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NWTRB PANEL MEMBERS PRESENT

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Dr. Patrick Domenico, Co-Chairman
Hydrogeology & Geochemistry Panel

Dr. Donald Langmuir, Co-Chairman
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I N D E X

P R O C E E D I N G S

DR. DON DEERE: Good morning, ladies and gentlemen. Thank you very much for coming a little early. Clarence Allen will not be with us this morning. He asked me to go ahead and handle the ESF Alternatives Study. The little introduction that I read yesterday applies to this study primarily and I will ask Ted Petrie of DOE to please introduce your presentations.

MR. PETRIE: I just have a couple of opening remarks. When I said I would be brief, I meant that I'd like to introduce myself. I'm Ted Petrie, Acting Director of the Engineering & Development Division at DOE. This morning we're going to bring you up to date on what's going on on the exploratory shaft facility, the alternative study, and how we're going to proceed into the resumption of design.

Since we last got together, we've made progress. In December, Sandia submitted their findings report to the project office for acceptance. We completed our review of that on January 5, provided a revised report to the project office on January 9, reported to RW-1 through John Bartlett on January 14, and then he provided his action guidance for how to proceed on February 12. So, we'll be talking about the things that occurred during this period plus what we plan to do over the next few months.

We have a slight change in the agenda. We're starting a little bit earlier, as you mentioned earlier. And Lee Merkhofer will be talking, speaking, rather than Paul Gnirk, and other than that, it's pretty much the same. So, we'll try to get you out of here about noon time. And, with that, unless there's a question, why, Lee, you're up.

DR. MERKHOFER: Thank you. You'll recall that the last time that we gave you a presentation on the ESF alternative study, we had literally--actually, just the night before--obtained the last inputs that we needed to conduct our analysis. We worked, then, over that weekend to produce a preliminary ranking of our options that we were, then able to present to you the next day. Obviously, at that time, we had not yet had the opportunity to go through and really understand the basis for the ranking and we hadn't yet conducted the sensitivity analysis that would enable us to better understand what some of the key drivers were, what some of the features of the options were, that were most important in determining how that ranking came out.

So, the main purpose of my part of the analysis is to bring you up to date on the work that we've conducted since that point in time. Specifically-the sensitivity results. And then, as Ted indicated, we'll follow that up with: a discussion of some of the findings that come out of the

studies; some insights; and a report on where DOE is now with respect to a decision.

So, I'd like to, in order to begin, give you a quick recap of the methodology underlying the study. This is a slide that you've seen several times before. It lays out the major components of the analysis. And, it starts over here on the left hand side in which there were three parallel activities that began the study. Options generation, you'll recall that for the purposes of the study an option is defined as an ESF configuration of physical layout plus a structured method, plus a compatible repository configuration. So, an ESF option is really a combination of an ESF and a repository. Option generation consisted of considering some historical options, plus a number of new options that were defined to encompass or reflect some of the concerns and comments that have been made by you folks. Some options reflect some concerns and comments expressed by the NRC. Those are put into a hopper and then screened down to a set of 17 that reflected: alternative means of accesses, ramps versus shafts, alternative location of accesses; alternative locations for the MTL; and alternative excavation methods.

You'll recall that midway, then, in the course of the study we then expanded our list of 17 options to a total of 34. What we did was, essentially, come up with two

versions of each option, one of which emphasized early access to Calico Hills, the other which emphasized early access Topopah Springs. So, we went into the comparative evaluation with 34 candidate options.

Meanwhile, there was a parallel effort involving looking at requirements. Some 2500 requirements were analyzed to identify about 250 that were considered potential discriminators for the study. And, those 250 then became important inputs to the design of the methodology.

The design of the methodology involved: coming up with an initial design; conducting a pilot study to test that design; and to refine it; and then the refined methodology became the basis for the comparative evaluation which was conducted along with a number of supporting analyses and information that was developed. That produced a ranking of the 34 options. And then, based on the sensitivity analysis and other insights generated from the analysis, we've now proceeded to a set of findings. And I mentioned to you that Larry Costin will describe the findings and I'll talk about the comparative evaluation and results of the sensitivity studies.

Just to recap what the comparative evaluation consists of, you'll recall that it really consists of just two major components. The first was identifying the impact of the

selection of the ESF option on subsequent or down-stream uncertainties; namely, decisions that are made by other parties. And, we represented those in a decision tree. Here's the decision tree that was developed for the analysis. The down-stream uncertainties that are listed here are, first of all, something we call programmatic viability. That is essentially uncertainty over whether the program would be viable long enough to enable us to get to the characterization stage. So, two possibilities were represented. One is we get to characterization, the other is that the program would be terminated prior to characterization.

The testing stage is divided into actually two separate stages, what we called early testing. So, the suite of tests representing early tests were identified. Two possible outcomes there; one is that the data is collected when analyzed which suggests that from a technical standpoint, the site looks okay. The other possibility is that the site is not okay, in which case the assumption in the analysis is that it will be abandoned. The same thing for late testing, two possibilities that the site seems to be okay versus it's not okay. If both early and late testing indicate the site is okay, it's assumed that a license to construct and operate the facility would be sought. That, of course, could either be approved or not approved. If it's approved, the final

uncertainty we get to is whether or not we would be successful in closing the repository with the waste or that it would be necessary to go ahead and retrieve the waste.

So, these uncertainties define six possible scenarios and the purpose of this part of the analysis was to investigate how the choice of the ESF option affects the relative likelihood of each of these six scenarios taking place. And, that was accomplished by assessing the impact of the choice on the probabilities of each of these key down-stream uncertainties. So, that was one part of the analysis.

The second part of the analysis consisted of answering the question of how does the choice of the option affect the end consequences? That is, what would actually finally occur depending upon which of these six scenarios end up actually occurring? So, for example, the top scenario, the one we labeled Scenario A on the previous slide, is the only one that results in a functioning repository and one of the questions there, of course, would be how does the choice of the ESF option affect the releases that one would expect to occur from a closed repository? And, at the same time, our analysis had to look at what the effect of the option was on the consequences of each of the other five possible scenarios recognizing, of course, that the scenarios that result ultimately in abandoning the site, the consequences that are

relevant for each of those scenarios, depend upon how far you got before you had to abandon. So, for example, for the scenarios that resulted in abandonment before construction of the repository, we'd consider the consequences of the ESF only. Whereas, closure and retrieval would have to reflect not only the ESF, but pre-closure impacts of the repository and even the retrieval or the post-closure releases depending on which scenario was relevant.

Okay. In terms of, trying to or, measuring the relative value of the options with respect to end consequences, the approach used is multi-attribute utility analysis which we've heard a lot about already. So, that involves looking at different attributes of each of these end consequences, and as you'll recall, we've defined a number of relevant end consequence attributes which are listed here, eight all together. One that reflects post-closure impacts, so that would be relevant to Scenario A. And then seven others that reflected such things as: impacts on pre-closure health and safety to workers and members of the public looking at both radiological safety, as well as accidents and injuries; environmental impacts of the ESF and the repository; and cost impacts. We have under cost both direct costs of the ESF-repository combination, as well as, indirect costs. And indirect costs are there to reflect the impact on the

schedule. The fact that ESF options, all other things being equal, ESF options that produce the shorter schedules are preferable.

This slide is another one that we were able to present last time. It shows the complete table of the end consequences, that is the attributes of the options that were estimated for the multi-attribute utility analysis. And, as you can see, what we tried to do in the study was define these attributes in a way that was as unambiguous as possible. So, we came up with direct measures as well as we could. So, for example, releases are measured in terms of the fraction or multiple of the release limit established by the EPA standard. For example, radiological impacts to workers and the public were measured in person-rem of exposures and so forth. So, we tried to come up with measures that were unambiguous to reduce the ambiguity and the uncertainties that we would get from the discussions by the various expert panels.

