But, certainly, the near-field geochemical environment, lots of focus on that in the next year. I think we'll get a better handle on some of the key parameters.

Preliminary design concept of the key design features, you've heard some discussion of the concept of operations. That work is pretty intense over the next year heading into the end of calendar year '97. I think we'll put a lot of that down at least for the key features of the design that are important to safety and waste isolation with the big focus, as I think you know, on that work.

Reference repository and waste package designs such that we can make sure that we're very clear that the performance analysis that we do is of that particular design that is the reference case that we're taking forward at viability assessment time.

Identification and some evaluations of the range of design options that might enhance performance if it's decided they need to be concluded in that reference design either at VA time or perhaps between viability assessment and license application.

Okay. For total system performance assessment at the viability assessment time, we certainly will have every bit of the information that we're talking about here gathering in the next year, as well as whatever information we're able to pull in in the design process models at the end of this year and early in FY-98 and an evaluation of the performance of the reference designs. And, together, that should give us the basis along with some of the calculations that will be done for preclosure safety that we have an overall safety case that gives us the radiological safety of this system for both the preclosure operational period and the postclosure time that our total system performance assessment addresses.

This is just a little schematic that walks through or gives you a framework for the next couple of slides. It lists out a couple of the key site testing for LA now moving out to that VA to LA time frame, the design activities that are most important we've highlighted, total system performance assessment, leading to these three critical products that you know we have to deliver which is the Environmental Impact Statement, site recommendation with that Environmental Impact Statement going forward with it, and the license application. And, of course, the key point here being that our site recommendation at this point in time, we have to have laid out the information sufficiently that the Nuclear Regulatory Commission will give us those sufficiency comments that we're required to take forward with that site recommendation. So, assuming the viability assessment, in fact, is a go for license application, these three products will then just become the major focus of the program.

I won't say very much about this, at all, because you've heard from other people who are much closer to that information. Larry will talk, I think, about the drift scale heater test or at least can answer questions about it in his talk, Larry Hayes. It starts in December of this year and continues for several years. That will give us, I think, some really key and critical information on coupled processes on scales that will begin to help us validate some of our process models and our TSPA use of those process models.

UZ flow and transport tests, the ditch studies that Larry will talk about in his presentation are going to be key to giving us a handle on the UZ conditions of flow. Four new boreholes, I think Mike Voegele in his talk will mention where they are--perhaps, Larry has that in his, as well--that will give us a good handle. One of them, we just talked about, the--oh, that one was for the water table gradient to the north of the site. Four new boreholes in the vicinity of the repository block to give us a better representation of the unsaturated zone properties throughout that area that we don't have good borehole control.

Saturated zone flow and transport tests, Dwight did just talk about.

Rock mechanics/hydrologic lab tests, samples that we get from that east-west tunnel that is in the plan or is being planned now, useful to us to I think extend our understanding of the specifics of the rock properties to the western part of the repository block.

And then, of course, updating the site process models for TSPA.

For the design activities, we've chosen to highlight the engineered barrier system lab testing such as some that you heard Dave Stahl talk about yesterday on waste package materials, waste form degradation process models. It's going to be very important to us to make sure that we have the best credibility we can in the way we represent the waste package degradation and the waste form degradation in our TSPA.

Design option evaluation to enhance performance, you heard a little bit about that from Dick Snell yesterday. Evaluating the costs of these options so that we have a clear picture to take forward to the people who need to evaluate the safety case that we put forward and what it would cost if you wanted to make that safety case improve the performance of that reference system.

We select the design options that are important from the ones that we've evaluated, focus on the items that are most important to safety and waste isolation, as I mentioned previously, especially those with no regulatory precedent. I think, you've heard discussions about our binning concept and design where we would focus on those particular design features, those components of the system that have limited precedences. Those are the ones we know our regulator will be most interested in having detailed design available to review in our license application.

Update our EBS process models for input to total system performance and complete the operational concepts, as I mentioned.

From the performance assessment view of the world, of course, very important to us is to update and make our representation of the system better based on the comments we get from our TSPA peer review panel. As I think was mentioned yesterday, we have a draft report in the system in review at DOE right now. It just came in; it was delivered in the last week from our peer review panel. Of course, we get a lot of other insight. I was thinking as I looked at this slide that we get a lot of good feedback from you folks and the staff, from the Board, and from others who review the way the performance assessment is represented. So, I think this probably is just a little narrow now in retrospect because we do get a lot of insight from the expert elicitations, from the other people who look at our performance assessment approach.

We will have to incorporate updated data and process models. Some of them probably won't change that much. I think, some of them were pretty confident. We have a good representation. Some will and certainly in the EBS area, I think we'll get a fair bit of new information to make our process models better. For those that we do decide we really need to focus on, where there is some new information, good understanding to be incorporated, we hope to use an abstraction process like the one we've used because we feel it's been really successful because it has been--it has forced the interaction that has to happen between the performance analysts and the site folks, between the performance analysts and the design engineering folks. So, such that they come with us to performance assessment and understand the way we represent their information in the performance assessment models. I think that's been the key advance perhaps in the last couple of years in this part of the program is that the scientists and the engineers are now standing behind us because they have a good understanding of the way we're using our information--their information on performance assessment.

And, of course, do the sensitivity analysis of the EBS options that are carried forward into our license application design.

The key regulatory activities briefly, I've mentioned already prepare the final EIS which includes the draft EIS development and public comment period, very important to insure that we get the external involvement that's appropriate in this program. Final EIS has to accompany the site recommendation, as I said.

Prepare the site recommendation which documents site suitability in compliance with 10 CFR 960, DOE's siting guidelines. The key requirement, as I mentioned, is NRC's, what are called, preliminary comments on sufficiency of our information as a basis for licensing. So, the way we go about giving them the information they need in order to make this sufficiency statement at the time of site recommendation is a key part of our plan as we go between VA and LA.

Preparing the license application, I think I was asked the question about this document that we've called the integrated safety assessment yesterday. I mean, our concept is that that's our starting point for our draft license application. We pulled together all of the key information that's used as the basis for the three technical VA products and put it together in such a way that it gives us a real good start on a draft license application.

And, of course, extensive interaction with the NRC is needed to facilitate docketing, expedite the licensing review that would start at the time of docketing.

How we document all this, well, of course, the license application plan is one of the four products for viability assessment. In that will be a cost estimate to complete the VA as required by the appropriations language. The LA plan will contain the overall strategy for LA development, the work to be conducted between VA and LA, cost and schedule for that work, and a description of performance confirmation program.

We have a draft--and, I think this was discussed yesterday. We have a draft of that which will kind of be the framework for that. I wouldn't tell you that every detail in it will be ready for review, as you all indicated yesterday, in September, but we'll have the framework of that plan this year and then the final plan in August of 1998.

I might mention on this slide just because my title on the agenda did say I was going to talk about cost estimates, I'm not going to talk about cost estimates, but tell you that that's what we will be developing as a part of this LA plan. We're in the stage of updating the long range plan right now that was the basis for the program plan that was issued in May of '96. So, you know, our estimates right now are still those estimates that are in the program plan. We're going through a detailed planning starting now and through the summer to really update those numbers. But, right now, what's in the program plan are the best estimates that we have.

The work done for VA will help to focus the remaining work, I believe. The LA plan will document what will be done between viability assessment and license application in terms of workscope, schedule, and costs. And then, obviously, interactions with the Nuclear Regulatory Commission will help to further focus the remaining work on the critical issues per their key technical issues and the kinds of information that they are now feeding us, helping us understand what they're going to need to review in order to gain confidence in the way we've treated this information.

Thank you.

NELSON: Thank you. Let me ask you just one question, Jean. I'm tending to waffle back and forth between the current TSPA and what you're talking about LA because you are you with your responsibilities. So, I may be doing that here. But, you talked about sensitivity studies. And, it's clear to me, I think, that the process that is necessary for VA for your tasks are to really respond to a design, a concept that is going to be fixed and costed and scheduled and the whole scenario played out around. But, that there's an opportunity in between the VA time framework and the LA time framework to really do more than sensitivity studies to really look at some tradeoffs that involve costs and the uncertainties. Is that your office that would manage that? Do you expect to have this happen as a major operation in this interval between VA and LA?

YOUNKER: I'm sure it will. And, I think whether I'm still in this position managing performance assessment is not something I probably know right now. But, the answer, I think, is that within the M&O the responsibility will certainly rest between performance assessment design and the site testing that helps to--the site information that helps to keep us make sure our process model basis is sound. So, I think, there's no doubt we understand that will be a big part of the workscope and a very important part of the workscope. I think we do believe though that we will have some reasonable evaluation of the performance of some of the design options that Dick Snell presented yesterday even at the time of viability assessment because I think we believe that having a good handle on what additional performance you can get out of some of the--like the drip shield or the ceramic coating, if those turn out to be feasible after further evaluation, I think that will be an important part of what we lay on the table in the viability assessment.

NELSON: Okay. Alberto?

SAGγIS: Sagηϑs, Board. In going through these programs--again, apologies if this is not the right person to bring this to. But, I see a number of large scale, highly structured plans to plan additional information in support of these activities. Is there any provision anywhere for agile, small-scale investigations parallel to these large plans? I just want to bring a couple of examples today. Yesterday, Dr. Neuman presented what appeared to be a list that had 1/6 or so of the input used to evaluate the percolation flux. Based on some experiments--has done somewhere maybe on the side, in talking with Dr. Della Roy today, we reached the conclusion that there doesn't seem to be hardly any information, even minuscule amounts of data, on what happens to regular concrete if you expose it for periods of a few years at temperatures of a couple hundred degrees Centigrade or 150 or so. These are the kind of experiments that again do not require a Federally funded program, a multi-year program with 20 investigators to do. But, all of a sudden, it becomes extremely important because there is zero data on this. Is there any provision in this overall--maybe like 1 percent of the total funding or 0.5 percent or something for these kinds of things?

YOUNKER: That's a very good question. I'll make a comment and then I can see if there's someone else who wants to comment, as well. I think, your point is that do we have the flexibility, I think. Say, coming out of one of these expert elicitations, quite often those or abstraction workshops will identify a couple of key activities, either a lab test or maybe an analytical activity, that could really help us pin something down in a pretty short time. Do we have the flexibility to accommodate that into our work plan and make it happen?

SAG$_{\gamma}$IS: And, I mean at the $10,000 level; I don't mean at the $550,000--

YOUNKER: I understand. Yeah, I think we have a process in place where what the M&O does is define it to the best we can, take it forward to the Department of Energy, have a good discussion about it. If they feel like it's a good plan, we have a process in place to make that happen, to reallocate funding. We have to do a tradeoff because obviously if everything is fully funded, then you'll have to not do something else and that sometimes is a difficult decision of what you're not going to do even if it's a small amount. And, you know, if it's a really small amount, then, of course, it should be able to be accommodated. But, I think we have a pretty good system for doing that; probably, a lot better than it's been in the past, my personal opinion.

Dick Snell? Could I ask Dick Snell to just comment on that, as well? You have to go to a microphone, Dick.

SNELL: Kind of a supplemental response with Jean's. The performance assessment work that's been done over the last few months has given us probably the best focus that the program has had ever on which elements in the design, which elements in the performance are really crucial. We are just getting into the '98 planning and multi-year planning as you mentioned. So, we have again perhaps for the first time, or if not for the first time, we certainly have the best information at this time, to decide where we should focus efforts and specifically on cementacious materials, for example, which may have a significant bearing on long-term performance. And, there are other features in terms of materials and so forth which clearly are important to us and help when we look at making a safety case for the repository where clearly we need to put in additional effort. So, in doing the '98 planning, we're going to use the performance assessment work, evaluations that have been made so far, and based on which elements are critical, which elements buy us the most significant performance improvements, which ones are crucial to the safety case, those are the ones that are going to get the attention and the funding.

NELSON: Okay, thank you.

HAYES: Larry Hayes, M&O. If I could, I'd like to give two specific examples to your question. First answer is, yes, we can respond to changing needs. Two examples. Early in this fiscal year, the DOE and the M&O identified needs that we had not planned for in FY-1997. We got together, identified workscope, products, outcomes. As a result of that, we have about a $10 million change this year in what we're doing. Things that we had not planned to do, we are now doing. Example, additional work in ESF to better define percolation flux. Some of the cement work you brought up, we've added that in. Another example is during the elicitation workshops that Jean has talked about where the process modelers got together with the PA modelers, things were identified that needed to be done in order to perhaps better feed the PA model. Those things are now being done.

The scientists who worked in the site evaluation program are to some extent changing what they're doing and they're going to give things to PA that they had not planned to give by modifying some of their '97 work. So, I think we can respond very well to change.

SAGγIS: This will be all done within the context of the designated laboratories and the like, right?

YOUNKER: Yes.

SAGγIS: Perhaps, I should have said is there any such thing like additional support for investigation to be conducted in other areas? For example, the University of--

NELSON: Can you try another microphone?

SAGγIS: For example, say, universities and the like, several other programs--again, transportation agencies and the like--will have in the framework we are doing here extremely smaller scale levels of funding which introduce an element of agility that just does not exist when you're having a national laboratory conduct the investigation.

YOUNKER; Yeah, I think in general the Department of Energy encourages us to try to use the people who are going to be able to give us the most cost-effective information we can get. So, there's no--there's certainly never a restriction on going to a university and going to a small company for that matter instead of one of the national labs. But, again, there are defined responsibilities, as you know, for some of the work where I think we probably have the foundation in place to better do it with the labs. So, we have got flexibility.

HAYES: Specifically, in answer to your question, some of the work I'm talking about did go to the university system in Nevada; UNLV, UNR, as well as private industry such as Hewlett-Packard. We did realize that some of these things could be better done perhaps more quickly with perhaps less bias by some people who are presently not so involved with the program. So, yes, we're doing that.

NELSON: Okay. At least five people have identified themselves for additional questions and we have less than 10 minutes. So, keep that in mind as you pose them. We'll go Dan, Jeffrey, Debra, and Jared and Richard.

BULLEN: Bullen, Board. I'll defer my field test question to Larry this afternoon or later today because I think that's appropriate.

NELSON: Thank you.

BULLEN: But, you talked about your preliminary safety case postclosure and I wanted to bring this question up yesterday, but I didn't get a chance. So, now, I have you again; so, will jump in.

We mentioned the 25 mrem per year dose and I guess the question that you'd have there is that would you expect that to represent the 50th percentile of a distribution or the 95th percentile of the distribution or the 99th percent out of the distribution? Keeping in mind that if it were a regulator and it was 25, we would look at 24.99 and that's acceptable and 25.01 is not acceptable, what kind of additional confidence do you think you'd like to instill in the regulators when you come in with a 25 mrem dose and what part of the tail is that going to represent?

YOUNKER: Well, I think as it's stated on the slide here I used yesterday, it's an expected value. So, we're talking 50th percentile, you know, middle of the--modal play of the distribution. But, I think our internal discussions that I could share with you would be that, you know, there are people who would feel better if you had, say, an order of magnitude or so of, you know, additional performance above that standard. So, I mean, it depends on your risk preference obviously, but--

BULLEN: And, along those lines, this is the last follow-on question. I'll be done in a second. Since neptunium may no longer be the most hazardous of the most significant contributor to dose and it comes back to tech and iodine, one of the things you might want to consider is the similar low-level waste where they're taking an iodine dose of 75 mrem organ dose as opposed to whole body. Now, you can do that back calculation and figure that's a 15 mrem whole body dose, but those kinds of scenarios where you're taking a look at individual organ dose in parallel to something that NRC already accepts might be something you want to consider.

YOUNKER: Yeah, I think the people who are going to look at the biosphere piece of the process modeling that we have to do are going to have to look at that kind of thing. Exactly, good point.

NELSON: Jeffrey?

WONG: Jeff Wong, Board. I have a series of interconnected questions. In the past, the DOE has provided very detailed time lines of the milestones and I see in your handout a simpler milestone. So, I'm curious as to are those charts with those milestones and those time lines changing, one, and what are those changes? Number two is was the EIS restarted--or the EIS activities restarted in October of '96 as was laid out by Wendy back in April of '96, and second, on that time line, when will the waste containment and isolation strategy be finalized?

YOUNKER: Okay.

NELSON: Okay. Number one dealt with the milestone charts will be changing--

YOUNKER: Right, the charts. The 7000 activity detailed networks, they are the basis for the long-range plan that was mapped into the program plan in May of '96. They are the things we will be looking at. As I said, we are updating the long-range plans, starting a detailed replanning of '98, but looking at the complete long-range plans. So, those activities, those milestones on those networks, are the ones that will be looked at to update them based on two years now since we actually put that together. So, that was the first one.

WONG: First one. And, the second one, were the EIS activities restarted?

YOUNKER: EIS activities were restarted in October of '96 as planned, yes.

WONG: So, that original time line, this time line here, is fixed in stone or fixed in budget or--

YOUNKER: When was that briefing given to you?

WONG: This one was in Austin, Texas in April of '96.

YOUNKER: I think that's basically the one that was in the May program plan, and I think that's the one we are still working to at this point.

WONG: Okay. And then, on that changing time line that you're talking about, when will the waste isolation--

YOUNKER: The waste isolation strategy, yes. Boy, I'm really glad you asked me that question. I think, Leon put you up to it, right?

WONG: Leon told me to do it.

YOUNKER: The highlights document, I believe, probably within a few months will be available again with the update representing the kind of a strategy that I talked you through yesterday and that Steve Brocoum presented a month ago to the ACNW. I think we're prepared to put at that level out, I think, quite soon. I think the detailed one that we've been working on now for some time probably is going to take some additional time to mature, to get the volume that we're going to need because, as you might guess, there's still a lot of debate about some of the items as you heard in the UZ expert elicitation panel; same kind of debate among our own scientists and engineers. So, I won't give you a definite date on that one, but certainly it's not going to be in the next couple months. But, the summary one, I think, we're probably pretty close to being prepared to issue that one again.

NELSON: Debra?

KNOPMAN: Knopman, Board. As the saturated zone has been the stepchild to the unsaturated zone work, it seems to me operations has been the stepchild of the design side of things. I don't know if that's a fair comment and I'd like you to respond. But, my concern is that in looking at the work that you're presented that the so-called operational concept comes down the line after you've gone through various design options as opposed to a more integrated consideration of what sort of operation you actually want to run and then proceed with some design options flowing from operational options. Could you comment on that?

YOUNKER: Yeah, and I'm probably not the best person, but I will give you my view of that. That is that we do have parallel work going on on the concept of operations and that, to me, so much refers to the preclosure period. Whereas the design features that we're talking about as sensitivity cases for performance assessment almost totally are our postclosure performance enhancements and parts of the postclosure system where an operational concept, per se, doesn't apply except that I have to make sure I have it appropriately installed at the time I close the facility. So, I think, we're paying attention to the design or to the operational concepts and I think Dick Snell would very much like to help me out in his view of that.

SNELL: A couple of brief comments if I may. The operational concepts have been carried in parallel with all the design. In most of the sessions that we attend with you or where you hear from us on information, the emphasis tends to be on long-term waste isolation performance. So, what you hear from us generally deals with the aspects of design that relate to long-term performance.

Oh, and one other aspect, from a regulatory standpoint, Jean mentioned binning a little while ago. From a regulatory standpoint, the tendency also is to have those features that bear on waste isolation especially be those that do not have a long regulatory precedence. So, those are the Bin-3 things. Those are the things where we expect to have the greatest amount of detail at the time of viability assessment, for example, because they are performance related to the repository in terms of long-term waste isolation. However, we are doing simulation modeling of the service operations for the facility, looking at waste received rates, throughputs, so forth. Those models are being expanded so that we will have a simulation model that goes from the plant gate receipt, if you will, if the waste all the way through to underground emplacement. And, those models give us a good basis for evaluating operational considerations.

There's a whole array of operational standards and guidelines and history which are being incorporated into the designs right now. You just don't hear very much about them in the arena that we're operating in.

NELSON: I think from that standpoint, Dick, I can promise that the Board panel on repository design will be hoping to maintain a continuing conversation with you on that.

SNELL: I welcome that; thank you.

NELSON: Okay. Two more questions and then we shut down. Jared?

COHON: This is more of a comment than a question though. If you care to respond, it would be welcome. The program, overall, has always struggled to find the right balance between schedule-driven and keeping the eye on the ball, as it were. I'm starting to get worried again and the thing that prompts this, of course, this September '98 deadline which you've imposed on yourselves which you quite appropriately have to focus on and move towards. But, I worry. This goes back to my question yesterday about sequence of activities and also is in the same spirit as some of the questions you just heard about things like flexibility to conduct smaller studies.

First, a more substantive comment. The program has made great progress in pulling things together. The focus on TSPA and, I think, VA and TSPA/VA has helped greatly to do that and we've heard that. On the other hand, given what we know about the current state of TSPA, one could only assume without having assumed results that the error bars, if you will, the uncertainty in the estimates that one would get from a TSPA in its current state would be so large that it would be difficult to make definitive conclusions about important design features, let's say. But, it sounds like decisions like that are, in fact, being made. Now, I'm working from a premise that there's these large error bars in the TSPA and I don't have the data to support that because I haven't seen results.

I would feel much more--I would suggest that a key focus at this time should be reducing that range in TSPA;

that that really should be the focus. And that, furthermore, the activities that follow VA should be directed at exactly that. What do we have to do to reduce uncertainty in TSPA? Those words don't appear anywhere in what you just presented. It's all focused on LA, the next milestone. Suitability is sort of something that happens along the way to LA, but suitability--we have our own definition and we're waiting for DOE's--is all about uncertainty associated with the performance of the site. That, I think, should be the focus.

Then, this takes me to the other part of my comment in going back to yesterday. We have the program coming up with a draft statement about what is needed for LA in September of this year, 10 months before the draft TSPA/VA is done. So, back to my first part. If you agree with me that the focus should be on reducing uncertainty in TSPA, then it would seem to me that identifying the activities that you need after VA should come later in the game when you have a better idea of what the uncertainties are in TSPA. It's the cart before the horse.

YOUNKER: I agree with much of what you said. I think I have a lot more confidence that we're dealing with those uncertainties are and that we are using them to drive our plans for both design and site information. So, in short, I mean from the inside looking out, it feels like we're doing that.

COHON: Okay.

NELSON: Okay. Last question, Richard?

PARIZEK: Yeah, Parizek, Board. Just in following up with this sort of thought process, I saw Bo Bodvarsson's chart, 20 bullets which the unsaturated zone models group identified as issues that could be refined or should be refined. And then, when it summarizes nine recommendations for action on a summary page, either Bo has brought together a number of these under one of the nine or some dropped out. So, we'd be interested in what the process is of reviewing the recommendations of expert panel members, for instance, and how one decides and who decides what goes in and what falls out. Obviously, it costs money and you can't do everything, but the things that fall out may be the people who won't go away in license application. I mean, if those issues are still there, it's going to be hard to defend later why these were dropped if they might have been included in the study process. Then, again, it requires money to do that and this question of flexibility of putting funds in to deal with emergency issues, obviously, are difficult to forecast in advance.

YOUNKER: We're trying to have a documentation process both for those expert elicitation workshops, as well as for our abstraction workshops, where we make it absolutely clear that you have to go through a screening process. You can't address every uncertainty, and the way you try to do that is to get your best judgment about whether it's important to performance or not as early in the process as you can. You only carry those forward that we already have reason to believe are sensitive parameters, sensitive processes. So, yeah, there's screening going on at all times, but we're trying to document that with a reason for why we believe that it not an important parameter or process to be carried forward and we develop that paper trail so that when we're challenged by someone who said, yeah, by my idea wasn't taken forward, we can say, yes, and the reason was we don't believe on the basis of these results that it's important enough to performance to pursue that. So, we have the right, I think, approach.

PARIZEK: Because the saturated zone group will come up with another voice and then the shopping list will continue to grow; it won't shrink.

YOUNKER: Correct. That's right.

PARIZEK: And, the Board would find it useful to find out what study plans are in place for specific projects. For instance, if in fact nine of these items are to be pursued, if there's going to be a study plan and a program of how to go about doing it, we could kind of review that and see the specific thought process that's being used. Now, that's probably a lot of detail there, but things are going on in the ESF that we don't know about; you know, tracer experiments, injecting water above the tunnel. You know, these are important concepts and a lot of useful information will come out of it. We can't evaluate it until later, but it would be interesting to see that up front and we can take part in that exercise.

YOUNKER: Yes. Yeah, we've kind of stepped away from the old study plan concept and now we do that detailed planning as a part of this overall plan that we were just talking about. So, there certainly are detailed plans being developed as we go along. I guess, we'd have to work on your access to those; at what point it was appropriate, etcetera. But, it's a good point.

PARIZEK: Another point, the whole program is ramping up to meet the deadlines. At the same time, funding is ramped down and some good people have left the program or have been assigned to other duties. In that whole process, it seems like the institutional memory of their efforts may be dropping out at a time the license application needs that and the supporting material at some later date. I'd be interested in the comments of how you're capturing the institutional memory of those past programs or those past people who might not have money to finish off the report and leave; how to have that available at the time of the license application in support of that application, not just the submitting of it, but the defending it later. That's the hard part.

YOUNKER: That's a very important issue and I think we have spent some time worrying about it. A lot of the effort in '97 and part of '96 was on making sure that we had written documentation. You'll recall we talked about synthesis reports. Much of that was trying to document and put down in writing what we knew at that point in time for exactly that reason because we knew that some of our scientists and some of our key contributors were going to move on to other projects. But, it's an important issue. It's an important problem and we have to address it.

NELSON: Okay. We need to shut down discussion. Thank you very much, Jean.

We're going to move on to hear from Richard Wagner. Richard Wagner is the manager of the systems engineering and integration group for the M&O in Las Vegas. He is going to speak about the performance confirmation plans after licensing.

WAGNER: Really, what I'd like to do is give you a little bit of performance confirmation prior to licensing to set the stage. The objective I really have--and I thought about it when I listened to Chairman Cohon yesterday--was my objective today is to introduce you, the Board, to performance confirm--a program that's just starting to evolve in the project. I believe, this is the first time the Board will have heard that. Some of the Board members--Priscilla has been in some meetings with the M&O and the DOE where we've discussed pieces of it, but I'd like to introduce the Board to that.

Jared, I think your comment yesterday was appropriate that the Board needs to understand TSPA in some detail between now and licensing. I would propose that as time goes on, the Board will need to understand in the same sort of detail performance confirmation. One, when we go to the NRC in 2002 and say I'd like a license to construct, we're going to have to explain to them what our performance confirmation concept and program is. More importantly, when we get to license application, the amendment to the license, prior to 2010 when I want to receive an emplaced waste. Because the real way we're going to communicate with the regulator post-accepting and emplacing waste is through that performance confirmation program.

What I'd like to do today is take the Board through a little bit of a tutorial since it is the first time. Talk about the regulatory background; talk about how the performance confirmation program is part of an overall test and evaluation program that the project is updating as we speak; give you some insight into the program approach; identify some of the key parameters we believe we're dealing with; talk about the important processes and parameters. A complicated diagram, but I want to talk through it just briefly on the confirmation concepts. A little bit of information on where we are from today from a design implementation of the performance confirmation. We started some work last year to try to get a front end head start on performance confirmation to identify those key parts that may play a role in the existing design activity we're doing; trying to understand if we have some pieces of performance confirmation that affect the activities that are going on today from a repository design, both surface and subsurface. Lastly, talk about how the transition of the performance confirmation program testing, and then last, a summary of the planned activities we have both near-term and far-term.

Some quick words, this is a--I took and built a synopsis of the words that are in 10 CFR 60, but basically the requirement is we need to put together a program that consists of tests and experiments and analyses to evaluate whether or not our performance objectives are being met postclosure. One of the key requirements is for us to be able to understand during and after construction if the actual subsurface conditions encountered and any changes in those conditions are within some limits that we have defined and assumed when we talk to the regulator with our license for construction. We're going to say this is our assumptions as far as conditions. We need to be able to go back, if necessary, to that regulator and say what we assumed is not what we saw or what we assumed is exactly what we saw. But, we need to confirm that.

Another key requirement goes more--a lot of words, but I think the important part here is we need to have the capability to provide data to determine that both the natural system, as well as the engineered system, is performing the way we predicted. We need to make sure that we're functioning as we intended and as we anticipated when we went through the license application. You've heard for the last day a whole bunch of smart folks on how we think we're going to predict what the natural system, as well as the EBS system, what the two systems will do. The job of performance confirmation is to come behind them and confirm what we've predicted. Abe used the analogy that he was the locomotive. I would say that performance confirmation is the planning to put together the rail bed and the foundation on where that locomotive is going to take that train Abe was talking about.

The other thing is performance confirmation--in 10 CFR 60, they talk about the fact and we happen to agree, it starts in site characterization and continues through permanent closure. The data we're collecting today through TSPA and with Larry Hayes' scientific programs is data that's feeding the database we're starting to accumulate that will be the basis for performance confirmation in the next 10 to 100 years.

I mentioned briefly there's a test and evaluation program plan being updated. It's due to be delivered to DOE at the end of September of this year. There is in existence a site characterization test and evaluation plan. This test and evaluation plan is being revised to take us out of site characterization and move us into a system where we can verify throughout the life cycle that the MGDS is performing properly, that the system itself is meeting the requirements we defined for receipt, handling, retrieval, disposal. And, lastly, the performance confirmation program, a major player, will serve for the systems verification on the isolation of the waste function.

A simple block diagram on what we believe the approach is both during the site characterization/license application/pre-construction phase and then during the construction/operation/caretaker phase. We're in the process of defining the key performance parameters that we need to monitor. We're also going to define a baseline for the site characterization as the scientists and the PA folks come together. We're going to predict postclosure performance for the systems, structures, and components in Dick Snell's engineered barrier system, as well as the natural setting. We're going to put together and predict the performance of those same systems, structures, and components in the natural system preclosure, and we'll use the preclosure period to start to validate those prediction models we've put together on how we think it's going to perform. We're going to get 50 to 100 years of date depending on when we choose to close the repository. That 50 or 100 years worth of data is the only actual data we're going to have that looks at a 10,000 to a 100,000 year prediction.

As we move into the construction/operation phase, we'll monitor things like the observation drift which I'll give you an artist's concept of. We'll be monitoring the waste packages as far as how they're living in their new environment. We'll monitor the thermal measurements. We'll monitor the environmental parameters that we've identified. We'll have in place a system that will help us analyze and assess that data.

I'll show you a chart that talks about there's an iterative relationship between TSPA and performance confirmation. We need to be able to understand how to assess any deviations we see to the standards. And, lastly, be able to deal with some kind of corrective action and, if necessary, go back to the regulator and say what you gave me a license for based on Assumption X, Assumption X has changed slightly. We may need to modify and have a discussion with the regulator as to what that means from a licensing perspective.

Dick Snell mentioned yesterday about his dependence on performance confirmation. We've defined--in preliminary stages, we have test scope sheets numbering somewhere between 150 to 200 potential type tests that the performance confirmation team has composed, but to sample the near-field, as well as far-field environment, to sample the in-drift environment once we close the doors, as Dick mentioned. To talk about monitoring the emplacement drift liner, whatever it ends up being, in the final design. To monitor the waste package degradation. You heard about a model that we're building. We're going to collect some data to help validate that model.

This is a complicated chart, very busy. If anybody is interested in discussing during the break, I have a poster of this and the engineer who put this together--well, it wasn't put together--let me say that differently. We've been using an integrated product team to build the performance confirmation. Most of the members of that integrated product team are members of some of the activities that you've heard of over the last day and a half. That team is comprised of scientists, as well as performance assessment folks, as well as designers. Bo is a part of the team. Almost all the different M&O folks you've listened to are in and out of that team as far as identifying requirements for what they believe they need downstream.

One simple--again, very complicated; I apologize. But, we're going to look to collect data from the waste package. When we collect that data from the waste package, we envision it coming in. We may take a waste pack--we may take an entire waste package, pick it up, take it out of the subsurface, bring it to the waste handling building, do tests on it. We're not sure what type of tests yet. We'll collect some data, we'll process the date, we'll be able to go back at the end and understand if there's any corrective action required and then recommend how we deal with--recommend any corrective actions to any deficiencies we note that are outside of our defined parameters. And, lastly, when the system gets ready to put together a license to close, the basis for that license, I believe, will strongly depend on the results and the data we've gathered from the performance confirmation program.

I mentioned briefly that we've done some design implementation for performance confirmation. The team has decided that we need an observation drift with some borehole instruments into altered zones to sample--these are only examples of the parameters, but their concept is to put the--and, I'll show you--I think I have the picture here. Let me just flip on the other chart. Their concept is to put the observation drift above the emplacement drifts. There was a big discussion a while back over the last year or year and a half with Bo and the team. They wanted to understand what the rock looked like above the drift after you get some heat. Their concept is I could put boreholes and I can put those boreholes from that emplacement drift either above or below the emplacement drifts. So, I should be able to sample any of the regions around the emplacement drifts.

We've also designed, at least conceptually--enough, at least conceptually, to help the cost estimate of what performance confirmation is really going to cost from a total life cycle cost perspective. We have a concept of a Remote Inspection Gantry. This gantry, it's envisioned those same rails we talked about, that Dick talked about as far as using for emplacement, we'll bring this gantry in. We're cool that one drift back down to a lower than 200 degree Celsius. We'll put this in for an hour or two or no more. We're still struggling with what the design requirements are. If there are awfully hostile environment I'm going to put that gantry into, but the concept is I'll put it in, it will collect samples and data, it will come back out, and then we'll analyze the data. Again, enough of a concept to put some cost numbers together so we have a basis for a cost estimate.

As we move along, this is the way we envision the transition of the performance confirmation program. We're in site characterization as we pass--as we get to license application, we have already started to ramp up the performance confirmation program. There will be other testing going on. We'll feed off of that. I have a better chart that I apologize for not putting in your handout. I picked it up last night as I was going back through this. This is a near-term version, but what it's meant to show is we're ramping up now. But, as we move along, TSPA/VA will feed the performance confirmation program; TSPA for LA will feed the performance confirmation program; and at least today the team envisions that there are TSPAs of some sort post-LA that will be collecting data, feed it into performance confirmation as an iterative process.

I need to refer to my notes. Most of these planned activities--as I said, this performance confirmation plan will be complete and delivered to the Department of Energy the end of September 1997. During 1998, we will start to implement the implementation of the program prior to VA. Post-VA, we will begin the baseline definition phase of the program. In FY-98 and '99, we will start to shake out the approach using the Enhanced Characterization Repository Block in place, the block effort that Mike Voegele will be talking to you about. Long-term at VA, we will have a preliminary cut at the baseline information; by LA, we will have the final cut that we're willing to show to the NRC.

The design activity for the test and the facilities will continue to mature. We expect that at LA, we will have relatively mature designs, particularly for the Bin-3 type components that Dick Snell was talking about. By the time we get to construction start in the 2005 time frame, we will have a final design and we will be ready prior t the license to receive and emplace to do some demonstrations to show the NRC that we've got something up and really works. Lastly, this is going to be an ongoing process in my mind as we progress now and license application in 2002 and ultimately a license application in the 2008/2009 time frame to receive and emplace waste.

One bullet I probably would have added on the bottom here is, I think there's another long-term activity and that is to collect and analyze and assess the data to confirm those predictions we used at LA and understand what the position is we want to take between license to accept and emplace waste versus license to close when we decide to close.

That concludes my introduction for the Board. Questions?

NELSON: Thank you very much. Let me ask you just one question first. For the operations itself, the operation of the repository, is there a performance confirmation process involved in looking at the operation itself as opposed to the physical aspects of the repository looking at operations and where assumptions have been made about how the operations systems will be running?

WAGNER: I would tell you today that for us to have an efficient operation, we must have that. Again, the program is in the infant stage. Dick Snell talked about a model. We need to do some confirmation as we start to actually process wastes. We're going to have to validate that model to make sure because that model is a major management tool in the future that if somebody says I'd like you to take 5,000 metric tons a year versus 3,000, can you do that?

NELSON: Okay. John?

ARENDT: Arendt, Board. I'm looking for something like a control sample or some control and I'm looking at the observation drift. Could that be interpreted as a controlled risk or a control sample that you can compare all the rest of the waste packages and the drifts to or will there be something like that, I guess, if you're--

WAGNER: Okay. John, first of all, that drift will not be that controlled. The team has had some discussions and it's still in process. To me, it's not unreasonable with the number of emplacement drifts we have. We could choose to come up with a defined requirement and have a control drift. You know, we have a family of--I think, Dick mentioned yesterday--over 100 drifts. I don't think it's illogical to assume that between now and the time we're really into operating that we've come to that conclusion that we may need a control drift.

NELSON: Dan?

BULLEN: Bullen, Board. Could you put up your picture of the observation drift again?

WAGNER: Sure. I say that; let me find it here.

BULLEN: You mentioned that one of the things you might be able to do is use the Enhanced Characterization of the Repository Block as a means of doing some of your preliminary observations. But, this observation drift doesn't look anything like what the ECRB was proposed as coming from the northeast and going to the southwest. It actually looks like it's going between two drifts parallel to the layout east to west or whatever angle you are off of the ESF tunnel. Could you comment on--this layout, believe it or not, makes sense to me as opposed to using the ECRB for any observation characterizations primarily for two reasons. One, if there is a negative impact of putting something above the repository, you've messed up at those two or three tunnels that may not be usable for emplacement.

A comment on how you might use the ECRB and have what kind of impact the ECRB might have on your selection of locations for observation drifts. The reason I say selection and location is because, as we understand, the repository layout is not complete or the design is not finalized yet.

So, if you don't know what the design is, how do you know where you want to put your observation drifts?

WAGNER: I don't think today we have a clue on where we want to put that actual drift. I think we understand we want it above the emplacement drifts. I'd ask Mike Voegele's help. I have not been too intimately involved in the planning team's effort for the Enhanced Characterization of Repository Block. There's been a lot of discussion that I've only been on the edges of and I'd be more comfortable with Mike. And, I don't know, Mike, are you going to get to that later?

VOEGELE: Uh-huh.

BULLEN: I'll re-ask the question later.

WAGNER: Okay. And, if not--

BULLEN: But, maybe you ought to keep that viewgraph handy.

WAGNER: Absolutely. Because as the manager of that systems engineering group, this is an interesting cartoon today. We've got to come to closure on why--my job is I keep asking people, well, why do you want to do that? You know, tell me why you want to it? Why do you want to line the drift?

BULLEN: You're asking the exact same questions I'm asking.

WAGNER: Okay.

BULLEN: Why do you want to put this where you are? And, I would say that, you know, after I've got some interesting data from doing the drifting that looks like it might be the repository horizon, I can see some very interesting features and say, hey, you know, I probably want to go up about 10 meters here, build an observation drift, and see what the heck is going on.

WAGNER: Sure.

BULLEN: But, until I know what the repository design is, I can't take any credit for using an ECRB as an observation drift.

WAGNER: I wouldn't disagree with you, Dan.

BULLEN: Okay, thank you.

NELSON: Jared?

COHON: Cohon, Board. Two questions. The first one is in the same spirit as John's previous question. I know or I believe it's not the plan, but suppose one were to ask the question or if one were to consider emplacing some amount of waste less than all that could be emplaced as a first step towards understanding how the repository would work under real conditions with real waste in place. Is there any sense of how much waste would be necessary--how much would you need to get a good real time, real waste prediction of performance?

WAGNER: Jared, I don't believe and I'm not knowledgeable. I've been with the project now for--the program for two years. I am not aware that we've ever done any analysis or any type of a study to ask ourselves that question. So, I'm not prepared to answer that question.

COHON: Okay, that's fine.

WAGNER: We can take a look. Mike, you've been with the project a long time. Have we ever asked ourselves that question?

VOEGELE: This is Michael Voegele. The entire characterization program was built with the recognition that we would begin to acquire data during the site characterization program that would eventually roll into a performance confirmation phase. The question as to what will be the exact performance confirmation program is one that we will not be able to answer until we understand what a license looks like because, as Richard pointed out, the performance confirmation program is, in fact, to verify the terms and conditions of the license. If we were able to through a performance confirmation program go back and make an argument to the Nuclear Regulatory Commission as part of our formal licensing process that we had acquired sufficient data to change our performance confirmation program, I would argue that it would be in the country's best interests for us to do that. So, I have always envisioned the performance confirmation program as continuing the site characterization program through the initial phases of the emplacement--construction and emplacement operations and then, as we gather additional data as the rock mass was more fully explored, we would begin to shut down pieces of the performance confirmation program because we would have reduced uncertainty that we might have had as a condition that the NRC asked us to continue to monitor. So, I can't give you any specific information that would tell you at what point in time you might shut something down, but I can give you some general examples.

If we had, for instance, an ability to do a couple of crossdrifts as part of something that would be eventually used as a performance confirmation program and were able to sufficiently enhance our confidence about structures throughout the repository block, we might be able to make some arguments and say we don't need to do quite so much mapping, we don't need to do these types of measurements, and go negotiate with the NRC. So, I have no specific number that says four years of additional data will reduce this; only if a philosophy that says it's in our best interests to use that performance confirmation program iteratively and try to modify it as time goes on.

COHON: Good, thank you.

The second question has to do with how much flexibility you have. The answer I just got, I think, goes part way towards answering that one. The way you couch your performance confirmation, quite appropriately, is to ask questions like, well, is the performance within the bounds set on us by the license. I wonder if you feel that you have the flexibility to go beyond those limits? That is, suppose after emplacing some waste and doing some testing you figure out a better way to do it. You could see a way to optimize the repository hypothetically, though it may not be necessary because the performance you're seeing is within the bounds. Do you have the flexibility to substantially alter the way you're doing things if you see a better way to do it, even though the current performance you're getting is within the limits?

WAGNER: I'll try to--you go ahead, Mike?

VOEGELE: this is Michael Voegele. My immediate answer to that would be, absolutely, the repository license is, in fact, phased; that you apply for a license to construct, and then after you've done after what is referred to as substantial construction, you go back and apply for a license to emplace. It would not surprise me, at all, to see our concepts of how the repository system functioned changing during that period of time. I believe that's why the NRC has the license structure set up in that phased way.

WAGNER: I think the only constraint would be on the program itself. I think that flexibility is inherent the way the NRC has laid out the structure. I think they're expecting us to be flexible.

NELSON: Last question from Alberto.

SAGγIS: Yes, a very quick question. Sagηϑs, Board. If you have a backfill in the drifts, then, of course, that complicates the monitoring, entry, and the like, right? Do you have contingent plans for a backfill case?

WAGNER: Today, let me address just--

NELSON: Can you repeat the question, please?

WAGNER: What I think I heard the question to be was if we use backfill, then I inhibit my capability of using that monitoring gantry I talked about and do we have other alternatives? That's what I heard the question to be.

SAGγIS: Yes.

WAGNER: Today, our concept that we just reviewed at the first part of the week in a management design review is we believe the concept we're using today--and we haven't come to a final decision--is when and if I use backfill, it will be part of my closure process. Our plans today, at least our preliminary planning and again we're still balancing pros and cons, but our plan--if I had to make a judgment today, we will not backfill until at the end when it's part of our closure process.