As in a typical multi-attribute utility analysis then, in order to combine those things, these various measures, we had to come up with a set of weighting factors. Another advantage of defining the measures for the multi-attribute utility analysis in terms of real items, items that have units attached to them, is that it enabled us to rely on other value judgments that have been made in other applica-

tions to help us pick a set of weights that were reasonable. The weights were, as you'll recall, assessed from a panel of DOE managers; however, the managers were provided with a lot of information regarding other kinds of weighting judgments or value judgments that were relevant. And, the weights, as you can see, for the most part, we were able to find some references to insure that the weights that were assigned were not inconsistent with value judgments and weights assigned to other applications.

I should make one other point. John Lathrop mentioned yesterday that one feature of multi-attribute utility analysis is that whereas in an abstract sense it enables you to convert apples and bananas and whatever to a common unit, utiles, that you also have the capability in a multi-attribute utility analysis to express utiles, that is the overall figure of merit that you're calculating, in terms of any other measure that's used in the study. And, since cost is one of our measures, we were able then to assign weight in such a way that we reflected utiles, this figure of merit, in terms of an equivalent economic benefit or equivalent economic cost. So, rather than see things expressed in terms of utiles, we're also able to express them in terms of an equivalent net benefit, either an equivalent social cost or a benefit measure, which allowed us to get

something that was a little bit more intuitive than just--use something a little more intuitive than just utiles.

I should point out this slide, I realize, is just a little bit different than the one that's in your packet. The one in your packet was an older slide and this one updates and corrects some of the numbers. But, again, the idea was for each of these scenarios, we have a set of consequences estimated. The weights that we showed you were then used to convert these consequences, things like releases, miner fatalities, person-rems of exposures and so forth, to an equivalent economic cost. Obviously, the scenarios that result in abandonment of the site have net benefit estimates that are negative because nothing but bad things happen. Whereas we had to distinguish this top scenario, Scenario A, the one that results in a closed repository, saying there's a real benefit to having a closed repository. So, at this stage in the analysis, we added what might be thought of as a somewhat arbitrary, large, positive benefit, namely $50 billion to say we've got to recognize that Scenario A really is better than the other scenarios, but it's a sign of benefit to having a closed repository and at this stage we said let's arbitrarily call that $50 billion. And, you'll recall that we were able to show that the magnitude of that "benefit", whether it's $50 billion, $100 billion, or whatever, really

didn't affect the ranking of the options very much, so long as we assume that there was a benefit large enough to justify all of these costs that were involved. In other words, the benefit of having a closed repository warranted the costs, both economic costs and the adverse impact, associated with developing a repository.

Al, did you want to make a comment?

DR. STEVENS: Would it be beneficial to point out which numbers on that figure changed compared to what they have in there?

DR. MERKHOFER: Oh, I'm not--Phil can probably tell us that. Phil provided the output. I think what was going on was almost all of them changed because--

DR. STEVENS: All of them, okay.

DR. MERKHOFER: The earlier slide, the slide that's in your packet, was one that was produced under an earlier set of cost estimates. Probabilities were the same. Yeah, there was also a mistake, a typo, in which I think your version has a minus sign there. It's obviously not a minus.

All right. So, that enabled us to completely quantify this decision tree and then the basis that we used for ranking, comparing and ranking the option, was the expected value of the tree that's associated with that option. So, in other words, we took each of these end consequences,

multiplied them by the probabilities of reaching that point in the tree, probabilities of the scenarios. So, we weighted the consequences by the probabilities and added up the result at the expected value--the net expected, the best bid from selecting that option, and that expected benefit was the measure used for ranking the options.

DR. REITER: Lee, one change is you have a benefit to abandonment that was not in our slide.

DR. MERKHOFER: Yes. I talked about that last time. There's a question here of what is the benefit outside of these measures, these consequence measures that have been defined? Obviously, there's a big benefit to having a functioning repository. It was also postulated that there may be some benefit, in the event that you have to retrieve waste, of ending up in a situation where all of the waste is located in one fixed spot at Yucca Mountain. So, we said there's a big difference. If there is a difference between this abandoned scenario and the other abandoned scenarios, the difference is the wastes in all these scenarios is still at the reactors. The waste in this scenario is at Yucca Mountain. There may be some benefit or perhaps some cost associated with that. To explore whether that consideration had any effect on the ranking, we also arbitrarily assigned a value here in this particular base case analysis. We said

let's arbitrarily say it's worth $2 billion to have the waste at Yucca Mountain. We also did a sensitivity analysis to this particular assumption, varying it across a wide range of positive and negative values, and also showed that had no bearing, whatsoever, on the ranking. Thank you.

All right. So, that was the logic. Here is the ranking and this is--I believe, this is exactly the same as what we showed you before in ranking. Option 30 is at the top. We've talked about what Option 30 was last time. It's an option with the ramps and the tunnel boring machine and involves a relatively large amount of exposure of rock, especially in the early stages of testing, and all those are features that are reflected in the analysis as being beneficial features.

I think we also pointed out last time that the options at the very top of the list are what we call twins. Again, the way we assign the numbers here that--the option numbers that are 17 units apart reflect the two versions of the same physical configuration, that is the version that involved early access to Calico Hills versus early access to Topopah Springs. So, you can see at the top that we have 30 and 13. We have 23 and 6 and we have 24 and 7 and so forth. So, evidently, the testing strategy was somewhat less important, although we do see a difference in the ranking

regarding the various testing strategies. That the configurations had somewhat more of an effect on the ranking than did the different testing strategies.

Okay. What drives this? Probably--well, before I get to that, let me remind you about how we did the sensitivity to these arbitrary estimates of what it's worth to have a functioning repository. Remember, I said for the purposes of those numbers on the previous slides, we arbitrarily assumed having a functioning repository was worth $50 billion. This is the sensitivity analysis to the benefit of the functioning repository wherein we varied this $50 billion amount over a wide range and you can see what we've done is plotted the expected net benefit of several of the options as a function of what we assumed the benefit of having a functioning repository is and you can see fairly clearly here that as long as that value is large enough to warrant doing work in the first place that the ranking of the options stayed the same. The relative difference is spread out as you get further along the line, but the ranking really wasn't sensitive to that.

Okay. What drives that? Well, I think it's pretty easy to see from this slide here what really is behind that ranking. What we've done here is plot in the estimated or the computed expected net benefit for each of the 34 options which

are shown along here and then, on the same slide plotted, as a bar chart, the probability that that particular option would produce a closed repository. That is, the probability of Scenario A in the tree. And, what you can see very clearly from this is that the ranking of the options with respect to net benefit is virtually identical to the ranking in terms of the probability of achieving a closed repository. So, what this says is, of the two components of our analysis, the MUA that worked on consequences, and the decision tree that looked at the probabilities of the six scenarios, it was really the decision tree part that dominated the results.

Now, there's a good and a bad side to that. The good side to that is that, it's always nice when you've conducted a large analysis that involves a lot of factors, as this one did, to find out that only a subset of those factors were really dominant. That enables you to focus your attention on that subset. The bad side, of course, is that estimating probabilities--again, the way we got these probabilities was to estimate individually the probabilities of each of those events, programmatic viability, regulatory approval, and so forth. Probability assessment is a very difficult thing to do. Now, again, we spent a lot of effort making that process as simple and as liberal as we possible could. As you recall, we used expert panels composed of

individuals selected for their expertise in each of those areas. We had the panels develop influence diagram models that laid out all of the considerations and factors that were considered to be relevant in estimating each probability, such as the probability of regulatory approval, what were all the factors, all the features of each option that might be relevant in making that assessment. We had our panel members rank the options in terms of each of those features. So, for example, one of our influence diagrams for testing had testing interference as one of the factors potentially relevant for judging the effectiveness of the testing program. The panel members were required to rank the options with respect to the potential for testing interference, as well as, all the other considerations that were reasoned to be potentially relevant in estimating that probability.