SAGγIS: Okay. But, of course, the backfill introduces a whole bunch of new questions as to mass heat transfer, conversion properties, and so on that will be explored and--

WAGNER: Sure. I think with the flexibility that Jared talked about, I think we're going to come to a point and an understanding that when I keep the backfill option out there as far as closure, I may have to take a representative part of--I may have to backfill a part of a drift or somehow develop a test that answers the kind of questions you're talking about because then, once I decide I'm going to backfill, then I have another set of predictions to make and another set of parameters to define that I have to go measure. We may not have to do it with a full scale--with a natural waste package, but we may be able to go to a university and have someone help simulate that for us. You know, I don't believe that's out of the realm of reality.

NELSON: Thank you very much. We're going to have to close discussion at that point. Thank you, Richard.

I would like to introduce our next speaker who is Mitch Brodsky. He's been with DOE since 1991, formerly with the U.S. Bureau of Reclamation and in private geotechnical practice. He's going to speak to us under the title plan for developing projected costs of repository construction and operation. Good morning, Mitch.

BRODSKY: Good morning, thank you. Good morning. Thank you very much for that warm introduction, Priscilla. This is the first time I've been exposed to you all. I know most of you are new or all of you new; I'm not sure which. But, I can see why the U.S. Congress thought enough of you to ask you to go ahead and do what you're doing based on the questions that you've asked. I'm quite honored to be here.

NELSON: And, you have quite a suite of viewgraphs that you've prepared for us.

BRODSKY: The rest of them are backups. I know you all have expressed a lot of interest in trying to understand the cost estimates, what we're going to do, and how we're going to approach, and I'm here to answer those questions. I'm going to go through a lot of material. Prior to this, I generally spoke real slow; you know, anywhere from 40 to 50 words a minute, but thanks to Larry Hayes and Dick Snell over the last week or so they've taught me how to speak at about 100 with gusts up to 250. So, that will allow me to get through the material a little bit.

What we're going to talk about here is why we're doing the cost estimate, some of the components of the cost estimate itself, the estimating approach or approaches that we're going to use. Those will vary, as you'll see, depending on the individual design and scientific technical subject matter. The cost control processes and review plans, an example of an estimate with some numbers. I know that John asked for some of that information yesterday. I've got further review slides to talk to about that. Some key milestones on our road, as well as some challenges that we're going to be having to deal with.

Tying into what Steve talked about yesterday, clearly, the MGDS-VA cost estimate is a limited life cycle estimate that we're going to be constructing. Obviously, that's one of the four--Jean alluded to the cost estimate as part of a license application plan. We'll talk to that in a little bit further detail later on.

Now, what do we use our cost estimate for? Well, our MGDS-VA cost estimate is clearly based upon the reference design description that I believe Dick talked about yesterday and it's been talked a little bit about this morning, as well. It leads into use--all trade and optimization benefit studies, that kind of thing, and it falls right into part of the program cost estimate which is obviously used for things like waste fund fee adequacies, computations of defense funding, and probably the most important thing and probably the reason that you asked the original questions that you asked, determinations of economic viability from a program standpoint. The program cost estimates are also clearly used for tradeoffs and benefit studies, as well.

Visually, this is pretty much the difference between the MGDS-VA cost estimate, as well as the program cost estimate. I'll talk about the differences in the various cost estimates, but understand that it's basically broken out into development and evaluation of time frames and cost, pre-emplacement constructions, emplacement and operations, and caretaker operations, and finally closure and decommissioning. The differences revolve around inventory more than anything else, as well as the inclusion of post-dated license application costs.

Before we talk about what's included in the MGDS-VA cost estimate, let's talk about what's not included. Clearly, historical costs prior to 1998, as well as license application costs, are not included. All other program costs such as waste acceptance, national transportation outside of Nevada, as well as other program costs and storage costs, are not included. Those are included in the program cost estimate.

Now, what is included? I'm going to talk to D&E costs, surface and subsurface facilities, disposal, waste package containers, performance confirmation. I'll be cataloging and jumping around the back of what you just heard about a little bit, as well as Nevada transportation.

Now, we do have some other design costs that are going to be incurred after '02; okay? Most of your final license application design cost is going to be covered under the license application plan that Jean talked about earlier from '98 to '02, but past that, you're going to have some design activities. You're going to have other planning activities, particularly with regards to ready-for-construction and actual construction and emplacement type of operations. You're also going to have PETT, as well as PC work continues to improve. Like Richard was talking about earlier, those costs will be able to be more deeply defined and be able to be integrated into the program. And, also, obviously, Nevada transportation is also going to be accelerated right along with PC.

Now, this is where it starts to get from a cost estimation standpoint both interesting, as well as exciting. As you understand the binning concept, our charter, as you know, is to be able to supply this VA. Now, we couldn't possibly complete the design for 100 per cent of what we're doing. We've got to be able to differentiate. The binning concept allows us or mandates us to be able to estimate different facilities, different aspects of our design different ways. From a radiological facility standpoint, a lot of those will be Bin-3 type activities. Those will be more bottoms-up. You'll have those more definitized in being able to identify exactly how this thing is going to look, feel, touch, and be constructed. You're going to be able to more accurately estimate what those things are going to cost. Some of the balance of plant costs could be from a surface facility standpoint of Bin-2 or Bin-1 activities and those things are going to be more parametrically estimated based on similar technologies that have taken place and been constructed in other areas of the country, as well as here.

That leads right into subsurface costing. One of the advantages that we have is we've got a lot of history that we've done a lot of work with respect to the ESF, with respect to the subsurface boreholes that were constructed. That history and those pricing techniques, we have that as a basis. Does that mean that we're going to be pricing everything out exactly how it was constructed? Well, no, because the state of knowledge that we have is further along than when we first experienced those costs, experienced those methodologies of construction, etcetera. But, we're going to be able to catalog on those TBM costs, road headers, and other costs and be able to do those--let's call it more from a bottoms-up standpoint. Obviously, we're going to use trade industry standards for men, equipment, and materials. Some of the typical types of pricing techniques, John, I'm sure you'll recognize a lot of those. All of those will be input into what we estimate from a subsurface standpoint.

Interestingly enough, I do want to say that the M&O is way ahead in this department. They've put together right now ahead of schedule a model that will allow us to be able to tweak our cost estimate with respect to a subsurface in a very readily manner. They've been able to do that predominately due to the cost that we've experienced in the past.

From a disposal container standpoint, understand that we're not necessarily dealing with new technology, but new applications. Okay? That presents us a lot of different options as we go down through and price this thing as to what kind of supplier arrangements that we're going to have and what kind of estimated unit cost that we have. As our design progresses further, we'll be able to even more accurately define what those prices are going to be with respect to disposal containers. We have other facts; sales tax, factors for transport and project management. The contingency, I'm going to address that in a little bit, and I think that Jared or maybe Dan addressed the contingency question before. I'm going to get to that in just a little bit. As the waste stream gets more defined, obviously that's going to have an impact on our ability to price out what we're doing, as well. At this point in time, we're dealing with the current estimates for waste stream.

A PC standpoint, a lot of the pricing techniques that we're going to be using for performance confirmation stem directly from the surface and subsurface pricing techniques that were already used because, by and large, a lot of that work will be integrated very closely with those particular systems. As the PC system gets more well-defined, it will kind of take a life of its own and we'll be able to more accurately define those costs like I talked about. So for right now we're going to do a lot of scaling and a lot of factoring and a lot of parametrics based on what we know today and based on how close to new technology is, how much we can use from existing technology.

I know the State is going to be actively interested in Nevada transportation. Well, when you perform any cost estimate, you've got to be able to make certain assumptions when you can't come up with a number. Well, here's assumptions that we're going to be utilizing at this point in the game. We're going to be taking the average of the five EIS rail routes from a pricing standpoint to include in here. We're also going to assume that we're going to have the Regional Service Agency operating the line. That will determine our pricing techniques from a transportation standpoint until such time, obviously, as a final decision is made, and as time goes on, we'll get closer and closer to that.

Now, the models that we have now and that we're going to be building in the future to be able to update the cost estimate as time goes on are going to take a more active role in our design process and this is the process that we're basically going to use. We're going to use some cost trend assessments like you would in any normal engineering design organization and integrate that with not only updating of the

RDD like Dick talked about yesterday, but also a very, very fast turnaround with respect to the potentials for updating the cost estimate. In other words, the decisions aren't going to be made to change the reference design document until after you already have the costs in place that would make the change. It may not make good engineering or science sense to go ahead and make the changes that you're talking about making in the RDD. So, you won't do that. You'll have more lower level decision making potential as your design further progresses. Now, on those Bin-1 and Bin-2 items, obviously, those decisions will take place at a higher level and the process allows us to be able to do that.

Now, from a contingency standpoint, our contingencies are pretty much based on an individual element by element basis. If you've got a Bin-3 activity that you're pricing from bottom-ups, clearly you're not going to go ahead and have a 30 or 40 per cent contingency because your designs are more well-defined. When you actually get down closer to your actual construction, you may have only a 5 or 10 per cent contingency based on normal construction practice. So, those Bin-1 and Bin-2 activities, those are going to have higher contingencies because you really don't have the designs more fully developed compared to those in Bin-3.

Now, from a review standpoint, I know Steve talked a little about this earlier. We're going to clearly integrate all of the aspects of the cost estimate into a composite whole at the end of fiscal '98. The M&Os will have their package together by April. Now, in order to be able to marry up all of these things and have them, let's call it, externally reviewed, we've assembled the next turnover review team coming out of FM, field management, to be able to come in and work with us starting in October as the various design packages are completed. A good example is waste package. The basic waste package design will be done at the end of September. Well, that will allow that particular team to get in there and start reviewing it so that the comments from this review team can be taken into account and the cost estimate updated or the designs re-looked at based on this process. That's a good thing because what we basically wanted to assure ourselves is that when we took the MGDS-VA cost estimate and combined it with the other three aspects as a composite whole and sent it forward to not only Washington, but to Congress, as well, that you had a basis for the cost estimate itself and that's what this review is actually going to attain for us.

Obviously, Yucca Mountain is the largest element in the program cost estimate; clearly, 73 per cent is about what it's at. The other elements, we talked about earlier. But, the question that you are asking yourself and a question I'm asking myself is where is the slide for what's the repository cost drivers. Okay. We're going to go to a new slide. You don't have this in your handout. You've got another one, I believe. Pie chart, right. And, basically, what that particular chart was designed to do was to give you a feel for amongst the repository MGDS-VA cost estimate and it was based on a 97 PCE, but pared down from that. Since that represents the total inventory, we've got to pare it down to meet what our requirements are from a MGDS-VA standpoint. This additional chart here basically shows from a life cycle standpoint the various costs pared down from the 97 PCE. And, you can see either looking at this from a different vantage point or looking at--anybody who wants a copy of this chart, I'll be happy to get it for you. I'll leave that one up there. I'm sure there's going to be questions on that.

From a milestone standpoint, our various design freezes that will be integrated with our external reviews are shown here. Obviously, all VA documents are going to be due at the end of August. The assumptions will be done at the end of this year so that we can start integrating our external review.

The challenges. Well, in preparing these slides, we talked about issues and challenges. We really don't have any issues from an engineer's VA cost estimate standpoint. We do have some challenges; things that we're going to be watching as time goes on. Clearly, one of those is reconciling the external review comments. We're going to want to use the cost control process to reconcile anything that might lead to a significant change in our overall design and henceforth changes within the RRD and changes within the cost estimate itself. We're also going to want to integrate late design changes. As the designs progress and get further along and go from Bin-3 to, let's say, the Bin-2 or something along those lines from a progressive standpoint, we're going to want to update our designs appropriately and our cost estimate right along with it. Obviously, integration is a key and I believe someone yesterday talked to the fact that integration is the key. Absolutely, it very much is so and the cost estimate department, as well.

And, with that, I think I'll take some questions. I bet I know exactly the questions that are going to be asked here.

NELSON: Thank you very much. We're going to let you get a drink of water, and I'm going to call on Dan Bullen to take the lead.

BULLEN: Bullen, Board. You put up the one that's in your overflow viewgraph which was total system life cycle costs comparing existing estimates. That sort of caught my eye. I have just a couple of quick questions about that, yeah.

BRODSKY: Is that the one?

BULLEN: No, the one that's got existing estimates in parenthesis.

NELSON: The other side.

BULLEN: The other picture that has $32.8 billion as the total system life cycle cost.

BRODSKY: Uh-huh.

BULLEN: Does that $32.8 billion include revenues pre-1998? I mean, you excluded, you know, things that happened before '98 as not being a cost in one of your previous evaluations.

BRODSKY: Yes, it does.

BULLEN: Did you put those back into the mined geologic disposal system pie chart there?

BRODSKY: Yes, it does.

BULLEN: It's in there?

BRODSKY: Yes, it is.

BULLEN: Okay. And so, if you do the quick back-of-the envelope calculation and you figure out how much money is there in the whole pie which means if we did the existing life of all the reactors and said they generated at a 70 per cent capacity factor and so many kilowatt hours or megawatt days or whatever you wanted to use as a measure, do you know how much money total the estimate might be that there is going to be to do the job? What's the total pie that you have to draw from?

BRODSKY: This is the life cycle cost estimate based on the life cycle--

BULLEN: No, what's the revenue source? What's the total revenue that you can expect to generate? Is $32 billion enough is my question.

WAGNER: Mitch, this is Richard Wagner. Let me try to help you with that.

BRODSKY: Go ahead?

WAGNER: Lake, would you like to do this or do you want me to do this?

BARRETT: Lake Barrett, DOE. What the Board is seeing here is--for the Yucca Mountain folks, is on the cost side, the outflow side. It's another whole set of folks that are doing on the inflow side. We did a fee adequacy report two years ago. There, within the range of what your estimate--your assumptions of the interest rate over the inflation rate really drove the whole thing because it's the money, the $5 billion that's in the waste fund and what that's going to do. When you look at it on a straight income without that interest, you don't make it. Also, you made the assumption that reactors complete their license lifetimes which in the world that I think we're starting to see is probably not a good assumption anymore, okay, in a competitive changing electricity environment. So, it's another whole matter that we can discuss at another time, I think, and have numbers for you. Or, if you want, we can try to do it now a little bit, but I think it's the wrong person.

BULLEN: No, I agree. I just wanted to know if we were in the ball park and I think we are.

BARRETT: Last time we looked, they were in the ball park.

BULLEN: Right. I guess, the followup question that I have for you, Mitch, is you said you'd taken the regional servicing agents out of the transportation scenario beforehand, but kept the Nevada transportation in. Those five rails per averages, that's the cost of building the spur to the site from wherever they pick, Caliente or whatever?

BRODSKY: Nevada costs, yes.

BULLEN: Yeah, the Nevada costs. Are the RSAs back in this one, then? I mean, because the RSAs have to come out of the waste fund, too.

BRODSKY: The answer is yes.

BULLEN: Okay, thank you.

COHON: Cohon, Board. Now, I'm really confused because earlier on you said you were excluding national transportation in your cost estimate, but now you're saying it is included in this?

BULLEN: I jumped ahead. This is for this last one I asked.

BRODSKY: Jared, let me see if I can make this a little clearer. From an MGDS-VA standpoint, okay, you had to break out--since we've got transportation costs that are across the country, as well as inside Nevada, we had to call it the bottom line. Okay? So, those costs that are inside Nevada are included as part of the MGDS-VA cost estimate, but those costs that are outside of Nevada are included in the program cost estimate. Okay? So, the various constituents are all in there as a total, but from a VA standpoint since we're required to itemize the cost estimate for constructing and operating a repository, those costs are included here. Just those Nevada costs. Does that answer the question?

COHON: Yeah, but where is here, I guess? Which is which?

BRODSKY: These costs, Nevada transportation costs, are included here. Okay? Now, inside the overall pie chart which is included here and here is the remainder of those transportation costs. There's a portion in each one.

COHON: Okay. Can I continue with my other question?

NELSON: Yes, please do?

COHON: My other question had to do with the nature of this cost estimate, in general and in general terms. You characterize it as a limited life cycle cost analysis.

BRODSKY: Right.

COHON: In what sense is it a life cycle analysis and in what sense is it limited? Life cycle of what?

BRODSKY: Well, I heard a term--well, I use a term "cradle to grave". Okay? When you talk about life cycle costs, you've got to deal with the full spectrum, the big picture. Okay? Other than that, you're really not giving yourself a good, big picture and you're certainly not going to give the Congress a good, big picture as to what this thing will cost that we're going to be constructing. Now, we're only dealing with a small limited piece. So, when you deal with the overall system architecture, as it is, you're going to deal not only with the costs that have transpired before from a program cost estimate standpoint, the costs that have transpired before, all the D&E costs from 1983 until the current year, you're going to also add onto it the cost to complete the license application from '98 to '02. You're going to carry right into the cost to construct the and operate from '02 onward and then go on to closure and decommissioning.

COHON: Yeah, just to save time, I get all that. But, there are two questions. Whose life cycle is it? Whose cradle and whose grave; the repository, the waste? It's got to be the life cycle of something. Whose life, what's life?

BRODSKY: The entire program's. From an MGDS--

COHON: OCRWM's.

BRODSKY: Yes.

COHON: OCRWM's life cycle?

BRODSKY: Lake?

BARRETT: Maybe I can help again here. When we use the word "life cycle costs" like Mitch is using it, it's the DOE cost. It does not, for example, include utility storage costs and those types of things. It's what we're doing under the Nuclear Waste Policy Act and the waste fund and also the defense costs. The subset of that is the repository element which is what's going to be in the viability assessment. The viability assessment does not include other program costs like national transportation and other things. We will have a companion document of the total RW life cycle costs which will be from the monies that we've expended under our Appropriations under the waste fund. Does that clarify or confuse?

COHON: That's fine, thanks.

NELSON: Okay. Richard?

PARIZEK: Parizek, Board. On contingencies, I didn't know whether you include in there slippage, Congress' delay in deciding something, because you seem to have a time clock that moves very rapidly between license application and construction, as an example. The reality is there's probably--like WIPP suggests, it takes quite a while to finally resolve all the conflicts that come up in between. Are they in there or how do you put those in so society knows what may add to this program in terms of its delays that it creates to the whole program?

BRODSKY: Slippage is kind of a hard question to forecast; would you agree, generally? So, you've got to be able to use engineering estimates and what has transpired in the past to be able to define what your contingencies are. Okay? We had this slide put together basically last night to be able to answer some of John's questions that he had when we were talking privately. This is basically a listing of what some of the potential contingencies are based on the individual design elements that we're talking to. Some of those will relate to how far along the designs are clearly. If they are far along and you know that you have the potential for having significant slippage, well, you're going to have to include something in there for that. What they will be will be on an independent case-by-case basis and that would make good engineering sense to do that. As your designs are less farther along, you obviously have more contingency not necessarily from a slippage standpoint or from potential delay standpoint, but just from a--if you don't have designs further along, it gets harder to price it. So, you need to have some more contingencies based on that aspect more predominately than you do from a float standpoint.

BARRETT: Maybe I could add a little bit. These are all--the assumptions and the dates that he had are what these cost estimates are. The contingencies are not based on any slippage. They're based on uncertainties of construction and changes and design change, etcetera. So, these are all--those estimates are as good as the assumptions that go into them. It has no basic slippage due to political or regulatory aspects. If slippage is introduced, then slippage may well be likely. Who knows what that's going to be, if there's going to be increased cost, and that would be beyond what's in those.

PARIZEK: But, the program takes hits always. Society is always beating on the program for costs and delays, some of which are beyond the control of the program. I think it would be worthwhile to make it very clear to the public that horsing around costs money.

BARRETT: yes, sir, we will. But, we're not going to put a, let's say, scheduled slippage contingency dollar in our total life cycle costs as an assumption either. So, yes, we will clearly make that point that time costs money. It's true everywhere.

BRODSKY: Richard, if I could just--part of my background, I used to negotiate construction claims for a living. When you start out a project, if you were to anticipate that everything would go wrong, well, you'd never get that project done. Some of that, you may think that you might have a problem over there, but from a pricing standpoint, you've got to make certain assumptions and you have to assume on a positive proactive nature using best engineering judgment as you go down through.

PARIZEK: But, that wasn't an assumption that was listed clearly in all of this. So, maybe that's a bold print thing right up at the beginning of all of this that the program will move smoothly onward.

BRODSKY: I apologize for not taking that--

PARIZEK: Not now; I'm saying for later when this is presented to Congress.

BRODSKY: I understand. Good question.

NELSON: Okay. Just before the break, Dan, quickly?

BULLEN: Bullen, Board. How big is the repository that you're designing with this cost estimate?

BRODSKY: MGDS-VA costs us just for an inventory about 70K. Now, the program's got requirements that go up to 100K with all the inventory.

BULLEN: And, how much more will that cost? Does it scale linearly? I mean, you said that the mine geologic disposal was the biggest hunk of the pie. And so, if you've got a 50 per cent increase in that cost, does that mean that we can take that $23 billion and add another $11 billion or $12 billion and that's going to be the cost?

BRODSKY: There's your numbers, Daniel. But, very clearly, I think more of a better answer to your question lies in the fact that the cost models, the pricing models that the M&O has already put together will allow us to be able to itemize those in less than a linear fashion because let me give you a good example. When you deal with the additional inventory, the cost to get into those additional areas are--let's just call it from a unit price--are going to be a little bit higher than it is for the body. Okay? So, from a unit price standpoint to approach it linear is not basically good engineering practicing. If you've got those models and we do and we've got some of those preliminary conceptual designs and we've been able to put those inside the pricing models themselves, the numbers that you're going to see are clearly not going to be linear once we get done with the MGDS-VA cost estimate and we're going down to PCE. So, the answer to your question is, no, it's not going to be linear.