The purpose of all this, of course, was to obtain the necessary understanding and background to enable this difficult task of assessing the probability to be able to be conducted. We trained our subjects in probability encoding. We ran them through a training session. And then, finally, I think perhaps the most important thing that we could say about this is that, in estimating probabilities, our panels, of course, found it quite difficult to know exactly what the probability number should be for a given option. In other

words, in Option 17, should the estimated probability of that option for, let's say, regulatory approval be .5 or .6? There was a lot of uncertainty there.

On the other hand, what's really important for this analysis is the relative judgments. Our panels found it much, much easier to reach the conclusion that Option 17 is a little bit better, that is a little bit more likely to result in regulatory approval, than let's say Option 12. So, it was relatively easy for them to say whatever the difference is, I know the probability for Option 17 ought to be higher than Option 12. I'm not so sure whether the probability for Option 17 ought to be .5 and .6. So, I think we were helped out there a little bit, but these relative judgments were much easier to make than the absolute judgments.

This is just a set of numbers to show you how the probabilities come together to produce the overall probability of obtaining a closed repository. And, so again we've got the five different uncertainties that are represented in the decision tree. The overall probability of Scenario A, the closed repository, is just the product of those five numbers that are shaded in in each column, the particular option that has the best, that is, the highest, probability in each case. And, you can see that Option 30, which has the highest probability of obtaining a closed repository, is really the

result of having relatively good probability estimates for each of the five measures. None of the options really dominates in all categories.

You can, also, point out from this a number of other interesting features. The various probability estimates for the various options against programmatic viability varied, the most, from a high of .9 to a low of .45, so that there was a delta of .45 units there. That one really is the particular estimate that varied the most from option to option. Some of the others varied very little. For example, the probability of closure was estimated to be very high for all options. The probability of obtaining a closed repository varies from, as I said, a high of 60% chance for Option 30, and the low here was .19, 19%, or a little less than one chance in five.

So, what's going on is we have an analysis that has concluded that these options really do seem to differ quite significantly in terms of the likelihood that they would produce the one scenario in the tree that has a sizeable positive benefit in a closed functioning repository. And, that dominates, by far, the small changes, relatively smaller changes, that were seen in the specific consequences that result from any one of those six scenarios.

Do you have a comment, Warner?

DR. WARNER NORTH: Just I think it might be useful to

remind everybody exactly what programmatic viability and approval are and where those judgments came from.

DR. MERKHOFER: Yes, I'd be glad to do that. You're anticipating the story. From this point on, it's just going to get stronger with regard to the importance of programmatic viability. Once again, programmatic viability is a term we use to describe the uncertainty over whether or not the entire program would remain viable long enough to enable us to begin characterization testing. As in the other assessments that went into this analysis, the process of generating the programmatic viability numbers involved developing, number one, an influence diagram that identified a whole slew of considerations and factors that were deemed relevant by our panel for influencing or potentially impacting this likelihood of programmatic viability. And, some of the key factors that were identified as potentially relevant were such things as: the near-term costs of the effort, were they high or low; the extent to which the design was similar or dissimilar from the base case; an estimate of the potential for schedule slippage associated with the option; an assessment of the extent to which the option appeared likely to respond to concerns that have been expressed by this group; the extent to which the option seemed responsive to concerns expressed by the NRC; the ability of the option to support a testing program that would

result in a low, what we call, the residual probability of--a real problem with the site so the probability that the site is, in fact, really not okay even though your early and late testing said it was okay; and, finally, an assessment of the degree to which the option seemed to be very clearly responsive to regulatory requirements and, therefore, would be likely to be approved. All the options, by the way, were determined to be consistent with regulatory requirements, although some of the options seemed to be more apparently so than others. So, there was an analysis conducted of the options in which each option was assessed against each of those major critical factors that I mentioned. Those assessments, those analyses were then provided as input to the programmatic viability panel. The panel then ranked the options with regard to all of those factors simultaneously and then, finally, took that ranking and converted it over to a set of probability numbers.

There were some additional wrinkles that I mentioned last time, and I'll mention them again here, involving the fact that we had one panel member from our seven in programmatic viability who did not agree with the majority regarding what the probability assessments might be and I'll go back again and show you what the implication of that is. But that, Warner, was the process we went through.

DR. NORTH: Remind us who the members of the panel were for that?

DR. MERKHOFER: Ted, you can probably do that quicker than I can.

MR. PETRIE: It was Steve Brocoum, Ted Petrie--the members of the panel, as I recall, were myself, Ted Petrie, Steve Brocoum, Max Blanchard, Tom Blejwas, Tom Hunter, Tom Isaacs, and Carl Gertz. Did I forget anybody? That's my recollection of who they were.

DR. MERKHOFER: Just one other interesting way of looking at this to help clarify what is going on that we were not able to show you last time. The tables that I have been showing you regarding both the consequence estimates and the probability estimates show only one of several numbers that were elicited from our expert panel. They were what we called our best judgment estimates. They really reflect what we interpret to be medians of probability distributions reflecting the uncertainty in those quantities. So, many of the assessments we were making really represent uncertainties in the minds of the expert panels and we asked them not only for their best judgment values, but also for high and low values and competence ranges that enabled us to construct probability distributions to represent the uncertainties in those judgments.

In addition to this, what you might call, deterministic analysis that I've just been presenting, we conducted a probabilistic analysis where we explicitly investigated the magnitude of these uncertainties and what the implication of those uncertainties was for the way these various options looked, the gambles in a sense that we're facing by choosing each option. And, we've displayed here two of the options in the form of cumulative probability distributions. Okay? And, the way these read--I'm sure most of you are familiar with them--is the height of the cumulative probability distribution shows the probability that the actual, in this case net benefit, that's produced by the option will be less than or equal to any value or the corresponding value on the X axis. So, you can see what's happening here. First, they look kind of strange, but if you think of it, you can figure out what's going on. Only one of the scenarios again produces positive benefit.

So, the probability--let's take Option 30 here. The probability that that option will result in a net negative benefit is really just a probability that you don't end up in Scenario A, the one that results in a closed repository. We said earlier that that probability was 60% that you'd end up with Scenario A. So, there's a 40% chance that you end up having to abandon the repository. And, the detail in the

curve down here shows the varying losses that might result depending upon exactly what stage in that process you find out you've got a bad site and you end up abandoning it. On the other hand, the detail up at this end are the various levels of consequence that could occur given that you've got a closed functioning repository. They're a function of such things as the uncertainly over the releases that would be produced and the uncertainty over level of magnitude of environmental impacts and health and safety and so forth.

So, what is happening is, although we're seeing in the figure of merit the expected value changing from option to option, what's really going on primarily is this point on the curve where this plateau occurs is moving up and down depending upon how likely that option is to produce the closed repository. So, it makes it very clear that there's a tremendous uncertainty over exactly what's going to happen depending for which option you get and really this is depending tremendously on which option you get. At the low end is the possibility that you don't get a functioning repository, the high end is that you do, and all you're really able to vary here, to a significant extent, is the likelihood of can you close the repository.

Okay. Some of the key sensitivity results, probably the most important one that we ran was in a few cases our

expert panels were unable to reach complete consensus regarding the recommended inputs to our analysis and what we promised our panel members was whenever we could not reach a complete consensus, we would carry on through the analysis a minority report and run the analysis with minority reports, as well. This slide summarizes the cases in which we could not get complete consensus and the key one is the difference between, again, the programmatic viability estimates provided by the majority of the programmatic viability panel versus the estimates that were provided by one individual who had a fundamentally different view than the majority.

This one individual really differed in two primary respects. One was whereas most of the panel members felt that all of those factors that influenced programmatic viability, that I just mentioned a little while ago, were of importance, this one panel member said that it was really the potential for schedule slippage that was the key driver. So, he tended to discount all of the factors except for the impact on schedule, number one. And, number two, he had a very different view as to how likely it is that the program would make it through to characterization testing. For many of the options, this individual said the probability is essentially 1. He didn't see any way in which the program would be cancelled prior to beginning the characterization testing.