BULLEN: That's exactly the answer I expected. I didn't think it would be linear, but it would be nice in your backup viewgraphs next time you talk to us to say, okay, I know I have to design for 70,000 metric tons, but, man, if it's 100,000 metric tons, it's going to cost you this much more and it would be nice to know that number.

BRODSKY: Absolutely. I have no doubts that next time we get a chance to share some information with you, we're going to have better cost information from a number of standpoints.

NELSON: Okay. Closing question from Paul Craig.

CRAIG: Paul Craig, Board. A characteristic life cycle costing is that those numbers are very non-intuitive because you're mixing up dollars from different years.

BRODSKY: Yes.

CRAIG: And, another characteristic is that there tend to be only meaningful when compared with something else with what you would do instead. One of the insteads is how much is in the bucket, the inflow. But, another instead is what do you do if you don't have Yucca Mountain operating on the time scale that you expect? And, another characteristic of all discounting is that the further off you go in the future, the cheaper it is in terms of net present value because of the discount factor.

BRODSKY: Right.

CRAIG: So, all of that leads me to suggest that it is exceedingly important that you provide us with information that shows what happens when you have various types of stretch-out because those numbers are needed in order to compare with the costs of doing whatever the nation decides to do instead, whether it be on-site intermediate storage at reactors or at Yucca Mountain or someplace else.

BRODSKY: Sure.

CRAIG: Which is not your domain clearly, but somebody is going to be doing those calculations and the cost of delay becomes really important. Are you doing those calculations component by component?

BRODSKY: Absolutely. I'm glad you asked that question, Paul. Clearly, in order to be able to compare apples to oranges, you've got to deal with current year dollars when you're dealing with that because then you're really--you can relate to it. One of the things that I used to deal with a lot was litigating the word "reasonable". Okay? It's like everybody has got a nose and they all stink, okay? But, when you start talking about trying to get agreement on where you're going to be in the future, you can probably have as much fun litigating escalation factors as you can litigating the word "reasonable". Would you agree with that? And so, consequently, that's why all of our dollars here are showing in now-year dollars, and when you get to talking about the waste fee accuracy from a program cost estimate standpoint, those will be escalated because you've got to take that into account as to where it's going to go. Now, those escalation factors change year by year and I've watched them change. Okay? But, that's when those calculations were made clearly from a budget standpoint. Those things are also factors, but that's why we go to cost on your dollar so that we have a common base with which to lead from. Does that kind of answer your question?

CRAIG: My concern was not about using that present value. Clearly, you should be doing that. My concern is that it's important that you give us information so we can understand what happens with various receipt schedules so that we can compare it with other possible and national strategies. That's the only point.

BRODSKY: I think that I don't have that kind of "what if" information with me at this point in time, but very clearly, we can answer that later or at some future point in time. I'd be happy to do that.

BARRETT: Let me add to the record here. Lake Barrett, DOE, again. That is a very assumption driven situation hazard not within the program, certainly not within Yucca Mountain. We have answered questions to the Congress, you know, in testimony as to what that situation is. We refer to those in the program as societal costs because somebody, be it the rate payors or the stockholders or someone in society, is going to pay for safe storage of the material at reactor sites or at DOE sites that we're not doing if we are late. And, we've answered one of the things we've got--for every year we delay this program of moving that material, it's nominally about a half a billion dollar a year societal impact, $500 million dollars a year. This is very adjustable depending upon what the environment is out there. For example, if there are more shutdown reactor plants where the removal of the spent fuel is holding them to keep their expense of--you know, auxiliary building pools functioning, the costs are much higher than if they've already taken the capital investment to go to relatively passive dry storage. So, it's a very complicated subject. If the Board is interested in that, I might suggest at your next meeting or when you would like put that on the agenda and we'll come and tall you what we know and you may wish to invite, say, utilities to come and tell, you know, what they believe those costs of delay are. But, that's an extremely important issue that if the Board wishes to go into it, I would like us to have adequate time with the right people so there's no misunderstanding of a very complex issue.

CRAIG: You're making my question more complicated than it was intended to be. All I'm getting at is the reality that your net present value of your program is going to get lower as the program extends. You take the same program, shift it later in time, and it gets cheaper from a net present value point of view. On the other hand, there are other costs that appear. All I'm asking you to do is to provide us with a database so that we can understand what's operating. I don't ask you to look at what's happening with the spent fuel at reactors. I do ask you to provide us with the information for your program so that when we get information or when somebody gets information on other programs, they can do the comparison. That's all I'm asking.

BRODSKY: You want the database to be able to go do some work yourself?

CRAIG: That's correct. That's what my question is about.

BRODSKY: Gotcha.

NELSON: Okay. Thank you very much. We are running late, per normal. I would like a shortened break to exist until 10:40 which is approximately 7.2 minutes.

(Whereupon, a brief recess was taken.)

COHON: Dr. Nelson is too polite to scream at you, but I'm not as you've all seen. Right now; thank you.

NELSON: My hero, Jerry.

Okay. We are reconvened and we are set to hear from Mike Voegele who is part of the Minnesota Mafia in geologic engineering and rock mechanics. He came to Las Vegas in 1981 with SAIC and he's the deputy for technical programs on the project. Mike is going to speak to us today on the variably titled east-west tunnel or the enhanced crossing of the repository block--that's not right either--the ECRB, the plan studies and their objectives.

Mike?

VOEGELE: Thank you. i wouldn't have believed that there were still people around who remember the Minnesota Mafia. Thank you; that's a compliment actually.

NELSON: It was a bedtime story when I was growing up.

VOEGELE: Okay. The ECRB acronym is not--actually didn't put it in the title. That stands for Enhanced Characterization of the Repository Block. That just simply acknowledges that the effort that we undertook looked at more than just simply a drift across the block.

I wanted to start with a particular figure. Sometimes, the fates look out for you. This is actually the figure that you have in your package. I'd like to look at Dr. Bullen and say what drift. What drift? Sorry. Priscilla has copies of the--

BULLEN: My response to that is, fine, pick one of those and use it. That would be great.

VOEGELE: Okay. This is, in fact, the recommended layout and I wanted to just momentarily highlight a couple of things on there. We were undertaking--I think Larry Hayes was mentioning earlier the $10 million change request that went through earlier this year. There are actually two boreholes that were taken as part of this; SD-6 and SD-13 were started in advance or the planning was started in advance of the Enhanced Characterization Repository Block. So, we made the decision to not include them in that recommended change request. WT-24 which is the borehole that Dwight Hoxie mentioned, that's going to the north and looking at the steeper water table gradient. SD-11, down here, are two boreholes that were recommended as part of the Enhanced Characterization Repository Block effort. So, all in all, coming out of our replanning efforts this time of the year, there's four new boreholes. This is, in fact, the recommendation for the--I guess, you should call it the generally southwesterly drift rather than the east-west drift. I'm going to try to leave enough time to fully explore that. I know that many of the Board members have not seen the presentations we've given to some of the staff and some of the Board members and how we arrived at this. So, I'd like to leave enough time to come back to it. I imagine it's too much to hope that the 15 minutes we're behind schedule comes out of my half hour, right?

NELSON: You're okay.

VOEGELE: Okay.

NELSON: Larry Hayes is yielding some to you.

VOEGELE: Oh, really? Okay.

I want to go through this. It's a very brief presentation and you're going to find that it overlaps very much what Bo talked about yesterday because many of the hydrologic uncertainties that we're going to talk about are, in fact, things that are related to the unsaturated zone model. And, you're also going to see a lot of this coming from Larry Hayes' presentation where he talks about updating the site characterization program. So, what I've tried to do is put it in a smaller context. I wanted to show you what the proposed tests were coming out of the enhanced characterization recommendation. Then, how the results of those tests are used to reduce hydrologic uncertainties generally because I assume that was the primary interest.

I'm going to talk about two different types of testing. There's a set of testing proposed to support the design and construction. We're going to monitor construction water usage and ventilation impacts. It's very important because we're switching from a relatively dry mining situation to one that involves more water. We want to understand what the effects of the use of that additional water are. We're going to be looking at dust suppression strategies not just with water usage, but perhaps through different ventilation approaches.

We're going to be mapping fracture distributions, frequency of fractures, and the physical attributes of those fractures. We're going to be looking at the deformation of the footwall in Solitario Canyon Fault, characterizing any potential hazardous minerals that we might encounter in this drifting, understand the location of the basal vitrophyre of the Topopah Spring formation.

Now, all of this is going to be done in the context of a predictive analysis. We're going to look at exercising our geologic models and try to understand how we can predict features of engineering and construction significance and anticipated ground conditions. So, that particular report will be done and used to look at the information that comes out of the construction testing programs.

There's also a series of tests that are proposed to support the development of the hydrologic models. We're going to be looking at saturation profiles and the hydrologic properties of the different units from the surface boreholes. We're proposing niche and alcove studies to characterize percolation flux and very importantly--I think you would have picked up from Bo's presentation yesterday--seepage into the drifts and how the fracture and matrix interact in this hydrologic model. We're going to look at saturation and water potential measurements from the crossdrift to characterize spatial variability of percolation flux. We're going to be looking at environmental isotope distributions and fracture fillings. If you've seen the development of Bo's model, you recognize there are about five or six different ways that we use to try to estimate percolation flux. I believe Larry's going to cover them in some detail. These particular tests are tests that are gathering information that you can use to help validate those models.

We're going to be looking at the tracer migration rates in boreholes, hydrologic properties of Solitario Canyon Fault. If we happen to encounter perched water in a surface borehole, we'll be doing the testing program on that. And, again, we're going to be doing this in the context of a predictive report. We're going to try to predict the ambient moisture--not try to; we will use our models and predict ambient moisture, gas, heat, and geochemical conditions along the crossdrift and then we will compare the results of the testing program to that.

So, that's a general overview of the testing programs themselves, the types of tests that we'll run. I'd like to focus now on how those particular tests will have importance in reducing hydrologic uncertainties. I'd like to look at them in generally a vertical section.

We're going to look at how you characterize percolation of water at the repository horizon in the different host rock units; how different surface infiltration rates are mitigated or moderated at depth, how they vary across the site. We're going to look at characterizing seepage into the drifts through our in situ testing, particularly in the niches. And then, we want to look at characterizing the movement of water below the drifts, as well. So, that's generally how it gets it in from the surface, moves down through the rock formation, is stored or moves outward laterally, how it might seep into the drifts, and how it might move below the drifts. Those are really the key attributes of understanding how water moves through the system and how it could eventually contact the waste packages and be carried out through the repository.

The testing programs are going to be used initially--two major ways that we're going to be looking at reducing hydrologic uncertainties. We're going to use this data to discriminate between the different models for fracture-matrix interaction and seepage into the drifts. We're going to be looking at dye infiltration to help us understand that. We're going to look at progressively increasing water injection above an excavated ditch to evaluate the seepage threshold and we're going to look at water monitoring from the launch bay crossing ESF main. Now, I want to come back to those tests to address the question that I know that Dr. Bullen is very interested in asking me. So, remember this viewgraph because we'll come back to it.

Okay. We also want to look at addressing the variability in the percolation flux. What we want to do--I think, this was Dr. Cohon who was asking us this morning if, in fact, that isn't what we need to do between viability assessment and license application is how you can understand and either verify that the rates we're using is correct or whether we can reduce the rates of some of these bounding calculations. And so, the testing program to support the model development has really been set up to try to do that.

We're going to be looking at chloride; chloride mass balance, chloride-36 in the main, niche samples in the east-west drift and in the new boreholes. We're going to be looking at other chemical elements; strontium isotopes, the environmental isotopes, technetium iodine in those same locations. We're going to be looking at temperature, geothermal gradient measuring in the borehole, and fracture coatings. If you remember the presentations you've seen on the development of the UZ flow model, those are, in fact, the different techniques that we've used to estimate what the percolation flux is. We've look at how--for instance, we've looked at temperature gradients in the boreholes and set an percolation flux of value X would result in this damping of the geothermal gradient and we've compared that to models. Zell Peterman, for instance, has looked at fracture coatings and come up with estimates over very long periods of time of what the average infiltration flux would be based on the fracture coatings. These are the same types of studies that are looking over different time phases. So, what we have here is a comprehensive program to look at validating that UZ model from all the different ways that we've looked at for developing it.

Okay. Now, I've deliberately gone very quickly here so that I can turn to what I believe is the question. Let me ask you, Priscilla, if we can take questions on the testing program first and then go into the bigger question of the drift itself?

NELSON: Well, that's fine with me. In terms of points related to the testing program, we'll take questions now. Richard?

PARIZEK: Parizek, Board. What's a hazardous mineral? Is it like indication of hazardous conditions underground?

VOEGELE: No. We have the zeolite minerals that are present in some of the tuffs. They're erionite and, in fact, mordenite that have not been found within the zones at which repository development will be taking place, but we haven't ben able to rule out that potential yet. There's also some potential hazardous minerals associated not as far down in the nonwelded tuff, but at the basal vitrophyre, as well. So, it's simply a recognition of the potential for those hazardous minerals and make sure that we understand where they might exist in the repository.

PARIZEK: And, for water injection tests, this is really driving the percolation flux and the way you can find free water.

VOEGELE: Yes, see if we can exceed a threshold.

PARIZEK: Yeah. What sort of rock conditions will you select; like some of the highly fractured zones or some of the less fractured zones? There has to be some thought process as to--

VOEGELE: No, I think that--well, there actually was a consideration of a couple of different types of variability in the rock types that made us turn to this recommendation of or the east-west drift. And, I wanted to show you a couple of ways--we're going to get to Dr. Bullen's question real quickly to deal with this. First of all, when we were excavating the east main of the ESF, we encountered geotechnical conditions about in this location that were different from what we'd expected. The rock became a little bit more fractured. That's one of the things we wanted to exercise. Our predictive models from the geotechnical perspective was to be able to go into a formation where we knew the rock fracture was going to change based on what we saw over here and try to predict how that would change. We also have that same opportunity to test variability in the hydrologic properties of the rock as we cross it; both from the structural, if you will, properties of the rock and then there's some intrinsic physical property differences, as well.

This is a cross-section of the mountain and the east main is indicated right there, the EM. These dots are, in fact, potential emplacement drifts. So that the section kind of goes across and cuts through here along this drift. So, they show up as dots on this. But, I wanted to call your attention to the fact that although the east main is in the middle nonlithophysal part of the Topopah Spring, must of the repository development could end up being in the lower lithophysal and, in fact, over into the lower nonlithophysal portion of the Topopah Spring. And, one of the things we tried to do when we laid out this drift was to be able to make sure that we looked at all three different rock types. So, you can see a drift that would come across starting somewhere over here between the north ramp and the east main could, in fact, encounter the three different rock types on its way out to the Solitario Canyon Fault. So, we're also looking at a difference in character of the rock, as well as structure imposed on it.

PARIZEK: Right. And, there was a lot of useful value coming out of the pneumatic test holes. Will there be new drill holes in the west block for pneumatic observations because it seems like you get a lot out of that.

VOEGELE: These are the boreholes that--this one is to the north. This one is actually off this sheet of paper, but we do have a borehole in the northern part of the block.

PARIZEK: That's existing?

VOEGELE: No, these are--as I tried to explain, the Enhanced Characterization Repository Block effort itself resulted in a change request at DOE. That particular change request recommended the boreholes, SD-11 and SD-13, to be included. Just as we were starting the enhanced characterization program, we were also processing another change request or going into processing another change request to provide enhanced data for the viability assessment and that's where we picked up SD-13 and SD-6. And so, if you'd like to, you can think of these as so closely associated with the enhanced characterization project that we have four new boreholes in the program in the next year or so. Or, if you prefer to think of them as two that we processed before the ECRB and two coming in after the ECRB. The point is we have four boreholes; SD-11, SD-6, SD-13, and WT-24 running northerly along the repository line that we're going to be looking at to get all kinds of information from; the full vertical section of the properties, different types of testing in those boreholes, as well.

PARIZEK: And, I also imagine a stress relief mechanism associated with tunneling in this rock. Priscilla got into this yesterday briefly. But, like an onion skin damage that you do to the rock, outside of the wall, some meter or two or several meters away, that might enhance permeability of existing fractures and could be a water shunt, is there any evidence for such a structure and will this be part of the observation program that you make?

VOEGELE: Well, there are--we did a program like that up in G-Tunnel. We tried to look at excavation damage through permeability measurements into the rock mass and there's a combination here. This is not a very highly stressed situation. G-Tunnel is up in the northern part of the test site up in Rainier Mesa. There happens to be a drift up there that we were doing experiments in the late '70s and early '80s that isn't welded tuff. It's the only piece of welded tuff exposed in the reference tunnels. So, we took advantage. We did our first heater block test up in G-Tunnel.

This is a very low stress situation. So, there are two attributes to that. First of all, you might not be getting the onion skin fracture that you're talking about, but you have a different complicating factor and that is this is a relatively very highly fractured rock with vertical fractures in it. And so, you've got a combination of the types of rock deformation that takes place in a larger opening with jagged rocks in the roof combined with the stress effects around the circular tunnel. So, it's not clear to me yet that it's very easy to predict under a given fracture situation where you have a low stress situation. You don't have a lot of high pressure to counteract any additional stress, as you put it. When you couple that with the thermal stresses that you're going to introduce through the emplacement of waste, I think the best information I can do is point you to the tests we're doing, the small heater test and the drift scale test that both have hydrologic and mechanical measurements in it to try to understand what the coupling is between those two. But, it's not a very simple problem. It's a very nice rock situation from a rock support standpoint because it's a relatively low stress situation. But, the fracturing in the mass has yet to be heard from. I think Bo might have mentioned to you that there are probably more fracture movement of the water flow than matrix flow. That's because that rock is relatively highly fractured.

PARIZEK: You're just expanding existing apertures is what I imagine. You might not create new ones; just expand the ones you've got.

VOEGELE: What we saw in G-Tunnel was the matter of fact that there is a preferred fracture orientation in these welded tuffs. They're thermally cool. You'd expect it at--I guess, it shouldn't surprise you that you might have something like that in the tuffs. But, we actually developed fractures through the thermal cycles in the G-Tunnel block that were clearly along fracture--what I would call incipient fracture planes. They might not have been developed as open, movable fractures yet, but they were sure sitting there ready to demobilize. And, when we started pressurizing the block, we got some movements along those. So, I think we're going to see that in these large-scale heater tests where we look at hydrologic and thermal properties.

PARIZEK: And, G-Tunnel also had free water drips in the ceiling? I saw it some years back.

VOEGELE: Do you have that chart of mine by any chance?

SPEAKER: Which?

VOEGELE: The figure of G-Tunnel. I gave Larry a figure. It turns out that there was one location near the welded tuff where we had a freely draining fracture. I walked past it every day for two years. But, it was actually below the welded tuffs. We saw it as we were coming up into the welded tuffs. It was at an intersection of two drifts and it was immediately below the welded tuff. So, I can only assume--and, incidentally, G-Tunnel is significantly higher. It's up in Rainier Mesa, a couple of thousand feet higher. You've heard reference to Alan Flint's work and we probably have two or three times as much infiltration and precipitation up in that part of the test site. So, we're in a wetter environment and clearly we have a fracture somewhere in the welded tuff system that was allowing water to get down there and dripping out below that welded tuff.

PARIZEK: I mean, that's a precursor of a pluvial climate change further south.

VOEGELE: I believe it is. I believe it's a good analog.

PARIZEK: It's telling you what could happen as you get into Yucca Mountain as it gets wetter.

VOEGELE: Yes, but I'm Minnesota Mafia. I'm rock mechanics.

PARIZEK: I'm glad to know that that's dripped for two years.

VOEGELE: Well, i did spend almost two years up in G-Tunnel when we worked on the heater block test. It was a long time ago. My recollection is that that fracture was running quite frequently. I'm not going to say it wasn't dry at any time, but there was a lot of water coming out of that--that fracture ran a lot of the times.

NELSON: Any other questions on the testing program? Jared?

COHON: No, actually I--

BULLEN: It's about the second part of your talk that you haven't given yet.

VOEGELE: Go ahead when you're ready? We should let Dr. Bullen ask the question, all right?

NELSON: Okay. Questions on the testing program, okay. Let's move on; go ahead?

BULLEN: Do you want to start or do you want me to ask the question?

MR. VOEGELE: It doesn't matter.

BULLEN: I guess, the beginning is you've shown me this cross-section of Yucca Mountain. Can you show me where the lower nonlithophysal, the middle nonlithophysal, and the lithophysal are on the other diagram?

VOEGELE: No. Oh, you mean where they encountered?

BULLEN: Yeah--

VOEGELE: Yes. The lower nonlithophysal, we pick up in this part of the block and the middle nonlithophysal sort of more like that. They kind of run along here. Okay?

BULLEN: Down dipping to the southwest?

VOEGELE: These rocks dip to the east.

BULLEN: Oh, they're dipping east, okay. So, we're coming across--

VOEGELE: You know, I've always been angry with myself for making that go in an opposite direction and people would think it was--

BULLEN: Oh, okay. I guess, before we get into that, you mentioned that the construction is going to use a lot of water which is different than you use at ESF. Is that going to be different than what will be used to construct the mains in the repository?

VOEGELE: I hope I didn't say a lot.

BULLEN: How about more water? Put it that way.