And, when you compare the rankings produced using this minority view on programmatic viability with the majority view, you do see that there are some substantial differences.

The other minority reports had to do with different views on testing, how testing would be affected by the different options, and the extent to which the options looked at, more or less, rock, and some different views on retrieval. We also did a sensitivity as to whether or not the net benefit of the options should be computed assuming just aqueous releases versus the case where we considered both aqueous and gaseous and there was a different view, another view, expressed regarding the testing probabilities. All of these other minority reports really produced very minor changes in the ranking. The only one that switches the top ranked option, as you can see, is one of the minority views on testing. This is early false negative potential and it doesn't change too much, as you can see. Option 30 then drops to fifth place and 23 which is second place becomes first place. So, it's really the programmatic viability where all the action is.

Here's some additional sensitivities again focused on programmatic viability that is, by far, the most exciting one. What we've done here is shown in the square boxes the expected net benefits computed using the best judgment values.

As I mentioned, all the panels, including this panel, were asked to provide both high and low estimates. And, the length of the bar here or the bar reflects what happens to the computed net benefit when, instead of using the best judgment values, you plug in these extreme values, the very high values and the very low values. You can see from the fact that the lengths of the bars are actually different for different options that the panel on programmatic viability felt that some of these options involved a little bit more uncertainty than others. Some of them just were inherently more uncertain with regard to the programmatic viability. And, so you see that if, for example, you use extreme high estimates for probability of maintaining viability, you get a different ranking. In fact, that's part of what's behind the fact that Option 30 in the view of the minority, that one individual, was not necessarily the best because he tended to be higher on the first one.

There's two ways of interpreting this, of course. One is that what this says is suppose--let's say, suppose Option 30, the best judgment value, really is a pretty good value. But, suppose for Option 15 we really were at the extreme. So, conceivably, it's possible that Option 15 really is better than Option 30. However, it was the consistent view expressed by our panels it was very, very unlikely that if the

panel was way off, that is either very low or very high on their estimate, that another option would be off in the same direction. So, it was felt much more likely if, for example, the panel tended to be low on their estimates of probability of programmatic viability that they were probably uniformly low on all options, not just on one. The reason for that is much of the uncertainty associated with these estimates is associated with factors that would affect uniformly all of the options, not just one option. But, I think it is fair to point out that because of this very large uncertainty range, it is essentially possible or it is possible for, actually, the lowest ranked option to turn out better than the best ranked option. That is possible, but again unlikely because of the fact that these uncertainties are probably very highly correlated.

I should make one other point that I forgot to make earlier and that is what is the magnitude of the differences among these options? I'll just say something about that. Again, this is the table that shows the end result, the expected net benefit computed to the various options. The highest, again, was about $24 billion. The second highest, here it is, $23 billion. So, they differ by about $1 billion in equivalent net benefit. And, that actually is a fairly large number. What that implies is if all the inputs that go

into this analysis are correct, if the weights are correct, then it ought to be the case that the preference for the number one ranked option over the number two ranked option is the same as the preference that would be established for two identical options except for the fact that one costs $1 billion less in current dollars. And, Warner might want to comment on this, as well. But, certainly, my experience is that in decision analyses of this sort, that's a pretty big difference. We're talking about roughly 4 or 5% of the total value of this venture as being the difference here. One is about 4 or 5% higher. So, you've got to weigh two things in interpreting results. One is that a fairly large difference has been identified among the options, but the second is that due to uncertainty, especially in programmatic viability, this tremendous uncertainty as to exactly what this benefit it. So, we've got a big difference, but at the same time we've got a lot of uncertainty.

DR. NORTH: Lee, isn't that almost entirely driven by the difference in the probabilities? Think of a 2% chance is the difference between your first and second times $50 billion, that's $1 billion in round numbers is what you've got.

DR. MERKHOFER: That's true. That's true. So, again, it comes down to these assessments of probability. There's about two probability units here difference and that's almost--well,

it's a little bit more here. Some of the--

DR. NORTH: So, if you can distinguish the .60 as 2% higher than .58, that drives the evaluation as coming out $1 billion higher for Number 30 as opposed to Number 3.

DR. MERKHOFER: That's correct. So, again, what you have to consider is the ability of the panel members to make distinctions here on the order of reviewed percentage units recognizing that there was a fair amount of confidence on the part of the panel members that they could distinguish one as being better than the other one. The more difficult task was how much better and quantified that number as fairly small.

DR. NORTH: Have you got a slide that systematically goes through the pairs? For example, I believe 30 and 13 are pairs. And, if I looked at your sensitivity slide, I notice that there are--if we go to the minority view for program viability, instead of 30 being one, 30 drops to 21st, and 13, the twin, goes to the top.

DR. MERKHOFER: Right.

DR. NORTH: I haven't looked through systematically to see what happens in some of the other cases in terms of the relation between the pairs. Have you done that?

DR. MERKHOFER: You're saying with respect to the different opinion regarding programmatic viability?

DR. NORTH: Yeah, and I'm looking at the situation where

you're comparing the early exploration of the Calico Hills versus early Topopah Springs. And, how does that relate to program viability?

DR. MERKHOFER: I think again we can easily do that. Probably the most effective way of doing that would be to look at the input analyses that were provided to the panel. So, the judgments regarding what's the potential for schedule slippage in each case, what are the cost differences, and so forth--

DR. NORTH: Yeah, what I'm leading to is I think, given how important program viability is, it would be useful to see the reasoning and some of the differences in opinion that led to the differences in the numbers. I mean, you explained the minority view on program viability, your second column in that sensitivity table, but it would be interesting to look at a number of issues, such as the Calico Hills first versus Topopah Springs first and see what impact those differences might have had.

DR. MERKHOFER: Yes. Obviously, that's a very interesting--

DR. NORTH: What I'm leading to is I think a number of us on the Board have the concern that maybe if you went back and iterated again and looked at alternatives that combine some of the best features of those in your top six, you might wind up

with something that's better than anything you have on the slide here for reasons that could be relatively easily identified.

DR. MERKHOFER: Yeah. Again, that is something that's coming up in one of the later presentation.

DR. NORTH: Fine.

DR. MERKHOFER: So, that last little arrow that went from the 34 of the ranking to the findings will involve discussion of what is the DOE's position on what this option ought to look at.

DR. NORTH: Well, it seems to me that a very important question here is what have you learned from all of this? And, these assessments, after all, were done many months ago and you've had the advantage of seeing all the insights to come out of this and it ought to be possible to go back and re-examine the alternatives with those insights in mind.

DR. MERKHOFER: Yes, and we're going to get to just that point. Let me, because it sounds as though you've pretty much figured out how the story goes, go through these other pretty quickly. Just to indicate that the only other factor that had a significant uncertainty and sensitivity associated with it was the output of the regulatory approval panel. Uncertainty probability of each of these options would--the option would be approved--

DR. NORTH: Now, let's review again where those judgments come from.

DR. MERKHOFER: Same kind of thing. There was an expert panel established for regulatory approval. That panel developed an influence diagram that--

DR. NORTH: Who were the members of that panel?

DR. MERKHOFER: Al, do you have that information of who the specific members were?

DR. STEVENS: They were technical people and not management people. You're looking at one of the parties of that panel. There were representatives from several different organizations including folks from Headquarters and their support contractor, Weston. I can provide you with a list of those names if you're interested in them, but it was a broad spectrum of people, largely people who have been involved in the program for a long time and were aware of a whole range of sensitivities and especially, as indicated in the influence diagram, procedural regulatory requirements, in addition to the fact that in that influence diagram, it shows an accounting for technical assessments that were made by the technical panels. The postclosure panel, the postclosure performance panel, the testing panel, and there was a third technical input.