VOEGELE: Yeah, we are going to look at water as a-- probably even wet head TBM. Now, let me take advantage of jumping to one part of where I think we're going and talk about one thing that we did deliberately. In fact, let me-- this will work better. Shout at me if I'm going too slowly. Okay? I need to show you a couple of figures just to get an impression across. We looked at a lot of different ways of doing this. We looked at doing it up in the northern part of the block. This particular recommendation was, in fact, that it be a performance confirmation drift above the block in the northern part of the block. We looked at doing it sort of in the center of the block and that particular recommendation is one where we looked at actually using one of the waste emplacement drifts as a way we might look at it. We looked at doing it combining those two features and saying, look--and, I will spend as much time on this as you want to. If we want to be above the block, if we don't want to go into the repository block for a couple of reasons, if in fact these layouts are subject to change and they might change by 10 to 15 degrees in a different direction, we didn't want to run the risk--I mean, this is just one of many, many performance based arguments that we looked at when we did this. There are about 52 criteria that we were trading one off against the other as we came to this conclusion. But, we said, okay, if we want to be above the drift in the center part of the block, you have to kind of go out and ramp up and come up to get across it because you can't really start above it easily. Then, you've got a situation where you've introduced about 1500 feet of drifting there, 1000 extra feet of drifting there, and we also looked at when we traded all this stuff off and started asking ourselves rock characteristics, hydrologic characteristics, 10 CFR 60.15 impacts to waste isolation including water usage, including potential to maintain the flexibility in the eventual repository layout, we came up with this idea.

There are a couple of things--I managed to get the same figure on two different viewgraphs and we're going to go to the east, right? Okay. We looked at this and said, you know, there's a flexibility argument about whether or not these drifts might rotate at angles. There's also a flexibility argument about whether or not you want to go up or down in this section. There's one thing here that--I'm sorry, I'm going to have to put it--you're going to have to just remember that east is in the wrong direction. Just look south--look north, excuse me; whatever direction that is, look east. That's okay. The north ramp is on the east side. It's just real easy. A lot of the repository layout would be in the lower lithophysal and we're constrained in this upper direction. Because of the 200 meter overburden disqualifier that's in 10 CFR 60 and because we're at the top of the Topopah Spring, it's not likely that we're going to go up if we change the flexibility. It's more likely that we're going to go down if we move the repository horizon. Another argument that we shared among ourselves for putting this thing above the repository horizon, in fact, if we elected to go along one of these emplacement drift horizons and then move the repository down, we'd be above it, as well.

So, the net to the technical community and I'm talking about performance assessment people, the site testing people, and the engineering groups was that we were able to accommodate a lot of desires out of this testing program by going across the top. We started over here--first of all, it appeared to us to be logistically cleaner to start off this ramp than to come down here and start in a circle and go back up. But, what I really want to call your attention to is, I think, a direct response to a comment you made earlier or has been attributed to you. I don't know how many people have told me to be ready for your question. We deliberately planned something into our testing program and that is we're going to start here using water with a test program that's going to evaluate how water moves through the repository as we use the water. So, what we're doing here is actually staying outside the repository block as we gain that elevation and start putting--see if we have the ability to put boreholes up in here for these different places and look at water moving down below the excavation horizon as we do it.

This has been straightened out a little bit since I drew this figure, but we actually said why don't we go close enough to the thermal test that we can interact with it when we're ready to. Some of us had said, well, why don't we just go over it and flood it in that area and see what that extra water does and how that interacts with the thermal test. We decided that probably wasn't appropriate given the scale that we might want to keep that for two years. But, we are here now ready to go in and interact with that test at a later point in time. It's part of both our performance confirmation and our characterization program. We'll have the ability to pass over drifts where we can do communication experiments both with tracer and with liquids to see how that happens. So, we've been tweaking these things to try to get close to alcoves and so forth.

I'm wandering because I never did really let you ask your question. I assumed I knew what it was. Can you help me where you want me to go with this with regard to your questions?

BULLEN: I guess, the follow-on question to the one I asked was have you done the hydrothermal modeling to tell me what the effect of this drift, 17 years old--

VOEGELE: It is not completed. In fact, among the--I think, the number ended up being 52 evaluation criteria that we used. There were probably a third of them--2/3 of them were things like how would you test this parameter. The other third was how could your test impact something, be it a safety and health regulation, bet it an NRC regulation, be it a DOE self-imposed order. Fully, a third of the questions were like that. So, there was a set of questions that talked about 10 CFR 60.15 which is the part in the NRC's regulation that says whatever you do in your site characterization program, you have to understand what its effect might be on an eventual repository. So, we do some things that are called determination of importance evaluations as matter of course during our design process. And, one of the hardest questions we had to come up against was going into a recommendation for changing the characterization program that involved drifting across the repository block absent the completion of that DIE evaluation. So, we put those performance assessment people right in the middle of a room and said you've got to tell us if there's anything that you've done in your evaluations to date that would lead you to believe that this is not a correct approach to characterizing the block and they said with virtual certainty we're going to be okay. We're going to continue to run the models. They're running the models right now as we speak. But, that is a serious question we asked ourselves. Is there anything we can understand about the behavior of the mountain that would tell us that this is not the right thing to do.

BULLEN: I guess, the follow-on to that question would be we've been surprised in the ESF, we've been surprised as we've gotten underground. I'm not convinced we won't be surprised as we go across the repository block with what we heard about infiltration from the Solitario Canyon and other options that may occur. I'm looking at your argument that says, well, I can't put it across the repository because I don't know the angle that I'm going to go because I might potentially screw up some emplacement drifts. I look at this diagonal that you've cut across about a third of the repository, and if I am surprised 17 or 20 meters above the repository and I do have higher infiltration rate or I do impact the hydrothermal response of the mountain, I've got a third of the repository that's a big, "Oh, shoot." And, that's a real concern that I have is I understand that you want to define the data from all three different geologic strata and I understand that you want to take a look at confirmatory testing possibilities. But, I don't want to screw up a repository by a mistake that I haven't foreseen. And, I know you're doing the analysis now and it may not be complete in time to get everything done, but I have a real concern that you look at all of the potential negative impacts. If those negative impacts are something that we haven't foreseen by doing a design like this and I've got a third of the repository that I can't use anymore or that is a potential fast-pathway for water and heat out, water out, radionuclides anywhere, doing it above the repository since gravity is my friend and things are going to go down for probably the next millennia or two, I don't care at the repository horizon if I've messed up a few tunnels. But, if

I've messed up a third of the repository above it, I might be in big trouble.

VOEGELE: There are, at least, four different dimensions to that problem and I imagine it's too much to--I shouldn't go so far as to assume that that's a Board position that we shouldn't do an east-west drift.

BULLEN: No, no, no, it is not a Board position. This is a Dan Bullen question asked as to why are you doing--it's a Dan Bullen question as to why are you doing it the way you're doing it.

VOEGELE: Okay. I have to take you back to your premises, okay? There was not one single evaluation criteria that we looked at that was a "have to". Okay? We did not say this is--it's got to be this. What we said was when we look at 52 different criteria, this makes the most people the most comfortable. Okay? And, it was heavily debated. Every question you've asked us was asked in internal meetings with the testing people. It was asked in internal meetings with the PA people.

Now, I want to call your attention back to this part of it. We've deliberately given ourselves several thousand feet to get us above the repository horizon that's going to allow us to thoroughly investigate how that water moves if we use water above the tunnel.

I can share with you ones you didn't mention.

There's a question of what if there's some sort of water pathway in the rock mass above the repository that this somehow taps into and spreads the water out. I think, generally, the position among the people who were involved in the development of this recommendation was if the repository has that big of a probability of being lost by us drilling a drift in that angle, then it's probably a good idea for us to drill a drift at that angle today and find out about it.

BULLEN: But, the concern that I have is I know you'd be using a lot of water and I think that's great, but you're still not doing the hydrothermal in that. Have you done the hydrothermal model that tells me what happens as I predict repository performance? I enjoy the fact that you're going to start off not in the block, that you want to take a look at what's going on. I might be more convinced that if you hung a hard right and came straight across that what you thought might be the layout of the emplacement drifts so that the potential for any problem that you ran into only intersected five or 10 or so drifts going across there as opposed to taking a third of the repository.

VOEGELE: All I can tell you is that the position that we ended up with was one that the people who recommended this are not uncomfortable with this. We asked ourselves the exact questions that you did. We asked the PA people to model that. We asked them is there anything in the modeling you've done to date, thermal hydrologically, thermal mechanically, that would tell us that this is a problem for us? And, the answer was no.

NELSON: So, the thermohydrologic models have been run with this opening over--

VOEGELE: No, they are being run. We asked them to extrapolate based on what they had done to date.

BULLEN: But, we would love to see the thermal hydrolic model run for this case before you cross that ESF and start going diagonally across what may be emplacement tunnels at some time.

VOEGELE: The schedule for completing that determination of importance evaluation is such that it will be done before we get across the block.

BULLEN: And, the Board can see that? I mean, is the timing such that we would be able to see it as a Board is my other question?

VOEGELE: I can't imagine why you wouldn't.

BULLEN: Okay.

NELSON: We'll make a special meeting.

Okay. Jared?

COHON: Cohon, Board. How much more does the recommended layout cost and how much more time does it take to dig the tunnel compared to just going straight across from the east main? In answering, I would ask you to abstract from whatever studies are planned and the cost of those, simply the tunneling costs?

VOEGELE: That's almost an impossible question to answer. If that weren't bad enough, I'm the wrong person to have standing up here to try to answer that question. Is somebody going to save me or am I just going to hang myself out here?

COHON: Tell you what, let's try this. How much longer is it?

VOEGELE: The tunnel--this is roughly 4,000 feet, and if memory serves me correctly, this is 5500 feet. It's 40 per cent longer. Time-wise, I believe the completion date--Rick, can you help me with the completion date? I don't have the schedule with me. Can somebody remind me what the estimated completion date is for this? I'm going to dig for a minute.

CRAUN: It may be March, but I might be wrong.

COHON: That was just for the record.

VOEGELE: I know that I have some material that I went back to my office and tried to pick up last night that has something in it. Let's not take up time. Maybe we can find that out later on. The completion date was about the end of April 1998 and then we would go out further for a few more weeks to get out to the Solitario Canyon Fault.

COHON: Were cost and time two criteria of those 52 that you considered?

VOEGELE: Not explicitly. Let me try to tell you what the guidance looked like that we started the study with. What I'm searching for is to put into words what the two difference objectives that we really have for this study. We were asked, first of all, to do a quick and dirty estimate of what it would cost and what the time would be to get an east-west drift across the mountain and we used the numbers that were in the program plan to respond to that question. We were also asked in the same time frame to look at this from a bigger perspective. What is the right thing to do knowing, for instance, that if you do this and come out across here, you find yourself in a situation where you can cross the Solitario Canyon Fault, come back around, and go down into the Calico Hills should our continued understanding of the way the site models are evolving suggest to us that that's a valuable piece of information to have. The DOE may find itself in a position where it wants to make that decision. This allows us to do that.

So, we asked a bigger question. We asked for the overall ECRB, the famous acronym that Priscilla was looking for. How do you enhance the understanding of the behavior of site, as well as understanding of the role of engineering, construction, health, and safety costs and regulatory performance aspects of the potential repository. So, we understood a bigger question than just doing the east-west drift. So, the costs that have been coming up are very different because they look at how--when you look at the possibility of putting a drift across the block and running some tests in here, how that might also offset the need to run some planned test that you had here, how it might provide better information if you run it in this location. So, we're dealing with cost numbers--this is why I'm reluctant to give them to you--that deal with changing numbers around in different parts of the site characterization program. So, any number I threw out is not directly applicable to the cost of a drift directly across the block.

Is that getting at your question and why I'm so uncomfortable answering that?

COHON: Yeah, it's actually quite helpful. That doesn't say, though, you couldn't make such a comparison. I mean, other people will.

VOEGELE: No, no. No, sir.

COHON: It does not--all of this is quantifiable and the comparison is made. Undoubtedly, it's going to cost more and the question--the justification you have to offer is why it's worth it and it sounds like you've got a good case of that.

VOEGELE: And, I would very much like to come at it from that perspective because we recommended a testing program to the DOE that we all had a feeling going into it was going to be more money than the DOE could afford to enhance the characterization program. It's been alluded to and I'll say the same thing again. We wrote our program plan under some pretty severe Congressional direction. I mean, we were looking at a situation where we just zero out the program just a few years ago and Dreyfus' commitment to get to a point in a couple of years where we could tell Congress what it would take to finish the program and then as firm of a commitment as I've ever seen made in this program that we would be there when we said we would be there. That's really constrained our flexibility. We have to be very, very focused on what we considered to be the single highest priorities and what we have available to us. And so, our program is focused that way. And so, now, when we're looking at some changes in that fundamental program and the DOE has just gotten these numbers to start comparing them back and forth, I think we have to wait until they've had a look at them.

I do want to show you two things because there was a comment made yesterday that suggested that we didn't address all the performance assessment concerns. I want to make sure you understood. This is a ranking. This is the ranking that came out of the ECRB study as to what we felt were the most important configurations to be looked at in enhancing our understanding of the block. It was the east-west drift. We looked at how we could enhance our understanding and it's very heavily driven by differences and changes in our understanding of the site models.

But, we also had some other things down here. You know, we did want to look at a couple of boreholes. We wanted to be able to look at going to the Calico Hills and the performance assessment stuff that may or may not be funded in this ECRB is generally laboratory testing. The priorities that one used to come up with these, you know-- well, I won't go into the process because I'm using up a lot of Larry's time. But, the process asked us to identify how you would acquire data and then the process asked us to prioritize it. I wanted to make sure I, at least, left you with the fact that the priority set that we used was, in fact, an integrated set developed between performance assessment design and the site testing program. This is what it was. These are Larry Hayes'. He refers to them as the customer defined needs for the testing program. He sat through many meetings with the PA people and the design people saying help me understand where your models are, where your uncertainties are so that we can focus the site characterization program to get the information that you need. And, when you look at what the highest priorities are in the site program's priorities which are driven by the PA and the design, you'll see that what we were trying to accomplish in reducing hydrologic uncertainties in our testing program are, in fact, directly hitting at the heart of the highest priorities in the performance assessment program and design program. This is not just the performance assessment program's priorities. And, Priscilla, I'll get you copies of all this stuff for your records. This is an agreed-to set by the design performance assessment and site testing people.

NELSON: Okay. Dan?

BULLEN: Bullen; one more quick question because you showed me your priorities. You obviously had a ranking and a number. You had four designs. This one ranked first. How did the other three rank and what was the separation or spread?

VOEGELE: It didn't go that way. What we did was--

BULLEN: Then, you lost me in your decision process.

VOEGELE: Of necessity, we had to resort to a consensus building decision process as opposed to a very form--I'm trying to say three words I can't pronounce--a very formal multi-attribute utility analysis type process. We did not go with that formality. What we tried to do was try to build consensus among the people who evaluated a common set of criteria that they, in fact, agreed were an appropriate set of criteria to develop. What we looked at, they did not prioritize a design configuration; they prioritized test programs and the need for information. Those groups gave us that information and said this is my highest priority piece of information. And, when we said go back and look at some design concepts and work together, the design people had some ideas, the PA people and the site people were so much on the same wavelength they started working together and we melded the design people back together with them. What I showed you as a recommended drift does not come out of a formal ranking process that says that this is four points higher than the next recommended design. It comes out of meetings which are documented between the performance assessment and the site design people that said we can get the things we want from our high priority testing programs by this arrangement.

BULLEN: Then, the follow-on question is how much do you lose if you go parallel to the emplacement drift or close to parallel to the emplacement drift?

VOEGELE: Well--

BULLEN: It is a significant amount or--

VOEGELE: There are so many things that you can do in this one where you'd have to give up to go in one of the other ones. This one will give us all three zones of the Topopah Spring. Now, we probably could get all three zones of the Topopah if we were down here far enough to the south, but then we would not be able to mine into what we believe to be the location where we would like to predict the change in the tectonic character of the rock. If we went farther to the north and did this performance confirmation drift, when we would miss getting into the lower part of the Topopah Spring. We would miss getting into that. It's just that this gave us such a better range of opportunities to look at test parameters than--this was the one that the group was most comfortable with.

BULLEN: This is going to be a terrible comment and you've going to hate me and everybody in the program is going to hate me, but if you really want to look at two different regions, but you have a potential for causing some adverse effects, why not drill two tunnels? I know that's a terrible way to say it and some of the Board--it's not a Board policy, but if you're looking for two different things and you want to get to two different places, just take the direct line approach instead of going diagonally to catch them both. Did you consider any of those kinds of options? I mean, you've got a lot of miles to tunnel here. I'm being a pragmatic engineer now and I apologize for that, but I--

VOEGELE: No. You know, there's an element of pragmatism that gets lost when you start talking about how quickly can you do this and keeping the costs down. I mean, you're going to take me right back to the very first testimony I ever gave before the Board where I had the privilege of trying to convince Dr. Deere that, you know, doing the outside drift wasn't the best idea that I'd ever heard. I mean, that was my first exposure to the Board. And, you're taking me right back there. I'm more comfortable today with the perimeter drift than I was in 1988.

BULLEN: Well, thank you for the compliment of comparing me with Dr. Deere, but I don't think I have quite the stature. I just have this pragmatic approach that, you know, if I haven't convinced myself that there's not a potential to mess it up and I know you're driven by deadlines and schedules and all this other outside forces, I'm very concerned that there's not a problem with I have an unforeseen issue that I can't see. As a result of doing that, I can mess up the repository. So, you know--

VOEGELE: I would only ask you to appreciate that I can build a comparable scenario from every single option that I can imagine to do up there. I can find somebody who has a concern about me doing anything that I can draw that crosses that repository block. I'll find somebody--

BULLEN: No, exactly. But, in your consensus building, you want to basically make compromises. Well, we need to prioritize a list of what's the most important piece of information and how do we gain that information without compromising the mountain. And, I'm sure you tried to do that. I'm not convinced that this is the answer.

VOEGELE: I can hardly resist.

BULLEN: Go ahead?

VOEGELE: We thought the best way to attack that problem was to not do the east-west drift for a couple more years.

BULLEN: I laid myself open to that one, didn't I? Thank you.

VOEGELE: I think Abe Van Luik wants to comment from a PA perspective if you can afford a couple more minutes.

VAN LUIK: It won't take a couple more minutes. This is Abe Van Luik. About messing up the repository with this drift, the PA people looked at this, I think, and it would really serve us well if we could look at this at scale. Then, you would see a 6 meter drift coming across intercepting other about 6 meter drifts with 20 meter separations and with a vertical 20 meter separation. That, in and of itself, I think, is--this picture right here is rather inflammatory, the way I see it, because the impact on each drift is only in one place and we know exactly what that place is. When we thought of the water from the thermal pulse perhaps being focused in this drift in our small scale tests, that's a good possibility. Then, coming down onto these drifts, we looked at two things. One, the character of that water would tend to be rather benign; and two, this is a transient effect that is well within the scope of what the engineers are telling us is a no-never-mind for this type of situation.

So, given those preliminary things, the actual geometry of the situation, knowing exactly where this thing is going to cross, and the relatively benign and short-lived effect that we're talking about, we said the preliminary look, it looks okay, but we will evaluate it further. And, of course, if the further evaluation shows that we're in some kind of mortal danger, then we will certainly change the design.

VOEGELE: I think on the scale that Abe is talking about, it's more like a dot like this. You know, on the same general spacing as those things are that we're talking about.

NELSON: Right. It's clear, I believe, that the Board has a vested interest in understanding some of the decisions that have been made relating to the east-west drift of whatever new acronym is applied to it. And, therefore, we would ask for additional information. We've been holding off on that direct request pending the application that you've submitted for change. And, when would you expect the resolution of that process just so that we might know when to expect to receive information about the plan?

VOEGELE: I have to apologize. I've been tasked with something else for the past four or five weeks, and I've not been able to follow that change request as closely as I would have liked to. But, my expectation is that's very short-term, a matter of weeks as opposed to long-term.

NELSON: Okay. Well, the Board is interested in learning more specifics about what's planned.

VOEGELE: Yeah, I think we'd like to share them with you.

NELSON: Good. Okay, we will stop there with that. Thank you, Mike.

Through the good graces of Larry Hayes, we've been able to have that extended conversation. I'd like to introduce Larry. Larry is site evaluation program operations manager. He's responsible for managing all the scientific activities. He coordinates the work done by the national laboratories in USGS, and he came to the project from USGS in 1995. He's going to offer us an update on the scientific activities on the project.

HAYES: I don't know what's more difficult; following someone like Mike who is so quick on his feet or having the last talk of the day and being behind schedule. But, I'll try to quickly go through what I have to say and perhaps I'll preface it by saying let's look at my talk perhaps as a Las Vegas buffet and I want to try to offer you a little of this, a little bit of that. But, the real gourmet meal would be served by one of these very talented people who actually do the work. So, certainly, if you see something of interest, we can arrange a more detailed talk.

I'd like to say a little bit about data collection. I think there's been some concerns expressed that maybe we sometimes do not have an adequate database. I think we have a tremendous database at Yucca Mountain. A little bit about thermal testing, what we've done and what we plan to do. A little bit on the--I'm suggesting maybe to save time, we might just want to skip the C-Well because you had a presentation in January on that and we don't have a whole lot new to tell you.

NELSON: Is that okay with you, Richard, if he skips the C-Well test part?

PARIZEK: Let's wait and see.

HAYES: Okay. Then, the ESF moisture studies, a little bit about where we are and where we intend to go. As Mike had said earlier, some of the more important questions, percolation flux, what are the bounds, what really happens with percolation flux, how does water seep into drifts.

Data collection at Yucca Mountain just to show you we do have a tremendous amount of data. We have our ESF which has given us much detailed information along the east side of the block. As Mike has said, we're planning on some kind of orientation, oblique or parallel, to potential emplacement drifts to give us more information about the block itself. But, from the ESF, from a tremendous number of wells, its trenches, we've got a lot of data on Yucca Mountain that people have used to develop some of these models that you heard about yesterday.