DR. MERKHOFER: Preclosure impacts that were input--

DR. STEVENS: Preclosure impacts, yes. Postclosure impacts, preclosure impacts, and testing. So, that broad spectrum of factors were accounted for. So, what we're saying is that, for instance, in the testing panel, if you looked at their set of numbers, a ranking of the options, their range came out rather narrow, very narrow, compared to the program viability, for instance, as we're seeing. As an approval panel, we looked at that and in the judgment process probably expanded that a bit. So, you can draw two points from that. I think the panel paid attention to that rank ordering and maybe amplified it a little, but the second point is we gave --we did account for other technical matters. So, in some sense, there was dependence there in that process. The same for the postclosure performance. If you go back to Lee's earlier viewgraph, you see that the range on the postclosure performance probabilities or consequences were relatively narrow. We accounted for that. And, I think it's a fair judgment to say that we--in essence, what we did was expand that scale a little bit. This would say so.

DR. MERKHOFER: Perhaps. Again, the guidance that people got was to give their best judgment as not to either artificially exhibit a difference if they felt, in fact, a difference does not exist. In fact, many times in these panel meetings, I would tell people very explicitly, if you don't

believe there's a difference in these options with regard to this plan, let's say regulatory approval--if you believe there's no basis for concluding that this one is more likely to be approved than this one, by all means, do not assign a different probability number. So, the fact that a different number was assigned meant that there was a consensus view among all the panel members because there were no minority reports in regulatory that one option was better than the other option. And, again, probably it was more difficult to say exactly how much better in terms of probability units this one is than this one. And, even more difficult to say whether one ought to be a .6 or a .7, but very definitely if there's a difference in the numbers, that expresses an opinion that one option is better than the other option with respect to that measure.

DR. NORTH: I have another very broad question. I'm not quite sure how to focus this. Let me ask it in a very general way and encourage you to think about how to respond to it. And, this is basically the relation between the probabilities that you had on testing okay, given the early test and then the late test, with the two other task force exercises that we heard yesterday. And, it would seem there ought to be some consistency in the pattern given that your questions were different than theirs, but presumably quite closely related in

some dimensions.

DR. MERKHOFER: Well, realize, of course, though, that we were asking about the effectiveness of different testing programs and we weren't talking about the same suite of tests. As I understand it, the methodology was analogous to the methodology used in the VOI analysis in that the measure of the effectiveness of testing was developed by looking at a number of things; the likelihood that a testing strategy would produce false positive--that is a conclusion that the site is okay--it was not okay meaning, in effect, that you would miss a problem, what's the likelihood that you could miss a problem, the probability of false negatives both in the early stage and the late stage. So, the methodology was the same. The subject matter was different. And, I'm not sure because of the difference in subject matter you could draw too much more by comparing the result of it perhaps and missing something.

DR. NORTH: I think it would be interesting to go through with some of the material we heard about, especially about the multi-attribute utility analysis where we're looking at issues and features.

DR. MERKHOFER: Yes.

DR. NORTH: And, look at the alternatives that you were looking at using some of those same ideas to see if the

pattern you've got in your numbers is similar to the one that came out of the other exercise or if there's a significant difference. And, if there is a significant difference, trying to understand why that might be.

DR. MERKHOFER: Certainly, again one thing that could be done to help that kind of exercise along would be to go back and look at the evaluations of each option with respect to each of the factors that was regarded as influencing testing, such measures as the potential for test interference. Each of our individual panel members individually ranked the options with respect to that measure and other measures and perhaps that would give you a foundation for making that kind of connection.

Dave, do you want to make a comment?

MR. DAVE DOBSON: I just want to point out one thing. Dave Dobson from the Department of Energy. I think the numbers were comparable that were obtained by both groups, but as Lee pointed out, the question was somewhat different. And, in terms of the comparison with the MUA, it would be kind of hard to make that because the ESF group assumed a configuration for the testing that came from a recommendation for Calico Hills. So, they didn't consider alternatives that didn't go into structural features. Their options all had the same basic configuration and the same basic access to the

major underground features. So, it would be a little hard to directly make a comparison between the MUA and, similarly, the main test level and configurations of all the different--with a few exceptions. You know, Options 15 through 17, I think, which have the double layer repository or main test level were distinctly different. And, so you could make a comparison between those and the other ones, but there wasn't nearly as wide a range or a spread of accesses to features and things in sight. But, I do think, having talked to some--a lot of times, talking with people who were on both panels that the general range of numbers in terms of the probability of getting--probabilities of tests being accurate and the probabilities of getting false positives and false negatives, those numbers are pretty close.

DR. NORTH: Yeah, I think it would be interesting to look at it in more detail. As I said at the outset, it's hard to phrase the question properly given that the efforts were aimed at different questions, the methods used were significantly different, yet some of the issues being addressed are the same kinds of issues. So, I'd like to be assured that there really is some underlying consistency and, if there isn't, what can we learn from the differences?

DR. MERKHOFER: I understand that the other groups also developed influence diagrams and I've also been told, although

I haven't reviewed those, that those diagrams are very similar which would suggest, at least, that the panels considered the same factors as being relevant. You're shaking your head, John. That's not the case?

MR. LATHROP: The MUA did not use influence diagrams. The MUA analysis did not use influence diagrams.

DR. MERKHOFER: Okay. I know the VOI study did.

DR. NORTH: And, it seems to me also some of the issues that were dealt with in the MUA, particularly regarding scientific confidence and the implications of that in the regulatory process, you've brought in through program viability and regulatory approval. Again, it would be interesting to look at the similarities and differences in the analysis from that point of view.

DR. MERKHOFER: I agree.

Okay. If I may continue, although I've probably just given the impression that the analysis is sort of sensitive to all the inputs, the vast majority of the sensitivity analysis was more like this. Here's the one, sensitivity to the range of probabilities or the uncertainty over the assessment, the probability of closure. There's very little impact. The discounted indirect costs, indirect costs again reflect schedule impacts, uncertainty over schedule impacts. It doesn't really change things too much.

DR. NORTH: On the other hand, that would seem like an area where fine tuning might make some differences. That, to the extent that you can craft an alternative that does very well on the schedule, I think it suggests that shifts of a couple of places in the ranking might easily come out of that.

DR. MERKHOFER: Yes. There are always opportunities. I think one of the values of a sensitivity analysis, it gives you a sense for what the potential opportunity is to improve things. Once we got into that last stage, we've got the ranking. We don't want the best of 34 options. We want to come up with a good option that takes what we've learned about all 34 options and to that extent these sensitivity results will be very useful in figuring out where can things be twiddled in such a way that you can generally improve things without producing a cost and some other thing.

MR. BROCOUM: Dr. North, we're trying to do that, but we're trying to implement that in our design study which has started. And, you know, John Bartlett has issued guidance to Carl on how to proceed in which he's to come up with a design that--if I can quote, "designs should include features and options that enhance the utility and performance to the ESF and construction and should be based on the findings developed by the ESF Alternative Study." It's also based on the recommendations that came in the letter from Dr. Deere on

December 12 which had several attachments to it. But, we're trying to implement some of the suggestions you are making, but we are trying to do them in a design--pulling a design study at this point. That's how we're trying to actually implement that.

DR. DEERE: The thing that sort of impresses me, I guess, favorably is that all of these graphs--this is the one on--would you go back to the first one that shows the sensitivity analysis on probability of program viability and then just go through the four or five rather rapidly? All you're trying to do is point out that those top six values never seem to change and Option 30 almost always is sitting up there with a sort of break in the slope, the one that you have x'd there. And, the next five seem to be sitting there on a slight incline plateau and then we drop down. Now, if you could go to the next graph and in the next and in the next and in the next, it never varies.

DR. MERKHOFER: It was a setup there that tended to keep pretty close to, but qualitatively different than the others.

DR. DEERE: And, the next?

MR. PETRIE: Another point in the same area is that you usually notice that the first three go to Calico Hills early, the next three go to Topopah Springs early.

DR. EDWARD CORDING: And, they're for the same pairs.

DR. MERKHOFER: The same pairs. It's really three.

MR. PETRIE: Yes. So, where do you want to go first?

DR. STEVENS: Well, in fact, the record shows that in spite of the different strategy, each member of a pair supported getting to both levels simultaneously and that's where the real value lay.

DR. MERKHOFER: That's the key.

DR. CORDING: That's right. I think that the first three options got you there to either level a little earlier. Isn't that correct?

DR. MERKHOFER: That's the key and that's what we're going to talk about, things like that.

Okay. We have a number of other sensitivity slides that don't show much difference. This one was kind of--I want to show this one because it seemed confusing when we first saw it. This was the sensitivity to discount rates and you'll recall that the cost estimate was discounted at a nominal value, 10% per year, to reflect preferences for delayed costs, it's possible, I guess, or more likely voiding the large immediate costs. And, when we first saw this, it seemed that this is odd. We thought, gee, it looks as though the range, the sensitivity of the options, its net benefit to the discount rate, we observed immediately it was much higher for the top ranked options than it was for the low ranked options.

And, the first reaction was, well, is it the case then that the top ranked options tend to have large costs in the distant future that would be affected more by the discount rate than the low ranked options? It seemed very strange. So then, when we thought about it, we realized that's not at all what was going on or, at least, not exactly. It is true that the reason the top ranked options are more sensitive to the discount rate than the lower ranked options is because they have larger costs in the distant future. The reason that they have a larger cost in the distant future is because they're more likely to survive into the distant future. So, they're more likely to produce a scenario in which the repository is constructed and operating than are these. And, since this is what this is showing as the expected net benefit, that is rolling all of those six scenarios together. That's the reason we see this effect.

One other sensitivity study or somewhat of a sensitivity study that actually has proven quite useful for the process of going from the 34 options to a design strategy is the following. What we did was we correlated the ranking produced by the analysis, the overall ranking, with the individual rankings against--or the rankings against the individual factors. The idea being to see if we could get a measure, a nice, convenient measure, namely the correlation

coefficient, that would show us to what extent the overall ranking is consistent with the rankings against individual factors. Here are the results. Programmatic viability, the ranking against programmatic viability again is a factor whose ranking is most closely correlated to the final ranking and not surprising. Regulatory approval, number two. Repository closure, this is the probability of closure versus retrieval, number three. So, we have the three main factors in the decision tree being there near the top. Some of the other important factors are shown here, as well. The correlation coefficient, of course, the closer that number is to one, the closer the rankings are going to be. If the number is near minus 1, we have a situation where the rankings will reverse. With a correlation coefficient near zero, there's absolutely no relation, whatsoever.

DR. STEVENS: Lee?

DR. MERKHOFER: Yeah, Al?

DR. STEVENS: That's opportunity to make again that point that I made earlier. That, for instance, the regulatory approval panel relied on, in part, the input from the values below this, those listed below this.

DR. MERKHOFER: That's probably illustrated most graphically by #4. There wasn't much difference, go back to the slide, between the estimated releases, postclosure

releases, and the various options. They're also all estimated to be well above the EPA standard. So, in terms of the consequences, the MUA, this factor had very little bearing. On the other hand, many of the panels, or perhaps I should say several of the panels, believed that the estimate of releases would be an important indicator for particular measures they were concerned with. So, for example, the regulatory panel felt that, in general, those that were estimated to produce the lowest releases would also have a relatively higher probability rate for the approval. So, the reason that this factor comes in, even though it was not a sensitive factor at all with regard to the consequences in any way, is that it was regarded as being an important indicator to several of the panels including the regulatory approval panel and the programmatic viability panels. That's why we see the correlation there.

We also correlated the overall ranking with some of the specific factors in the influence diagram for programmatic viability. So, if we had rankings of options with respect to each of these factors that were regarded by the programmatic viability panel as being important for assessing programmatic viability and we do that correlation, we see that right at the top from your concerns, followed by NRC concerns--and again this--so, the judgments being made there is the likelihood

that the option would be or that the program would remain viable is somewhat correlated to the reaction of NWTRB and NRC, whether they judge that the selected option is consistent with their concerns.

Testing duration, late testing and early testing duration, also show up to be very important factors regarding programmatic viability. And, here's some others that weren't quite as important. But, again, this helps us in the design of a new option, of figuring out how to tweak the design in such a way that we come up with something that may be better than the 34 that we've got here.

DR. REITER: Lee, let me ask a question. I think Al or Larry said that all first three options shared the fact that they would get early in to either the Topopah Springs or the Calico. Given that, am I to conclude from that that the basic reason that came up because that was a TRB concern?

DR. MERKHOFER: No.

DR. REITER: I'm trying to relate that factor to these correlation coefficients.

DR. MERKHOFER: Yeah. Okay. That comes up--there are two sides to that equation. One is how quickly can the information be collected? And, as you can see here, this duration was a very important factor in the programmatic viability. Duration is also an important factor for other

elements of the analysis including some cost measures, particularly the schedule, the overhead or the indirect costs. So, those three options benefitted on the one hand by the fact things just get done quickly. Testing gets done quickly. They also benefit from the other side of the equation which is how good is the testing? And, those options that look at a lot of rock and provide you with a lot of information early do very well on all of our parameters that measured quality of the testing program. And, that's important not only because of the direct impact in a decision tree on the probability of getting an okay result versus not okay, they're also important because the measures of testing quality were regarded by several of the other panels as important inputs. For example, the regulatory approval panel regarded one of the measures out of the testing analysis to be very important, namely again this residual probability that you've got a bad site, even though you've tested. So, you've made it through early testing and late testing and you've got okay results, testing is not important. There's some residual probability that you've got a problem with the site. The good testing programs produce favorable values here. In other words, low probabilities of false positives/false negatives produce low residual probabilities if you have an error and therefore have good measures on that residual probability, therefore good

regulatory approval scores. So, what is going on here is that testing--seeing a lot of rock early helps you in a number of dimensions on this model, simultaneously helps you in a number of dimensions.

DR. REITER: I guess, I'm not sure how that equates to those having a low correlation coefficient.

DR. MERKHOFER: Well, I guess, first of all, I wouldn't say these are necessarily low. And, secondly, there's a complexity in the testing analysis again in that there were four separate measures that drove the testing evaluation, early and late, false positives and false negatives. Those four parameters were then used to compute more fundamental measures of the quality of the testing program, the primary one being the residual probability that you've got a false positive/false negative.

This slide summarizes the results of the testing analysis. So, again, there were a number of inputs, early false positives, late false positives, false negatives, early and false late negatives. There is also a prior probability that the site is, in fact, okay. It didn't vary too much from site to site. So, the key outputs for this residual probability is that the site is not okay, even though your testing says it is okay, the probability is in your decision tree that early testing will give you an okay result, the

probability that late testing will give you an okay result, and the combined probability. So, these are the measures that are of more direct importance to the ranking of the option and these measures tend to be relatively sensitive to these probabilities and particularly the false negative probability.

So, I guess what I'm saying is that it's not as easy to see, but I could give an argument. We've actually got three separate measures. Each of them are correlated with the final ranking. And, you really, in order to appreciate the importance or the benefit that's assigned to an option that shows you a lot of rock early, you have to simultaneously recognize that that option will do better simultaneously on all of these measures. So, you're really getting the benefit of all three of these correlations and not just one.