Just a quick generalization here from those data. We put together a table like this just to give you some indication of perhaps some of the more important parameters of the main geohydrological units. And, of course, the unit of most interest to us is the Topopah Springs Well that the potential holds throughout the repository, and maybe one of the more important aspects, you can see that the flux is primarily in fractures, very little going through matrix. We do have different ages of water. Perched water gives us 2 to 6,000, 7,000 years, but we do have indications of modern water along faults or fault fracture phenomena.

I am going through this very quickly to try to get us back on time. Thermal testing, we have a considerable wealth of information on present day conditions down there in the drift, ambient conditions. We know we've got some pretty good rock. The water, the bore water, the water move through fractures is a relative dilute, oxidizing type water, nothing difficult about that water. The problem is when we heat this rock up, it's going to be above ambient conditions for perhaps 2 to 3,000 years and what kind of changes take place? That's why our thermal tests are so important.

We've broken our two main tests down to what we call a single element heater test. This is--most of you have been in the tunnel. If you go down the tunnel, you take a little right and there's the single element heater test.

This is primarily a shakedown test to help us really know what we need to know in order to develop a successful very long-term, very large-scale thermal drift test. But, we've learned a lot from this test. We have learned what instrumentation works, what instrumentation doesn't work, the kind of redundancy we're going to need in our instrumentation to assure success in the large-scale test.

Just a few key results from the single element test. As expected, we can pretty well predict temperature and what we did before we started the test. We ran some predictions and that as we conducted the test. We tried to see how our predictions worked with what actually happened. Temperature was not a problem. This is mechanical results, how the rock behaves under stress, and what we did find was in this area here of what we call Anchor-4. We had a map fracture zone. Our simple model did not predict well the impact of fractures on how the rock tightened up under stress. And so, our measured and predicted were not very much in agreement. What we learned from there, of course, is we need to look at our model and perhaps develop some different way of modeling rock closure where we have fractures. Also, I think we had some boundary conditions in here. This Anchor-4 is close to the face of the wall and we may have had some boundary problems there.

But, what we've learned, temperature conditions are consistent with the measured temperatures, deviations from the protected thermal mechanic were not unanticipated. We had expected that our model would not give us the result we would have liked and we're working on that. Water is mobilized by heat, but we do know that fractures play a key role in that mobilization. We did see some water where we intersected some fractures. We collected a considerable amount of water and we do know that fractures are really very important.

Near-field gas chemistry, we created considerable carbon dioxide which is of interest to us, of course, because we may end up changing the pH during the actual--if we have a repository and we may change pH and that is very important to design in corrosion. And, we could predict pretty well the water chemistry.

Now, getting into what we really want to do in the future is our drift scale tests. The single element heater test, we heated up I think about 20,000 cubic meters of rock. Here, we're going to heat up over 10,000--no, I got you a wrong number--20 square meters. The single element heated up 20 cubic meters, and now under the drift scale test, we're going to heat up approximately 10,000 cubic meters above boiling. So, we'll be heating a lot of rock. This test is designed to simulate a waste package emplacement. We're going to have a long heater. We're going to have wing heaters to simulate adjacent emplacement packages and try to really understand how a large area of the rock might behave if waste were emplaced in that rock. And, we'll run this test at least two years. We'll monitor what's happening. If we are still seeing significant change that justifies a longer heat-up, we'll run it for up to another two years. Then, of course, we'll monitor the cool-down. What we really want to try to learn here is what happens with temperature, how does the temperature move out into the rock knowing that we've got a heterogeneous rock, how do rock properties change? That's important for construction. It's important for the hydrology that we need to be able to predict. We will close fractures. We may open fractures. What will that do to flux movement and things such as that? And, of course, we want to predict how the water chemistry changes, also.

We expect to start that test December 12 and I'm very confident we will start that test as predicted. But, in the meantime, we're making some predictions to try to--let's think about what we might see. These are just a couple of snapshots of what we're predicting. Temperature, nothing really critical there. This simulates our wing heaters in adjacent drifts and we can see that we simply dry out near the emplacement drifts and the temperature, in effect, moves out. This is matrix liquid saturation and what we see here is near the heater. We're, of course, drying out. We're moving out a saturation front to where eventually we get higher than what the in situ saturation is. In situ saturation here is about .8. If we get higher than that, then we go over that hump and we start going down through the ambient saturation. And, that's very important because, as we move this moisture out, is it going to find preferential pathways drop out as real liquid and move somewhere, or during cooling, how is this liquid going to come back?

As we actually do our test, what we will do is a number of predictions as we collect data. We'll improve our model, throw those data back into the calibration, and continue to make new predictions. Of course, our hope is, as we come close to the end of the heating cycle, our predictions will be telling us indeed what's happening.

Okay. C-Wells, I'm going to skip a couple of those and just go to what we have learned. I don't think it's anything new to most of you. We're still doing some final data analysis. We know we've got a complex flow system down there with varying transmissivities, both laterally and vertically. We know that the flow lines themselves are complex. It's a tortuous path that it seems any actual water molecule would take. We can have our potentiometric lines and we can estimate generalized flow, but indeed the real flow is tortuous. We believe that can be good for the site because we have this very complex flow. It may lead to additional dilution. We did find that the major dispersivity is about 2 meters per 30 meters which is consistent with laboratory results at Yucca Mountain, as well as studies done elsewhere.

I think the last thing I would like to close on that is we have another test planned, what we're calling our southern tracer complex test, and we'll take what we learned from the C-Wells, design the southern tracer complex, and try to get additional data because, as we've talked today, the saturated zone database is not quite up to par.

This is something you've probably heard from Bo and I just throw it up. It's not in your package. I'm getting now into percolation flux and some of what we're doing to improve our bounds on percolation flux and seepage into drifts. We have all these different methods of looking at percolation flux and they all seem to be generally ranging in on something between 1 and 15. But, you've heard from others, I think, that there are experts out there that will say, wait a minute, that flux is really going to be a lot higher than 15; it could be as much as 40. This is an important issue to design. We need to be able to design some kind of defensible, reliable, upper bound on flux; not only on an average, but what can we expect during an episodic event? So, as Mike alluded to earlier, a lot of our work in the future is going to be to try to improve our bound on flux in space and time. Then, we want to go to something that I think is probably the most important question and that's seepage. We have flux, but how much of that flux is really going to drop down as free water into the drifts and contact waste containers and perhaps cause degradation, released radionuclides, and carry them down through the rock into the saturated zone and then out to the environment?

Ignore all of these colors. I've been criticized for what some people call a car wash diagram. This means nothing. The person that did this for me just perhaps wanted to be a little original. The point I want to make is we do have flux coming down, perhaps 5 millimeter per year. That's our, let's say, preferred number right now in the present day conditions. We know because of capillarity much of that flux will not come out. It will go down around the drift wall and keep going down. The studies we are going to do, though, will help us quantify how much flux will really be moving through that rock at the repository level and how much will come out as seepage.

Here's how we're going to try to do that. This is what we call our niche study. Again, I want to make the point infiltration is not the same as percolation flux. Percolation flux is not the same as seepage. We expect seepage to be considerably less than percolation flux and we believe we have pretty good evidence for saying at the repository level percolation flux is less than net infiltration because of the way things spread out over the mountain.

What we intend to do here and we're well underway is we're going to construct an alcove, but before we construct the alcove, we're going to drill a set of 10 boreholes, each borehole about 10 meters long. We'll construct three horizontal boreholes above the top of where we would construct our alcove. Then, we'll have three boreholes up towards the top of the alcove, but below the crown and then we'll have four boreholes down toward the bottom of the alcove. What we have done, we have drilled the boreholes and we have mined out part of our alcove. But, before we did the mining, we injected tracers into the upper boreholes, the boreholes that are above the crown, and this what we're finding. We wanted to see, indeed, is that water moving down through that rock? So, what we're going to do now is to complete our alcove construction. I think it is close to complete. We'll then go in and drill some additional horizontal boreholes, sort of wing boreholes. We will take the upper three boreholes that are above the alcove and we'll inject water with a tracer. Then, we'll have these monitoring boreholes to see what happens. Is that water going to come down and we'll vary our injection rate and see what we see. Are we going to actually see free water? Now, part of that alcove will go in 5 meters. So, we'll have some of the alcove roof itself to look at to see if water is coming down and then the remaining 5 meters will be boreholes with instruments.

Now, we have two phases. First, we have a niche that we've located in what we call a fast pathway. We want to just sit there, monitor that niche, see if water does come down through this fast pathway. And, we'll close the niche off from the ESF to preclude ventilation effects from drying out the rock. One we've taken this passive approach, that's when we'll do our actual injection. We're going to have two sites; one in the fast pathway that we've located using chorine-36 and then we'll have another niche where we don't believe there are any fast pathways and we'll try to estimate how percolation flux behaves in either a fast pathway or a non-fast pathway area.

Once we complete these studies, we think we--we're pretty confident. We'll have some good information in those two niches about percolation flux, what it really is, and how much seepage actually occurs. But, that's a small part of the rock. What we want to do then is set up a study and this is just for talking purposes. It may abe in this area or depending upon what we find out with the east-west drift--and, I like that because I have trouble with that acronym, too, Priscilla. So, we may put something like this up in the east-west drift because, as we know as we move over to the west, we perhaps may have higher infiltration, different kind of hydrologic characteristics, and we might get more out of the test right over the potential repository area. But, we've got to worry about what has been discussed earlier and that might be any kind of impact on the repository itself. This would be again a long series of horizontal boreholes where we would go in and run various instrumentation. We would put in sensors and try to monitor flux moving down past through those boreholes. This would be in a relatively large area of rock. So, we hopefully are going from a small scale to a large scale.

Okay. Quickly winding up, what I wanted to leave you with is we're focusing the Science Program. We've spent a lot of time, a lot of money in data gathering. We've done a good job of integrating those data, coming up with a good understanding of the mountain, but we still have some uncertainties, particularly in some of the important things such as the percolation flux and the seepage into drifts. So, as we move towards TSPA-VA, we want to try to focus on what are the most important things we need to know in order to give PA what they need, give Jean Younker what she needs to have a sound, defensible PA, give Dick Snell what he needs in order to do a good solid design. What we think we need to do are some of those things I talked about; the niche studies, the thermal testing, model confirmation. We need to do more saturated zone testing. We've only got that one C-Well complex. And, continued baseline monitoring. And, as we move out in time, we believe we're going to increase our confidence in these very important parameters and eventually will move towards LA and on in to performance confirmation testing that Richard Wagner talked about.

So, I rushed through that. I hope I didn't confuse you by rushing through it.

NELSON; Well, thank you very much, Larry. I'd like to express a personal compliment, I think, to the entire Science Program which is the one I have heretofore been most interactive with for really reaching out to the technical communities and offering papers and making presentations to technical symposia. I think that's really going a long way towards keeping the technical community on board with the activities that are underway. That's important to keep them on board and I hope they do other aspects of the projects, if they're not considering doing that, feel encouraged to do that, too, because I think it's very important.

HAYES: In fact, we would like to do more of that and that's what I meant when I said I'm giving you a buffet. The real important thing is when you people get here together, you hear from the scientists and get what you need from them.

NELSON: Yeah. And, to get the scientists communicating to the peer group out there in the technical communities is important, as well. So, thank you very much.

I'll hope it to general questions. Debra?

KNOPMAN: This is in some ways detailed, but I think in other ways may be a bigger point. To what extent did you have access to the expert elicitation on the unsaturated zone? Were you attending some of those?

HAYES: The scientific community provided team members for that meeting.

KNOPMAN: Okay.

HAYES: We were intimately involved with two types of meetings that Jean sets up and I think we really owe her kudos for those meetings. The first one was what we call abstraction. We take our process models, we get together with the PA people, and we talk about how do the PA folk take values from our models, put them into VA model, and not lose something important. That was a very close, active interaction among the PA people, the science folk, and experts from outside the program.

KNOPMAN: Okay. Well, the chart that you have included here with our handout on the generalized rock and hydrologic properties lists for Paintbrush a saturated hydraulic conductivity that's about 200 times larger than the number, at least, Shlomo Neuman was using--20 times, I'm sorry. 20 times larger than what Shlomo had.

HAYES: We're talking about right here?

KNOPMAN: Yes, and I guess this is the number that corresponds with Galen's view. But, I guess my concern is I know this is just a summary chart, but virtually all these numbers continue to have very large error bars around them.

HAYES: That's correct.

KNOPMAN: And, I think, in representing them, it's useful to get some representation of a plus or minus for any kind of public consumption. It, otherwise, I think, conveys certainty where there is not certainty.

HAYES: Yeah, that's right.

KNOPMAN: And, there's certainly here a substantial difference in view as to what those numbers are. Ditto on the representation of samples and sort of wealth of data because again the Paintbrush is not saturated.

HAYES: That's right.

KNOPMAN: It's in the unsaturated zone and we're really in a very poor state of knowledge on the relationship of conductivity and water moisture. So, I just point that out that--

HAYES: Your point is well-taken.

KNOPMAN: But, what worries me is, you know, to what--how much of that kind of detail gets lost as it pushes along into performance assessment, that all of the richness of the range of opinion starts getting pushed and pushed down to, bam, you've got one number and it's not--

HAYES: Good point and that's exactly what we're trying to prevent when we set up these expert elicitation where we actually have the people who collected and looked at the data as part of that elicitation team. You're right. This is something we really want to watch.

NELSON: Norm?

CHRISTENSEN: Christensen, Board. Just a comment on the last overhead. I generally agree that the trajectory is as you've shown it, but I think it's not nearly monotonic. It strikes me that one of the problems that we've experienced in the history is that as we learn more, the uncertainty sometimes increases. That's to be expected. I say that in terms of understanding what your expectations ought to be as we move into this east-west crossing. I would predict that we're going to learn some things that are going to tell us that the world is even more complex than we thought it was.

HAYES: Uh-huh, that's right.

CHRISTENSEN: That's one of the reasons why we're doing it and that the impact may be to in a sense increase our uncertainty, at least relative to what we think we know.

HAYES: Absolutely right.

CHRISTENSEN: So, I think that adjusting our expectations about how that arrow is going to move is probably fairly important. I think any complex system goes through a relatively non-monotonic stage.

HAYES: Absolutely right. I totally agree with you. It's amazing what you think you know until you get some data.

NELSON: Okay. Richard?

PARIZEK: Yeah, Parizek, Board. The southern tracer complex, I guess it hasn't been decided where to put that. Will that be like in alluvium or is it going to be bedrock?

HAYES: I think we have a general area. Dwight, would you want to comment on that?

HOXIE: This is Dwight Hoxie, USGS. We had a plan for our southern testing complex. In fact, it was going to be located at the south end of the site, very close to Borehole WT-17 that I mentioned in my talk, where we were going to do these Eh measurements. But, the planning is planned for FY-98. So, that is subject to change. But, we would want to put it, I would think, some place downgradient from the repository.

HAYES: I might digress. The question was asked how does the Board know what we're doing so they can get involved before we actually perhaps do some things you might have wanted to interact with us on. And, I think what we're doing now that would perhaps provide you that information is the detailed planning that we develop for each fiscal year. We have a long-range plan where we generalize what we're going to do out through 2002. But, each year--and this is the time process in which we're doing it right now--we develop detailed plans with schedules, with products, with reports for the coming fiscal year. And, I would assume that DOE would certainly work with you on making that information at the right time available to you.

PARIZEK: And, a follow-on with the injection experiments above the alcove, I think that's a very useful process to go through. Are you going to inject water at rates that approximate infiltration rate differences or--

HAYES: That's our intent. We are doing some preliminary modeling now to try to identify what would be the most productive way to do this test. What is the threshold for seepage, for example, and some of the LBL works has that threshold as somewhere around 30. So, our intent is to start with some of these more reasonable rates of flux that we think are out there, 2 to 5 to whatever, and gradually throughout the test, we may build up. Now, of course, there's a problem; we don't want to inject under unreasonable pressures. So, we may find the rock system itself will say you can't really inject more than 7.

PARIZEK: Yeah, there is another negative outcome and that is that the fracture or joint that you might penetrate with that borehole may be directly connected to the point of observation. And so, you've forced flow that would never have occurred if you had a lot of other rock above you and this continuous joint can--

HAYES: Exactly right, and that's one reason we went to considerable trouble to identify two sites. One where we feel we've got a relatively homogeneous representative flow system, fractures, matrix, permeability; and, the other one we're looking at is where we know we have some fractures that are going to dominate the flow.

PARIZEK: Yeah, there's just not enough separation between injection point and point of observation.

HAYES: Right.

PARIZEK: The other and Dr. Hoxie said Diagram 1, the Figure 1, shows the regional water table map. Your figure on Page 12 shows a water table configuration map. These are terrible scales to make any conclusions about, but nevertheless, it appears to me that the diatomite deposit of the southwest corner of Crater Flat near Bear Mountain is really in an area oblique to the flow direction that the contour lines would predict. That could be very helpful from a biosphere point of view. That is you may take 20 kilometers--which I guess that's about where those paleospring deposits occur--but if the flow direction is going to be southeast and then turn south to some other location, maybe that's not a spill point for a water level during pluvial times. And so, that's your closest discharge point under the pluvial, right?

HAYES: Correct.

PARIZEK: And, it seems to me unless isotropic conditions of the rock allow it to go that way, maybe that's not the place where the water would come out on its own. That doesn't mean you wouldn't put wells in and maybe mess the whole story up. Do you see my point?

HAYES: Yeah, I sure do.

PARIZEK: I think all the diagrams that show that flow as the nearest breakout point 20 kilometers away may not be correct in terms of the physics of this.

HAYES: That's right, may not. That's right. What we're really saying is that's a generalized flow. It seems it might go that way, but we know things are much more complex than I--

PARIZEK: But, you have two wells, basically, out in the Crater Flat area to help constrain this. But, from a science point of view, if the flow direction can't get there from Yucca Mountain, why make it go that way conceptually? And, from the biosphere point of view, people are going to say it's 20 kilometers and they're going to take the hit, good or bad outcome, because of it.

HAYES: Dwight, do you got any comment on that?

HOXIE: Not really. This is Dwight Hoxie, again. My impression is that actually the flow pathways to the paleo discharge sites actually bypass Yucca Mountain. I think, that's my conceptual model anyway. So that it's not flow beneath Yucca Mountain that is actually going towards the paleo discharge site. It's coming more from the west from Crater Flat.

PARIZEK: Well, that's my impression from the maps that you show here. The point is, I think, other people have drawn diagrams that show Yucca Mountain water table, paleosprings, and it's taken as a direct shot.

HOXIE: Yes. I have seen that diagram and I've protested it immensely because I think it is highly misleading.

PARIZEK: Unless an isotropic permeability distribution allows for that because the right angle rule won't apply in that case.

HOXIE: Yes, I agree with that. But, I think, all they were trying to do was to extrapolate a water table altitude and project it back to Yucca Mountain to show you that it wouldn't have gotten to the repository if that were the water table level increase. But, the diagram to which you refer is from my colleague from USGS, Zell Peterman and Jim Paces. i agree it's very misleading.

HAYES: While we're on the C-Wells and the flow, I did want to make sure you correct in your package something that I think needs correcting. Flow and transport data adequate for initial input to design and performance assessment. We certainly do not ask sufficient information for a final design and performance assessment. I screwed up and somehow initial input got left off that slide, but I don't want to lead you with a wrong impression.

PARIZEK: That's the map I was using to get to this diatomite site.

HAYES: Right.

NELSON: Okay. Last question, Dan?

BULLEN: Just a quick one on your single heater tests, what we have learned. In your fourth bullet, you mention that near-field gas chemistry under heated conditions is dominated by water vapor and carbon dioxide. Do you have partial pressures of oxygen and partial pressures of CO_2? Can you tell me some numbers as opposed to just a blanket statement that says it's dominated by that?

HAYES: Well, instead of me wallowing around and not giving you a good answer, could I turn that over to someone who probably does know?

BULLEN: That would be great.

HAYES: Bill Boyle, are you still here? I thought I would turn it over to someone who knew. Bill, got a question that I think you can answer. If not, perhaps, Dwight, you may know the answer to that.

BULLEN: I'll repeat it for you, Bill.

BOYLE: Okay.

BULLEN: Bullen, Board. In the fourth bullet of the single heater tests, it says that the gas chemistry under heated conditions in the near-field was dominated by water vapor and carbon dioxide. Do you have partial pressures of CO_2, partial pressures of oxygen to justify that claim? Or can you tell me how low does the oxygen go is actually the question I'm driving to.

BOYLE: Bill Boyle, DOE. I'm not a geochemist, but my understanding from someone who is is that that bullet is based on the fact that when we captured the water out of Borehole 16, Zone 4, they made pH measurements of it. And, it varies with time. It gets less acid with time. The two or three measurements they made were 6.2, 6.4, and then when they measure it 10 minutes later or 15 minutes later, it's up near 7. So, they viewed the pH change was due to CO_2 exolving out of the water. So, I don't know that they measured partial pressures or anything like that. They do take the water back to the lab and make many measurements on it. But, I don't know that they actually made those measurements.

BULLEN: Thank you for illumining that. I guess, the thing that would be of interest to me is in your large scale tests and any other data you can get form the single heater test, although it's been shut off, would be a partial pressure measurement because one of the claims that's made in the hydrothermal modeling is that water vapor may drive out all the oxygen and that would enhance container performance. That's a great idea if it works, but we sure need some data to back it up.

NELSON: Okay. Thank you very much.

I turn the session over to Jerry Cohon 10 minutes late.

COHON: Thank you very much, Priscilla, for your excellent job of chairing this morning's session and our thanks, as well, to all of the speakers and participants.

Before we get into our public comment period, Lake Barrett, the acting director of the program, would like to make some remarks.

Mr. Barrett?

BARRETT: Thank you, Mr. Chairman.

What I thought I'd do is quick give you an observation. This is the first time I've had the opportunity to kind of watch the Board in action. I've heard a lot of different things about the Board and put some of the things that we've talked about and you've talked about with some of our folks in a little context in more of the policy setting where I believe this Board, being a very capable and energetic Board, will have substantial national and probably worldwide influence over the next several years.

As I believe you probably understand, there are motivating forces and resisting forces that are all operating within a certain environment here in the high-level waste. One of the things, we have to responsibly manage the high-level waste that we've made, are making, and will probably make in the future. The motivating force is we must have responsible way to manage that in the future. The primary focus of that, as the primary focus of this meeting has been, is the durability of the Yucca Mountain as a repository and get into the scientific and technological aspects which are the key parts of that.

The resisting force is that we have reasonable assurance that we're not going to unreasonably expose future generations at Yucca Mountain downwater, downgradient at Yucca Mountain, and also there in the background is the question of if we don't do Yucca Mountain, what else are we going to do and what about the 80 some sites where we have commercial and defense high-level waste in this nation today and what the impact might be on other programs worldwide. Those two forces act within an environment of basically a Federal budgetary situation. There's Federal budgetary considerations that are Congress and President who make the decisions to the Constitutional process, who provide funds for us to do the right things with or not provide funds to us to do.

I thought I might give you a little bit of history on something that we have done where we've been over the last few years. I drew a graph to try to show that. It might be a little historical, but some of you may have been around and some may not have been. Back in 1995--and I won't go into previous history--we revised to our present revised program. Okay? At that point, we had spent about $2 billion on Yucca Mountain. We put in an intermediate stepping stone, not a conclusion, called the viability assessment in 1998. And, we basically within the administration and within the Congress said that's going to cost you in round numbers another billion dollars; all one significant figure here. All right. $2 or $3 billion expenditure at Yucca Mountain. And then, we said to go on, if we continue on with this investment decision, you could move to a site recommendation and then license application. That's in '01/'02. From a technological point of view, it's about the same kind of thing. There's another billion dollars to get to there. Nominally, the slope of this is about $300 million a year for the Yucca Mountain Project.

Now, back in the 1994 time line when this administration came, this cost estimate at that point was $6 billion based on a 1988 site characterization plan. We took out--this program took out $2 billion worth of stuff to get down to this. And, we stretched a lot of the science and engineering folks to get down to that. But, as a consensus, scientists did not bolt. They basically tightened their belt, took out any fat that was around, and I believe we have a state-of-the-art scientific program and we are, I believe, in the earth science, in the engineering, and in the modeling, we are the state-of-the-art with the team that you've been questioning. I would be interested in your views at various times about that. But, we came down to this.

All right. Now, that does not give all the answers. There is uncertainty. Now, I'm a terrible drawer. So, what is the uncertainty that's involved with how much risk we're going to be putting on to future generations if we were to do a Yucca Mountain Project or not? As it was mentioned, this uncertainty goes up and down as new questions come up and questions get discussed, but what I'm trying to make a point is in the early days it's coming down--the slope of this is very rapid. We've learned a lot about Yucca Mountain. At the far out--you know, it's asymptotic. We will never answer all the questions about Yucca Mountain in the scientific--we'll never know everything there is to know and it's going to come down. One management point is that when we're at the viability assessment, we're getting close to the knee in the curve. I've asked many of the scientists about Yucca Mountain. When we finished experiments and things that you describe--you've heard about, I should say, that we would maybe know in approximately 90 per cent about the natural condition of Yucca Mountain in 1998 as we're ever going to know. And, basically, the dollar per reduction of uncertainty gets higher and higher as we go out.

Now, one of the key things that is going to be happening over the next year or two is going to be what is the requirement, how safe is safe enough, and how much uncertainty can we tolerate to make a site recommendation decision or a suitability decision? Same thing. What does it take for a license application without the NRC returning it? What will it take for a true construction authorization from the NRC who are the duly designated safety sayers about how safe is safe enough based on EPA standards?

One of the things I didn't have in my oral remarks, but it's in the written remarks that we submitted, was the thing about the standards at Yucca Mountain. I'm saying, you know, one of the things we didn't cover is we must focus on issues central to protecting public health and safety of the environment and not require a degree of proof that is beyond what science and engineering can reasonably provide or we'll get ourselves in a Catch 22. You can't get there from here.

Much of the discussion that I've heard over the last two days has been a very healthy discussion. Are we doing the right experiments? Do we need more experiments? I didn't hear anybody talk about deleting any experiments. I kind of heard things, well, do a little more of this and a little more of that. Let me take the east-west drift as an example. It starts out as something simple. Usually, ideas start simple and they get more complex as time goes. Things get built in, you know, and they always get more complicated at the end than they will when they started. That's good and it's bad. Okay? But, there's a tend to growth and there's a natural ratchet effect. You know, you never go back; you're always going forward.

I would respectfully submit to the Board for their consideration as they go about the next couple of years and they say, well, should we do more of this or more of that, that we start looking at what are the cost implications of it? We must be doing adequate safety for the future generations, but how much can we afford and how much should we do and that type of thing. We have some margin in our plans in this billion dollars from here to here. Here, we have another $200 million we're--here to the VA because we're almost in--well, 300 million almost in '98. So, there's some margin to do it. We put contingency in and you've seen some of the scientific work. I think it might be valuable to--I'll say myself and I would take a guess probably the administration of Congress is what's the Board's view? Is this something that's doable or not? Or should we really be back here at 6 billion or something or, gee, is there some work that we really know enough about that we needn't do anymore? You know, what is the prioritization of that work? Because everybody, you know, has great needs and certainly in the scientific community there is no end to it in reducing uncertainty.

So, I just thought I would just make this comment and many of you, I think, know this, but it's something that as we get in the individual pieces of this, you kind of want to step back and you might want to consider the whole. And, the Board may decide, no, this is not an area where the Board wishes to go. But, there will be very many important national policy decisions coming forward. It is likely that in testimony or some other setting that the Board might be asked its scientific, technological views of that.

Thank you. If there's any questions or whatever since you never asked any questions of me the first time? You don't need to now, either.

COHON: Thank you. And, in fact, we may not, but thank you.

Are there questions from the Board?

(No response.)

COHON: Looks like none. Thank you.

To start our public comment period, we will begin with those people who graciously agreed yesterday to put over to today their remarks. One of those is Linda Lehman from the State of Nevada. Ms. Lehman?

LEHMAN: May I please come up to the front since I have some viewgraphs?

COHON: Sure.

LEHMAN: Okay. Thank you very much for allowing me to have a few minutes to speak today. Since most of the Board members are new and may not know me, my name is Linda Lehman. I'm a hydrogeologist who contracted to the State of Nevada. Previously, before that, I was in the performance assessment section of the U.S. Nuclear Regulatory Commission and had the great fortune to work with some of your staff members, Dr. Dan Fehringer and with Dr. Mike Bell who is also present here today. After leaving the NRC, I've worked for numerous States and Indian Tribes on nuclear issues. Since 1983, I've worked for the State of Nevada in performance assessment and hydrologic modeling.

I'd like to point out that in 1982, the Nuclear Waste Policy Act provided the State of Nevada a technical oversight role. The amendments in 1987, the oversight and technical review role was also extended to local governments. Although in Steve Brocoum's diagram of external peer reviews and oversight groups State and local governments were not included, I just want to assure you that we are legally designated as oversight groups and do fully intend to review the TSPA. In fact, one of the tasks in my new contract with the State of Nevada is to develop TSPA-VA review plan and put together a team of professionals to review it.

Part of the review capability that we have is to look for errors/omissions in the DOE program and also to develop alternative conceptual models where we feel they're needed. Nye County is going to have someone talk about the unsaturated zone shortly, Parvis Montazer. So, I'm going to limit my comments to the saturated zone today and hope at some later time I can present to the Board some of our technical research that we've done for the State of Nevada over the past 10 years or so.

With regard to the saturated zone, there's concern on the State of Nevada's part about the interpretation of the potentiometric surface at Yucca Mountain directly under the site. And, we believe that the interpretation is misleading as it presently stands and has an effect on the dilution calculation that is being performed in the TSPA-VA. As Dwight Hoxie mentioned, the saturated zone sort of has been an orphan until recently, and when the fluxes were realized to be as great as they might be at Yucca Mountain, then the saturated zone was needed in order to perform the dilution calculation.

Specifically, I'm going to talk about two documents of the USGS. This 1996 document and present status of the saturated zone and the 1994 document which also is their revised potentiometric surface.

COHON: Ms. Lehman, before you go on, let's have some--let's agree on some kind of time.

LEHMAN: I plan to take maybe five minutes.

COHON: Oh, that would be fine.

LEHMAN: But, certainly, less than 10.

COHON: You have, in fact, seven; how's that?

LEHMAN: All right, good; that will do it.

In 1984, the potentiometric surface of the USGS looked something like this. Later, they--and, first, I want to call your attention to some features which is this northern embayment and the southern embayment. They revised this surface in 1994. They re-leveled wells and recalculated the water levels based on temperature and density and their revised surface in Ervin 1994 looked like this. And, as you can see, it is quite different from the original potentiometric surface. What we noticed was the absence of these embayments. We looked at detail in the discussion in Ervin 1994 and found that they had not used all of their data points because they felt there was no physical meaning for the potentiometric glows in these areas. So, therefore, they excluded some of those data points in this map.

We took the actual data points that were used in Ervin listed in the table which they didn't use and replotted them. In fact, if you'll look at the 730 meter contour, you do see that these embayments do exist. And, we noted that they also seem to coincide exactly with several of the faults that are known to exist at the site. At this time in 1995, I believe--or 1994, we published a report that said basically we hypothesized another fault to exist at this location based on this deep embayment.

We believe that the structure underneath the site is in control of the flow field and that an alternative to the smooth flow field, northeast to southwest flow field, is one of structural control where you have water moving down the Ghost Dance Fault specifically and some of the other faults to the north; probably, Drillhole Wash. The reason I bring this up is that in order to do a correct dilution calculation and to know what the flow path is, we'd like to see more study at the site in terms of structural control. The TSPA-95 structural control on the saturated zone was not addressed, and I believe very strongly that it needs to be.

Basically, it would be nice if the Board could look at the detailed data rather than just having overview presentations and I hope you'll get to see some of that later on so that you can see where the discrepancies lie by looking at the actual data.

Thank you.

COHON: Thank you.

Parvis Montazer, are you here? There you are.

MONTAZER: May I come up there?

COHON: You're also carrying overheads, huh? Sure.

MONTAZER: Pardon?

COHON: If you care to come up here, by all means.

MONTAZER: I guess it's better to face the audience.

COHON: Oh, okay.

MONTAZER: I won't bore you with the background. I just want to quickly comment on some of the things that I heard on the expert elicitation yesterday. First, I was very pleased with the outcome of this review and really appreciate to be involved; DOE inviting Nye County to be involved in that process as an observer.

There are basically three areas that I had concern or I'd like to make clarification and if somebody in the project follow up on these things. The first thing that I noticed is the lateral flow in PTn was not considered important and in my opinion I think the evidence is for strong lateral flow. Chlorine-36 being the one important evidence if we believe that this is due to water percolation. The chlorine-36 is there mostly along these--has been observed along the faults and structural features. And, if you notice, on Alan Flint's geologic maps, Tiva Canyon does not distinguish between faults and structural features and others. That is, you put water anywhere in Tiva Canyon; as long as it's exposed, it's going to percolate down as fast as anywhere else whether it's faulted or not. Therefore, the only focusing mechanism for these chlorine-36 are in my opinion PTn.

There was a comment made by Dr. Neuman regarding the ventilation--use of the 50 millimeter a year of percolation that has been derived from ventilation. Nye County has been doing the ventilation studies for the past couple of years; actually, Nye County was the--I should say, the initiator of the idea of doing ventilation effect tests. Using the observed flux of the vapor from the ventilation process and concluding a percolation flux is totally inappropriate because as the 50 millimeter that is calculated by Joe Wang is under psychometrically stressed condition. That is, we stress the system. The water potential changes by three to four orders of magnitude. Observation has been made by us and Alan Flint and others and it's a stress system and it has nothing to do with the natural processes.

The other--can I make one more quick comment time-wise? The other thing that I was pleased to hear is the coupling of the surface water--basically, atmospheric processes with TOUGH-2. We've been pushing this for the past five years and we have actually developed our own TOUGH-2 version which is--we call it ATOUGH-2. Bo is not here. Bo always gives me a hard time about that, but we have been pushing this and I'm glad that the Board has asked--or, I guess, the expert elicitation and then the Board because--

concurred on that and we have actually provided copies of this code to the project over the past several years and feel free to use it.

COHON: Thank you very much.

Dennis Bechtel from Clark County?

BECHTEL: Thank you. My name is Dennis Bechtel. I'm the planning manager for the Clark County Department of Comprehensive Planning, Nuclear Waste Division. Clark County has been involved since about 1984 in reviewing DOE activities at Yucca Mountain. Clark County, I might add, is just one of 10 affected counties in Nevada that are concerned about the Yucca Mountain Project, and depending on funding and things like that, have varying degrees of involvement. Unfortunately, most of the counties are not here today because we've not been funded for the last two years. In Clark County, we're still kind of hanging on, but we appreciate you having the meeting, TRB, in Clark County here. I think it's important. The counties are going to be affected, the people are going to be affected, and to have meetings like this in the communities where the greatest effects are going to be.

I'd also like to appreciate the meeting you had in Pahrump earlier in the year where we had an opportunity to share with you some of our concerns about transportation. As I understand it, there's going to be a--or there was a thought at the end of the meeting that there might be a more comprehensive view of transportation issues at a later date by the Board. I might add that this is a concern not just of Nevada and Nevada communities, but this is a nationwide issue. I'd also add that right now we're looking at low-level issues with respect to the test site. The test site may be considered as a regional or centralized site for low-level nuclear waste. While I understand there's two different programs here, a lot of the issues in transportation are the same and the low-level are more an immediate concern. So, there could be an analog there to learn for some of the high-level questions.

I might also add when you're looking at your technical studies, just understand that this is in the context of a community and people. Just as you're looking at your technical studies and time, you should also consider communities and time. If you kind of jump in and out of Las Vegas every two or three years, I think you realize there has been some pretty dramatic growth here. And, I think that will continue as long as people, I think, are attempting to flee California, southern California especially. So, what may be an isolated site today, in 10 or 20 years may not be so isolated. I know there's some things going on in Nye County, as well.

Several concerns that we have I'd like to share with you. The viability assessment, I think we feel that that's kind of developed a life of its own and our concern is that the folks in Washington who are considering interim storage rate now are going--may misconstrue a viability assessment as a suitability determination. I know in a lot of the debates even Senators who were friendly to the fact that interim storage should not begin until suitability determination is made kind of misunderstood that. So, in your discussions with Congress and other people, I think you need to reinforce that thought that this is just a kind of an intermediate step and it's not the final answer to whether the site is suitable or not.

The other thing I hope you look at as maybe a why rather than a what is the 10 CFR 960. I know the informed public seems to feel that there's a shifting of gears going on here and I think there needs to be more probing by the Board just to understand, you know, why these changes are being made and if, in fact, they're appropriate. These things were set out in Section 112 of the law and things are very much--our concern, things are very much becoming schedule driven if they weren't already and this is just another one of those, I think, schedule driven things.

The other thing, performance assessment, the expert elicitation process, I think, has been excellent. I think, everyone has asked very probing questions. I hope that the pressure will be still placed on that you get answers for the questions because I think--I mean, I've been real impressed with the panels that I've attended.

The final thought is just with regard to public involvement. The public involvement, at one time there was a series of workshops here around the country just so you could kind of explain the program. That's kind of dropped off the scope. We really haven't had a public meeting for some time. EIS scoping, work is going on in EIS development right now since that's been funded again, but I think there needs to be more public meetings; not let's go out to the--I think the information office that DOE has is excellent. I think there's a lot of information out there, but I think the public information program needs to be a lot more proactive. I think these would be more meetings in the community, more workshops, and more opportunity for the public to get involved.

So, thank you again and I hope you'll have more future meetings in Las Vegas. If you have questions about the affected governments, you know, we'll be glad to meet with you at any time. Thanks.

COHON: Thank you, Mr. Bechtel.

Tom McGowan who spoke yesterday would like to speak again. Mr. McGowan, by my calculations, you had 20 seconds left from yesterday. Now, I'm not going to--now, wait, this is an honest negotiation. Don't turn his microphone on.

MCGOWAN: I hereby bequeath my 20 seconds to the highest bidder. Seeing as there are none--

COHON: How about five minutes, please?

MCGOWAN: I requested of staff--and not to be impertinent one bit or at all facetious--an opportunity to provide two separate inputs; one of five minutes and one of three minutes precise duration. I will defer to all other speakers and be the last one. And, if Mr. Lake Barrett has an opportunity to present additional information, I would invite him to do so, too, at your discretion. So, you give me your judgment on that and then we'll see where it goes.

COHON: Well, actually, since you're at the microphone and you promise to keep it to eight minutes, why don't you just go right ahead. And, you feel the pressure of the other speakers who--

MCGOWAN: I tend to be increasingly concerned as to precisely how much time you have left, not me. I've got the rest of time. This Board is finite to the best of my understanding. Thank you, sir.

Honorable Mr. Chairman, esteemed members of the Board, key staff, and meeting attendees, where did we leave off and how unsafe is unsafe enough?

My name is still Tom McGowan notwithstanding the fact that change is the universal constant which there is invocative (sic), perpetuative, and exacerbative of the subject topic of protracted discussion. And, therein, lies an important clue to the viable alternative solution to an enduring and seemingly insuperable problem. Therein, lies an important clue, blah-blah-blah to an enduring and seemingly insuperable problem essentially arising from the human proclivity to become habituated and virtually institutionalized as responsible; responsive to any, however, fundamentally flawed, but expediently deemed traditional policy and process paradigm, such as the NWPA. Thereas (sic), it comes as no surprise that our eminent colleagues in the former Soviet Union recently determined that in the vast regions of the firmament, there's no place to park. Cancel my reservations and resecure the cosmonauts and the American astronauts immediately if you don't mind.

On a serious note, when the eminent Dr. J. Robert Oppenheimer in the mid-1960s nationally televised an interview and was asked whether he thought it advisable and possible to place nuclear energy securely and permanently under international control, he replied in characteristic candor, it's too late. It was too late the day after Trinity. While I fully understand and concur with the factual and reasoning basis for Dr. Oppenheimer's prophetic assertion, my individual layman's opinion it was then not only too late, but also too soon. And, in today's world of uncertainties, complexities, and time constraints, it may still be too soon for mankind to come to its senses individually or as parably combined.

In the immortal words of Pogo, we has met the enemy and that is us. I'm reminded of the man who rushed into the store and demanded of the clerk, "Give me two pounds of spaghetti, six fresh tomatoes, some garlic, onions, olive oil, grated cheese, and a gallon of dry red wine, and snap it up, my wife is waiting dinner." The clerk smiled and said, "Excuse me, sir, but you must be Italian." "Oh, really?" said the customer. "What makes you say that?" "Because," said the clerk, "this is a hardware store." In my individual layman's opinion, so is this.

In both yesterday and today's abundance of excellent presentations, I was particularly impressed by the fact that the array of experts have the honesty and integrity to express and uphold in a straightforward manner their respective and however widely variant professional opinions. And, what if they're each and all right as is readily conceivable and what if a unified field theory based on uncertainty is as readily conceivable and invocative (sic) of a neopardigm based on creative imagination, pure intuition, and an abiding faith in our respective perceptions of an infinite Supreme Being? I would hazard the opinion that quality is a function of quality, aka integrity, notwithstanding dimensional scale or the particulars of sub-lineation. The fundamental crux issue problem is not now, never was, and never will be uniquely limited to the-- symptomatics of either nuclear energy, nuclear waste, or radioactivity, per se, but rather irrefutably is closely rooted and embodied in the human and hate perverse potential to an exhibit of human spiritual quality deficiency and limited special interested expediency driven furtherance of subjective agendas, adversely impacted upon the genuine best public interest, aka the common good.

Therefore, it seems appropriate and long since overdue that we now individually and consensually strive toward a higher idealized standard of attainment to human spiritual quality effectiveness in terms of ethics, morality, reason, integrity, responsibility, and above all conscience in the preservation of the existence of humanity and of the persistence of human consciousness itself. But, first, we have to want to do it and that deeply personal introspect of decision making process variably may require a fraction of a nanosecond or the rest of human time. But, in the instance of any residual uncertainty, coward; take my coward's hand. Together, we shall stride confidently across the nonreturnable threshold leading onto the brilliant horizon of challenges and opportunities for unprecedented human achievements that await throughout the Third Millennium and beyond.

In summary and conclusion of this first element, I would offer the heartfelt observations that the opposite of love is not hate, but indifference. And, notwithstanding, an abundance of that--evidence. To the contrary, I truly respect, admire, and regard every member of the DOE as superlative in terms of experience, expertise, and sincere dedication to purpose in the national interest and thereas ranked among the finest exponents of what this great nation has to offer. Notwithstanding their mandatorily imposed plight and securely constrained and admired between a welded tuff and a hard place. But, hope springs eternal, the words of Sam Ervin. Remember him?

As for the rest of you, and by way of assertive recommendation, the public reception of risk is not logical, but emotional and expressly contingent upon a sense of subjective control. Thereas, transparency and public acceptance are entirely a matter of equity based public participation in the democratic process. That is an aggregate of respect of the limited interest engaged as spectators in hierarchal audience, but as reasonably well-informed, real time, omni--communicative and omni-participant elements--relative to a non-hierarchal viable hold integer consistent with the eminent principle of E Pluribus Unum as in no one.