Okay. Just a quick recap on some of the conclusions or insights from the prepared evaluation alone. We can--Al Stevens is going to talk about those general insights. We were able to come up with a ranking of 34 options, although what we do find is there is significant uncertainties involved. The order was determined almost entirely by the likelihood of it being a closed repository, Scenario A, and this order was--with the exception of programmatic viability and perhaps to some extent regulatory approval uncertainty--relatively insensitive to the confidence ranges on the

judgments that were provided by the various expert panels. Programmatic viability again was the single most influential consideration in determining the rank order. And, the factors that were most influential, had the most influence on our programmatic viability panel in estimating the relative viability of the options, was the degree to which the option helped resolve TRB and NRC concerns and the duration of the characterization testing.

Then, finally, we look at the group of top ranked options, either the first six or the first eight. You'll see that they do sort of end up on a flat level. The reason for that is that they do do pretty well with regard to all of the key measures in the assessment. I can point out here that the releases--this happens to be the releases, aqueous only releases estimated--the top eight, all less than .001% which is 10^{-5} which was the same result with the--came up with roughly the same result, the same order of magnitude that the VOI analysis came out with. So, there was consistency among different panels there. The options all produced very low probability of accidents which, in turn, reduced the potential for radiological exposures during the preclosure stage.

And, finally, it's worth pointing out that the options were screened and all of the options appear to meet all of the regulatory requirements. So, in effect, I think

what we're dealing with here is for the most part a set of pretty good options. The analysis was able to discriminate to some extent. I'd say some of those options appear better than others, but again there's a lot of uncertainty associated with estimates.

I'd be happy to take additional questions or comments.

MR. PETRIE: Don, we were scheduled to take a break here. I would propose, though, that we let Larry make his presentation before we break if that's okay with everybody.

MR. JOHNSON: Don, can I ask a question?

DR. DEERE: Yes, please?

MR. JOHNSON: Carl Johnson, State of Nevada. Sorry for the raspy voice. I think I caught a cold at last week's DOE meeting.

Lee, could you put up the slide, it was summary of decision precalculations?

DR. MERKHOFER: This one?

MR. JOHNSON: No. The one with the table--it's the table with probabilities?

DR. MERKHOFER: This one, right?

MR. JOHNSON: Yes. My question is for Don. A high level waste repository is unprecedented, its impacts, potential impacts on public health and safety. There probably isn't a

construction project in history presently that approaches its potential impacts on public health and safety. If I look at that table and look at the probability of successful completion of the highest ranked option, and that is 60% probability, my intuitive gut feeling is that that is too low a number for a project that has tremendous effect on public health and safety. And, my question to you is, Don, from your experience in working on public projects that do have impacts on public health and safety--and the Chunnel Project is, I think, a prime example--from your experience, what kind of probabilities of success are calculated for other projects?

DR. DEERE: Well, frankly, we assume 100% success. We don't always achieve it. But, the probability of success from the viewpoint of being able to increase the length of time or increase the budget to get the job done, that it will come on-line, but it might come on-line late, it might come on-line more expensive, but they'll have a safe operating project. So, I think--well, the Channel Tunnel, for instance, it looked--a year ago, I think it would come in very late to the point that maybe the project wouldn't be viable because the money wouldn't be available to build it. It was a great, great concern, of course, just a little over a year ago, but they finally got over that hurdle and now it's going to come in on schedule. But, that costs them. And, so if the cost

overrun is measured in the billions of dollars--project costs now is $14 million. But, the idea that it will go ahead and be able to be completed safely and function safely, I think, was always a higher concern.

MR. JOHNSON: I think what I was getting to was initially when they were in the planning of the project and they had to go out and get money to build the project in the first place, they had to come up with some probability of success in the first place.

DR. CORDING: That's often not formally done.

MR. JOHNSON: Well, informally, I--I think it's done in all construction projects, whether it's formally or informally. Otherwise, you have a tough time justifying some of the costs--I mean, the funds required for these types of projects. What I was kind of getting to is if I was an engineer in a major utility and I was coming to the CEO and asking to--we want to build a nuclear power plant project and we think we have a 60% chance that we are going to successfully complete this project and bring it on-line, is that CEO going to commit $2 billion of the rate payors' or the shareholders' money based on that 60% probability?

MR. PETRIE: Don, could I try to help you with this one?

(No response.)

MR. PETRIE: This probability that we're talking--this is

Ted Petrie speaking. This probability is the product of about half a dozen probabilities, each associated with a gate the project must climb through. And, up to the point where you get to that gate, you expend a certain amount of capital. And, the question the CEO has really asked is do you wish to spend this amount of capital to get to the first gate? Once you've gone past that gate, the probability rises substantially from the 60%. If you get past the second gate, it rises substantially from that. And, well, as I said, there's many gates that a project has to go through. For example, going back to utility examination, one of the first things is that he has to get a site where he can put this thing and maybe he's willing to invest $100,000 to find a site. He is not really putting up his $2 billion on the first day.

DR. DEERE: Yeah. I think in the hydroelectric projects which are a little easier to site probably than nuclear reactors, there they go through the setting up of a whole number of alternative layouts and alternative sites and run through--I mean, how much water is available and how much potential head is available and immediately they've got a potential of how much money they can make over the year. And then, they start looking at different sites and running their preliminary estimates and so it's being refined over a period of, in some cases, five to 10 years. Because once they come

to the best layout and the best kind of dam and the best type of power plant, et cetera, then they've got to compare that with the new steam plants that they could put in or new gas turbine. So, it has to go through a whole series of checks. And, when those--I mean, I guess, every one of them has some probability that--but, when they get right down to the comparison, each time they're getting closer and closer that their project is going to do the job for a given amount of money. So, I would say when we get down to the money is committed for building, not for exploration--some companies or some utilities would spend a lot more for exploration than others might because they have other alternative sources. So, if the first cut doesn't look too good, they just walk away from it. But, if you don't have any sites left, you are willing to spend a lot of money and time to see if this bad site is good enough. And, so when you've finally committed, I think that your probability that they're looking at is--they're thinking certainly 99%.

MR. JOHNSON: Another point and that is that 60% number is also at least a hint as to the scientific or the confidence that the scientists have in completing this project. And, I'm certainly a little concerned from the scientific perspective we only have a 60% confidence level that they can successfully complete this project.

DR. MERKHOFER: First of all, there's a distinction between what the 60% is. Sixty percent is the uncertainty or the probability of producing a functioning repository. The probability that the repository functions adequately in a safe manner is much, much higher. It's virtually 100%. So, the uncertainty here is not a scientific uncertainty associated with the ability of a repository to perform. It's largely regulatory uncertainty, programmatic viability uncertainty, and admittedly some uncertainty regarding the ability of a testing program to effectively generate the level of confidence that would be needed to enable you to go to the next steps.

MR. THOMPSON: I'm Jim Thompson from Thompson Engineering. I understand exactly what you're saying with respect to confidence now and what you propose in the future in any undertaking as a design engineer. You want to have confidence in what your end results is going to be. I guess that's the disturbing thing for Carl and I when we saw this presentation about a month ago, I guess, in Washington with the NRC. I talked to Dr. Gnirk about it after the presentation was made. And, in any decision analysis you have to understand how many branches you're dealing with and it's going to be the product of several probabilities and you have to be conscious of what you're looking at. So, as such, when

you see a 60% probability, you have to be aware of the number you're looking at and then you have to refer and look back and say, look at those same engineers and scientists that were asked to make up those probabilities that were the end product of that overall probability and ask them what their intuitive gut feeling is of the success of this project. And, I believe that's what you were referring to when we were talking about the Chunnel Project. You know what is the end probability of that. You're saying that sometimes decision analysis isn't employed on the projects. I understand that, as well, because it is and that's true. However, the function of the confidence of the project managers is in its successful outcome. When I asked Dr. Gnirk, given that 60% overall probability, if we eliminated programmatic viability which entailed many, you know, political ramifications in it, as well, and went on pure scientific aspects of the testing later, or the regulatory authorization and closures, if you applied the numbers to that, you'll get approximately 67% probable success. Then, the question I asked was that given today, right now, if we asked those same panel of experts what they felt was the probable success, you know, of the project, would they feel that 67% was representative? His answer was yes.