And, I'll leave you with the teaser that the viable alternative to a deep geologic underground permanent repository and conceivably far superior to it on multiple grounds looms diagonally overhead in the alluvial sediment of the moderate--zone subject to certain controllable qualifications and solely pending final elimination completely and permanently. That's having achieved prompt super-criticality in the highest tradition of insufferable laymanship.

I'll drink the prescribed hemlock and leave quietly. Thank you for the opportunity to address the public record.

Here's the second part if you would like to hear it.

COHON: I'd love to hear it, but--

MCGOWAN: I can rush.

COHON: Could you?

MCGOWAN: Unaccustomed as I am.

COHON: Thank you.

MCGOWAN: Ordinarily, it takes me about an hour to say hello.

COHON: Time's up, right. Go ahead?

MCGOWAN: Respective of the comprehensive--spectrum of conceivable PC alternatives, it's important to recognize that we're in a traditional policy and process paradigm. We're--

of the PC initiative. It's fundamentally flawed, deficient, and defective to begin with. Any and all, however, respectfully perfect component elements ensuing in descending order of cascade and expanding and accelerating over a broadening base obtaining reiterative amplification of the initial defect and is precisely the best way to do precisely the wrong thing. Congratulations.

Regarding the interminably evolving work-in-progress aspect of the entire NWPA mandated mission, how many cuts at the ball and foul tips is a batter in a rational ball game reasonably allowed before being relegated to the Minor Leagues or worse? Consistent with the assist or recommendation of the Board's Dr. Wong, I invite your attention to the overhead and ask that you envision and--a pyramid, a solid rectangle, and a sphere; a graphic depiction of policy and process paradigms. Then, remove the first two traditional geometrics as oversized and hierarchal and contemplate the sphere as the idealized classic paragon of the non-hierarchal, omni-participant--iteration of an optimum viable whole integer, derived vehicle--consistent with the eminent principles of Republican democracy--virtual human laser whose efficiency is vastly greater than unity and its potential yield is expressed in a--energy equation, $QH=QMC^2$ wherein Q denotes quality and H denotes humanity. Assuming a simulation that is so deliverable and positive application, further overhead elaboration is reasonably deemed superb. It was Dr. Wong. Thank you so much.

In summary itself, explanatory sound bytes respective of the program expressed in one fell swoop; silk purse, sow's ear (inaudible) hypothesis, 450 meters deep, geologic gradient two kilometers north of Yucca Mountain and the difference between the in situ geology of the-- experience and Yucca Mountain in terms of migratory transport. --I received two letters, one from Amelia Earhart and another one from Drs. Bowman and Vinneri of underground-- catalytic criticality renown. They each want to know where is everybody? And, finally, the ultimate peer review group, ladies and gentlemen, is the interest in the affected public.

Thank you for your time and interest. Onward and upward and so long.

COHON: Thank you, Mr. McGowan.

Abe Van Luik?

VAN LUIK: Abe Van Luik, the DOE bureaucrat is officially out to lunch. In the interest of addressing just the public, I wanted to give you some very serious, very personal observations on one subset of the public to give you a flavor of how difficult it is to communicate. This is a very personal statement; it's not a DOE statement.

In 1995, I took part in a series of public meetings on radioactive waste disposal issues. In those meetings, I was shocked when I began to realize that what motivated some of these people who were very hostile to me personally and my work and who never tired of declaring that our waste disposal activities are immoral at their very root, was in essence their own vision of what life was all about. Their spirituality was involved. I interpreted them to be claiming a superior spirituality as the basis for their stance. I was shocked because I had for years included myself in the group that actively explored and shared that same relatively earth-centered spiritual vision.

A repeated theme was echoed by these particular critics and they questioned our merits of disposing of nuclear waste in geological setting which, as far as I know, is the preferred approach in every nation I know of. They said we are injuring and defiling the earth and not being good custodians. They said we continue to attempt to conquer the earth rather than revere it as our source. We are void of the very spirituality that comes with rootedness to the earth.

In every meeting where Native Americans spoke, these heartfelt ideas are stirringly expressed over and over evidencing what I feel is a deep-seeded cultural belief and reality. There was a lot of strong emotion behind these ideas and the anger expressed to those who were apparently, like myself to them, were blind to this vision is actually thought by those expressing it this is not play acting; it is very real.

We are perceived to thoughtlessly and with foul intent run roughshod over their strongest inner convictions and feelings. In our critics' eyes, we persist in continuing to defile our common Earth Mother and think we are intellectually superior not only to our critics, but superior to the forces of nature, as well. This kind of huberous (sic) is written all over our faces and is conveyed to them in every technical word we speak, and the more we speak technical stuff, the more it makes the listeners feel hopeless and angry. This anger is not something we want to aggravate. It is dangerous. We also don't want to discount these people just because in the U.S. they are largely perhaps devotees of the new age and Native Americans and thus are in the minority. When it comes to their perception of potential risk from our potential waste disposal activities, exaggerated as that risk may be, they are probably representative of a sizable fraction of the whole population. It is only in their gut feelings and spiritual convictions about why our activity is immoral that they drop into a minority.

Their description of an earth spirituality and the cosmological connectedness that it recognizes, fosters, and celebrates is one that matches in many ways my own experience in the perception of reality. So, often, in these public meetings, it was an amazing for me state of agreement with the sentiments being expressed on the abstract level. It is the application of these sentiments that I finally part company with these critics. There are two levels at which I parted company. One is at the public risk level and two is at that spiritual level.

Many made a rather typical comment that there was no environmental crises; hence, it should stay where it is in many locations on the earth's surface and not be disposed of in a central location deep in the earth. These comments echo a sentiment clearly stated in a recent book that is very popular which I will cite and reply to. It says--this is by Matthew Fox, Creation Spirituality, New York, Harper Holmes. "Instead of burying this waste to deny it, thus making life intolerable for generations to come"--there's the risk perception--"we ought to keep it visible above the ground in guardian sites." I'm not suggesting that all of our critics are familiar with the book from which I took this quote. I suspect some are because they sounded like they were reading it to me. And, they are feeding these concepts and sentiments to others. Hence, the vehemence, in part, of the feelings of geologic disposal as an option arouses. Others derived the sentiment independently and, of course, the Native Americans have no need of this type of priming by an advocate of creation centered spirituality which is to be conceptually the same as the Native American Earth Mother centered spirituality except that this new version does allow the adaptation to a larger group of religious symbols and systems.

My response to this personally is that I believe that until the earth's spirituality takes over the whole world, human political institutions will continue to be as unstable and unpredictable as they currently area and as they have been in all of history. Providing potential for relatively easy access through surface storage to this dangerous material above ground even with active defensive systems in place, to me, poses an undue societal risk. The possession of this material--and I was told that with a large truck, you can actually carry off one of these casks--does not necessarily represent the capability to create nuclear weapons, but it does give a potential terrorist group or individual the opportunity to seriously poison land and water unless demands are met.

Geology, on the other hand, is much more stable than human institutions or societies and deep carefully engineered emplacement in a competently selected site--and that's what a lot of the controversy here is about--promises an extremely low-level of risk to future generations. All over the world, the consensus is geologic disposal at the stable formations is the way to handle this risk.

And, in many nations, written statements, government policies on why this is the preferred option, they explicitly site the instability of human institutions. Highly radioactive long-lived waste repositories are under development in over a dozen countries. In discussions that have taken place as part of cooperative work between these nations' programs, it has become apparent that all are acutely aware of the need to remove these materials from the surface of the earth precisely because there is no way to guarantee the current institutional controls over the long time periods needed. Even just the 200 or 500 years needed for the decay of low-level wastes go well beyond the mean lifetime of most modern nation states. As was suggested in Matthew Fox's book and repeated by some of our critics in these public meetings, these sites, particularly if they also contain the radioactive wastes of weapons programs, could be marked with museums to human stupidity and cruelty and outlined as stupendous cost of assuring total mutual and self-destructive capability. I, personally, have no problem with that. I hope no one ever builds nuclear weapons again, but this gets us to the second level of my criticism which is the purposeful confusion of military and civilian power uses of nuclear energy, another section in Fox's book.

I was shocked and sorry to see the repeated and indiscriminate mixed mentioning of military plants which usually exist only to produce plutonium or tritium, not power, and civilian plants which usually exist only to produce power and are not particularly useful or efficient for making weapons--plutonium. I say usually because there have been a few exceptions. I take it that the reason for the purposeful mixing of civilian and military uses of nuclear processes is to underscore that to use nuclear fuel for any reason is incompatible with--and this is a quote from the Matthew Fox book--"with regarding the planet as a sacred trust."

My personal question is why do so many coming from this earth centered spirituality feel that way? Look at the gifts of Mother Nature that took their turns in creating the home on which Mother Earth could finally spawn life and us. They are a series of nuclear processes. The big bang's fireball of--particles are still expanding and the subsequent fusion of these lighter elements make the basic ingredients of the cosmos as we know it. The fusions are now localized in stars and still make the heavier elements that make worlds such as ours possible. All these creative processes are nuclear processes. Our earth from which we have our being after over four billion years still has a hot molten core. Why? Because it has a significant radioactive component, lots of radionuclides down there undergoing fission and making heat, keeping the core molten. This, in turn, fuels the ultimate long-term recycling machine. It allows the plates that make up the earth's crust to be continually--remolten (sic), and sends recycled crust back into the deep ocean spreading zones that eventually become new land. Finally, it is the radioactive energy output of a nuclear device, the sun, that is absorbed by the earth's crust and allows life to come forth and exist as we know it. Thus, all of Mother Nature's most fundamental creative processes are, in turn, energized and fueled by nuclear processes. And, since we are of the earth, we are ourselves radioactive largely because of potassium content.

Let me shift very quickly and wrap this up. I'll skip a lot of this. But, another point is that nature teaches us how to use nuclear energy. There are two processes by which ore has been deposited. In some of these ore deposits, we have actually because--for example, at Oploganong (phonetic) which has just been mentioned, these types of deposits were so rich in fissile uranium mainly because the new earth was rich in fissile uranium that they went critical as if they had been placed in the core of a reactor. They were quenched over a billion years ago, but they are still around today to be mined and to be studied. They spawned natural plutonium, the one material thought to be totally unnatural by many, most of which is now decayed away. This is a whale of a good argument for the stability of geology; is it not? And, a good argument for the geology's ability to contain the types of radioactive elements that many industrialized nations are trying to dispose of in similar fashion.

The point that I'm trying to make is that there's nothing intrinsically disrespectful, immoral, or unspiritual in using these materials or processes. These materials and processes are primary cosmic gifts of the first magnitude, but it takes discipline and knowledge for us to use them correctly and safely. That is true. It is difficult. There's significant danger in doing things sloppily and I think Chernobyl everybody is familiar with. I'll skip over that example, but it shows that when you think that you're smarter than your own tools, you can run into problems. But, the real point that I want to make is that learning chemistry and physics and practicing an exacting self-discipline in the manufacture of materials and systems are hardly crimes against nature and they are hardly incompatible with spirituality.

Maybe, you can see from the above why I'm chagrined at the denunciations that I received at our public meetings. The speakers are assuming that everyone with a creation centered spiritual feeling would feel that nuclear power and nuclear waste disposal are inherently immoral. It just isn't so. We moderns, which is what I was called by someone, are told that we lack a type of spirituality that the Native American peoples and others who follow their spiritual concepts claim for themselves. In my opinion, our accusers may well be on to something of value, but as with any human institutionalization of basic truth, they are as apt to carry their convictions into the realm of arrogance as we are.

Finally, I personally feel their way is not a priori superior to our nominal Western way, but neither is our way, our priori, superior to their way. My personal conclusion from attending all these meetings, speaking with these people, and listening to them is that no human being is superior to any other human being solely because of a claimed allegian to any tradition no matter how spiritually or intellectually superior it may be in concept. People are people and are capable of, if not indeed destined, to make a mockery of every noble intent and make a mess of every opportunity to doing a lofty deed. This is the grist for the philosophers in show business all the way from the Greek tragedies right into anything that you look in the newspapers today. This is also why the people, even those of us who feel we are highly idealistic which I would say most of my colleagues fall into, who run the world's nuclear waste programs need, despite our sometimes protestations, a serious degree of independent oversight.

I just wanted to share that with you. Communicating with the public is very difficult because the public is not a monolithic beast.

COHON: Thank you, Abe.

Michael Bell from NRC.

BELL: I'm the Michael Bell. I'm the acting chief of the performance assessment and integration branch at the Nuclear Regulatory Commission. Many of the things which have been discussed in the last day and a half have mentioned regulatory issues, regulatory applications, and I just thought the Board might see some value in getting a regulatory perspective on some of these items. I'm basically going to take them in the order in which they came up in the last day and a half.

First, on the issue of criticality, as you may know, the Department has submitted a request to the NRC to revise this regulation concerning postclosure criticality at Yucca Mountain and we have, in fact, responded that we would take that into consideration when we amend our regulations to conform to the EPA standard. So, basically, that is something that is planned. But, notwithstanding that, discussions and interactions have been going on between the NRC and DOE staff on postclosure criticality and DOE has prepared a technical report which we've had, I think, two technical exchanges to discuss and there was a commitment from the Department to submit a topical report on this topic. I guess, one observation at this point would be up to this time the Department has focused exclusively, I think, on commercial spent fuel. One of the outstanding issues, as far as criticality is concerned, is materials like the DOE owned spent fuel, Navy fuel, nuclide research reactor fuel, excess weapons plutonium. All the materials Lake Barrett mentioned yesterday may eventually go into Yucca Mountain that pose different criticality issues that need to be taken up. And, the Department and the NRC staff are, in fact, planning an interaction meeting tentatively scheduled near the end of July to start discussing these other fissile materials.

The next item I'd like to comment on, I guess, is the interim overall performance standard of 25 mrem per 10,000 years that the Department is using in their performance assessments. The NRC is in agreement that's in the right range. That's what we would expect that might come out of an EPA standard or out of legislation that would set the overall performance standard. It's very consistent with our own thinking.

One thing I would like to address though is the idea that the way this might be applied would be that if it was 24.99, you get a license, and if it's 25.01, you don't. The Commission agency-wide is grappling with what's called the concept of risk informed/performance based regulation.

We, in fact, don't see doing any deterministic single value calculation, but we would come up with a distribution of probable risks. The way we would see applying that would be certainly some measure of the risk like the median would have to be below the regulatory limit. But, we recognize because of the uncertainties, there might be some tail of the distribution that could exceed the regulatory limit. That's a very important concept because that's probably how all these concepts like performance confirmation and reducing uncertainty as the program proceeds would apply that probabilistic distribution. Basically, at the time we gave the construction authorization, we might tolerate a larger tail exceeding the regulatory limit provided that at the time of license to emplace that tail were reduced and certainly at the time that you eventually close the repository and you've got 100 years or so of experience with that site and you know exactly what you've emplaced and you've been monitoring how it works, you would try to achieve very high certainty that it was very unlikely that the regulatory limit would be exceeded.

And, basically, I think that ties into the discussions that you heard earlier today on performance confirmation. Basically, I did not hear anything in that discussion that basically I saw as inconsistent with our regulatory approach. I think, under the present Part 60 regulation, you can do everything that the Board asked about in terms of modifying the performance confirmation program as the program proceeds, modifying the way construction takes place. These, in fact, would likely require amendments to license. They may not be trivial things to do. Some amendment to the program or the way of constructing the repository that was perceived to have some safety significance would involve the NRC staff having to write a safety evaluation of that and perhaps even hold public hearings on it, but the regulatory mechanism is in place that if we get smarter in how we excavate the repository and line the drifts, do performance confirmation, even come up with a completely new design for a waste package 10 years into the program, that can be accommodated under the regulatory scheme.

Expert elicitation is a topic of much interaction between the NRC and DOE and some of the issues that I heard raised by the Board are, in fact, the same kinds of issues hat the NRC staff has raised with the Department. One involves this central tendency issue. One of the concerns that we have is documenting in the expert elicitation process how from the initial elicitations through the process of interaction and feedback the final distributions are obtained. Basically, at present, DOE does not document that. When we've asked about it, basically they say, well, all this, we have it in our records. But, since another concept that was extensively discussed in the last day and a half is transparency, we see this lack of documentation as a vulnerability in that it clouds the transparency of the expert elicitation process.

A related issue on expert elicitation is, in fact, the process for treating new data that arises after an expert elicitation is conducted. You know, we are certain that as the program proceeds, there will be new information that will call into question expert elicitations that have been conducted and basically we've just raised with the Department that they need to have a process in place for how to deal with that. These and other issues laying out some of NRC's concerns on expert elicitation are documented in letters that we've sent to Steve Brocoum in the last year or so. I talked to Steve this morning and, in fact, he tells me there is a letter in preparation that we may get as early as next week responding to these concerns.

I don't know if Dr. Hoxie is still here. Just an observation on the climate change slide that you showed. Basically, the way I read it, it said that in the period beyond 10,000 years, but between 10,000 and 100,000, climate change might be a consideration. But, it seemed to imply that for an initial 10,000 year regulatory period, you would not consider climate change. I guess, the regulatory staff's view would be that by the end of the 10,000 year period, we could be entering into a new pluvial period that would not be complete in a 10,000 year period, but you ought to be considering possibly thousands of years of a colder, wetter climate and considering its implications on the water table rise.

I guess, just one last point in how we are trying within the NRC to interact with the Department as their program proceeds and as they publish their viability assessment and eventually get to the site recommendation to the President and finally to the license application. Our, say, guiding principle is when we identify issues to raise them to DOE's attention and document them in a series of what we have christened issue resolution status reports, a number of which are planned to be published before the viability assessment is issued. Basically, our goal is that to the extent we can identify regulatory issues and, in fact, if there are issues where we reach the point where we have no further issues or questions remaining, we plan to document that so when the Department publishes its viability assessment, there will be no surprises and that basically were Congress to take the viability assessment and turn to NRC and ask what's your view on the performance assessments, the designs, the estimates of the costs for the regulatory process to complete the repository development, whatever our answer would be would not be unexpected to the Department.

Thank you.

COHON: Thank you.

All right. Gary Vesperman. Mr. Vesperman, before you start, let me just say we did, of course, receive your written submission yesterday. We've not had a chance to study it. Is there something you want to add to that written submission or is--

VESPERMAN: I thought I would give you a short progress report and ask you a question.

COHON: Okay. Please do?

VESPERMAN: Very briefly, there's a new technology developed by Fusion Information Center up in Salt Lake City. --50 per cent reduction of radioactivity can be achieved in--and appear to many elements not previously present in the sample. We expect to receive a contract from the DOE for about $2 million. It's supposed to be in in a few weeks. The process has been demonstrated at the Idaho National Engineering Laboratory. We expect a total ultimately of somewhere around $100 billion worth of application for this fundamentally new technology.

The question I have for you is now that Yucca Mountain is technically obsolete and we can save billions of dollars of tax money to shut it down as soon as possible, when can we have a public meeting to discuss how and how quickly we can shut down Yucca Mountain and put the money over to developing this new technology?

COHON: We will take that question under advisement. I'm sure this room is filled with people from DOE who would like to answer that question, but because the hour is so late--I'm sorry, I don't mean to joke. You raise a serious question. It's now one that I can answer. I doubt that anybody in the room is prepared to answer. The first part of the answer, of course, would be start with your premise and that would take quite an effort, I think. The starting point for that is to read the submission you gave us yesterday. We have not had a chance to do that.

VESPERMAN: I understand that. I have a few copies of my written comment I submitted yesterday. If anybody would like to have them, come and see me. By the way, do any of you have questions about this new process?

COHON: If people do, I'm sure they will seek you out. Thank you, Mr. Vesperman.

That concludes the list of people who signed up. Is there anybody else who feels a burning need to make a public comment noting how late it is? Mr. McGowan, I'll tell you what. How about if you and I talk privately? Oh, wait a minute. There's someone who hasn't talked yet. Shlomo Neuman has a comment.

NEUMAN: I am Shlomo Neuman, expert elicitation panel on the unsaturated zone. A very brief comment regarding Parvis Montazer's questioning of the 50 millimeter per year upper bound that I came up with. I had a discussion with him outside just a few minutes ago. We disagreed in the beginning, but I think that we now agree that it is an upper bound.

COHON: Would you care to nod your head or shake your head either way, Parvis?

MONTAZER: No, I'll pass.

COHON: Neither way, okay.

Mr. McGowan, by all means, don't be offended if people start walking out because it's way past the lunch time, but go right ahead. This is Tom McGowan.

MR. MCGOWAN: God bless you, sir. I wouldn't care to let more people than this hall under my bed. But, they are a very nice crowd. You're aren't many, but you are few.

In minuscule rebuttal and I feel it's obligatory to Dr. Abe Van Luik's excellent presentation. I mean that sincerely even though it was written by who, Matthew Fox, that's quite all right. You liberally abstracted from that tome, I'm aware, as you admitted frequently. Perhaps, characteristically--and I believe Mr. Van Luik is with the DOE. So, there's an enormity of training in that regard. You happened to omit direct reference or elaboration on the essential fact that you were referring predominately, if not entirely, to natural background radiation and never once mentioned artificially produced radiation which is what we're talking about and agenda itemized and/or the reason for the production of it in the first place.

Thank you very much, sir.

COHON: Thank you, Mr. McGowan.

With that, in closing, I just want to thank the staff of the Nuclear Waste Technical Review Board for all of their hard work. In organizing this meeting, I wanted to single out Linda Hiatt who got us here, Helen Einersen who took care of us here, and especially Victor Palciauskas who organized this meeting did an outstanding job. It was really a super effort. Thank you all. See you next time, somewhere/sometime.

(Whereupon, at 1:15 p.m., the meeting was adjourned.)

LL