And, so it's a great concern to the state when you

have a starting point at this stage where the scientific community is working on a project from an implementation standpoint that only has a 67% confidence that the--or thereabouts and I'm not going to play semantics whether it's 75 or just--just relatively lower, considerably far below 99, 98, 100% as you were referring to in a conventional project that we would normally work on--and, from a design engineer's standpoint, that's a disturbing probability.

DR. DEERE: I would guess that the .6, as you explained, Lee, would be what we might have at the preliminary state or the inventory state of a hydroelectric project where we say, okay, we have that river that's not developed and we find out there's a certain head and we have a certain storage and certain rainfall and, by golly, I think there's a pretty good chance, at least a 50/50 chance we can get a project there. Because there are all kinds of uncertainties that you haven't worked through it yet. There's a possibility can you get the water rights. When you really get down to it, you have a good foundation or are you sitting on something that's--and the Channel Tunnel went through that. This is why the Channel Tunnel started when, 18--you have two tunnels already out under, you know. One is a half a mile out in 1904 and then another one got out a little bit farther, but the early stages there was certainly lots of uncertainties. And, involving

financing, could you complete and have a successful project? Well, the bankers were really worried, you know, and this is private finance. This is one of the larger private finance things in the world. So, there was a great deal of uncertainty.

So, on a hydro project, I have been taken to look at it and if they say, well, this is one we're looking at and we'd like to start studies here, you take a look at it and your feeling is--in your reports you say I don't think you have a very good site. I think we ought to go farther. So, what you're really saying is I think the probability of a site going in there probably less than 50% because then we've got to see if we've found something better just--even without investing a lot of money, sort of an inventory study. And, that may well be where we are now. We're much beyond an inventory type study of how many potential sites are there, but when you're still putting in a lot of uncertainties regarding the regulatory thing--if you look at any one of those, take the 23,000,000 expected benefit, you take them all the way across, you find any one of those particular ones just sitting in the range of 87, 83, 89, 90, 99, 98. And, as you go along, certainly, some of those--the first program viability, well, if it gets approved and the site is licensed for construction, why, a lot of these drop out. They become

one. So, as you move through those and I guess that's why I say the final design stage, you're getting closer and closer with these and you're reducing probability because you've gone through certain restrictive gates.

DR. MERKHOFER: As Carl indicated to you in his comment, we did spend some time talking about these probability numbers and whether they were reasonable or whether they were way off base. I think, though, although the panel members generally felt that these numbers were not totally unrealistic, there is an important point that--remember, our decision tree breaks uncertainties into only two possibilities. To keep this project manageable, we simplified things by saying for each of these uncertainties, there's really only two outcomes, success of failure, failure meaning abandon the site. The reality which was expressed to us many times by our panel members is if, in fact, you do get, let's say, a bad outcome, you're not just going to abandon the site, most likely. What you're going to do is step back and see if there's some way to salvage the situation, come up with an alternative set of tests, for example. Try to negotiate an agreement with regulatory authority. If it looks as though approval is not going to be granted, see if there's some negotiating settlement that can be reached. And, so because of the fact that the tree does not recognize those as possibilities, it's

undoubtedly underestimating the true probability of successes.

DR. DEERE: Carl, I think that was a very good question that you raised. And, it may well be when somebody says, well, at this stage do we have a confirmed repository site, I think the answer by everybody is no. And, they're saying at this moment we're 60% sure. And, if you'd ask the Board, well, they would probably say at this stage, probably half/half, no better than a 50/50 chance. Because I don't think anyone's mind is made up, but I believe Carl Gertz has expressed that, that it's a site that he feels is worthwhile investigating because he has no degree of security that that would be an approved site. Right?

MR. PETRIE: Absolutely right. Yes.

DR. DEERE: So, I think the 60% is unrealistic.

MR. PETRIE: We are here from the DOE standpoint. From the DOE standpoint, we're here to determine whether the site is suitable or not. We have no preconceived notions about it.

DR. DEERE: I guess to put that in perspective perhaps, one could say let's go to an alternative site and make that decision right away. All right, what's the percent probability right now at this moment that we'll take that site to completion.

MR. JOHNSON: Don, I think the point that I was trying to make is do we gamble the rate payors' money on a 60% chance?

Whether we're gambling the $4 billion for site characterization or gambling the whole $35 to $40 billion contemplated for the total cost of the program? That's basically what the question I'm getting at. Is that a prudent gamble of the rate payors' money when we're only looking at 60% chance?

MR. BROCOUM: Maybe it's worth repeating, but what we're gambling now is the particular step we're in which is the order of 90% for a smaller sum than a total sum of money for the total cost of the repository. I think I made that point clearly earlier today. I just wanted to repeat since Carl came up again.

DR. DEERE: Now, perhaps, we should have the coffee break.

DR. STEVENS: Before we break, there is a hard copy of that revised figure, the tree with the numbers on it, and we'll make a copy of that available to everyone on the Board and others.

DR. DEERE: I have an announcement also if I may please. At the end of the meeting, let's say, it will be in the range of 11:30 to 11:45, I think it would be worthwhile since we have such a number of people here interested in the testing and we have scheduled for June 25 to 27 a meeting of our panels on testing, I wonder if at the end of the meeting those who will be involved in that, Max and Dave, Al and Tom, and

others that are here, we'd like to talk about that a little bit to see--you know, we see two things that we just haven't talked too much about here. That's the details of the groundwater testing program and particularly with changes in access. And, the other is the rock and canyons testing and the heater testing and things like this. We think it's time that the Board starts looking at this again, I mean, in greater detail. We've had very small parts of it presented a year or a year and a half ago. So, maybe the 10 or 15 of us involved can have just a very short meeting on that.

Thank you.

(Whereupon, a brief recess was taken.)

DR. DEERE: We're ready to continue.

Larry?

DR. LAURENCE COSTIN: I'm going to continue the discussion here on sort of what we've learned in this study and primarily focus on what we've learned about features of the various options that from the results of the study, we thought, tended to make those various options much better than other options that did not have certain features and basically go through what we did as far as a comparative evaluation of the features.

Part of our intent in conducting this study and, in fact, our direction in conducting this study was to

specifically look at a comparative evaluation of features. In part, this was motivated by requirements given under 10 CFR 60.21 that directs that a comparative evaluation of features for a repository should be conducted as you look specifically at those kinds of features that may enhance the capability of the site in containing isolated wastes. So, in that light, we designed at least a formulation of the options and various other features or various other parts of the study and specifically look at this comparison of features. And, in the context of our study, though, we brought down this comparison of features not just to look at the ability to contain and isolate wastes, but to look at how those features fared on many other dimensions. So, what I'm going to talk about today, first of all, is the approach that we used to incorporate this comparison of these within the study and then talk a little bit about the evaluation.

Just to remind you that as an integral part of this study we did intend to do this comparison of features. And, how we did that was by incorporating various features into 17 base configurations that we evaluated. And, the 34 options basically consists of 17 configurations or collections and features, if you will, with two different approaches to the testing program. So, what we're really looking at is combinations of features that compose these 17 options and we

have a method that we designed early-on to how we arrive at these 17 basic configurations, so that we could do this comparison features. In other words, we wanted to be sure that we spanned the space of possibilities and combination of features within these options, so that we could compare one option against another and see how they fared in the overall ranking and then be able to glean out of that what kind of features tended to be very favorable in terms of the overall ranking.

I think it's very important to note that we did not do a direct comparison of features. We didn't compare shafts versus ramps on all of these dimensions and just focus in on that. We had to do this comparison in the context of looking at the entire system mainly because we felt for the kind of study we were doing that the individual features couldn't be separated from the system because their effect in the system is different than focusing on them individually. And, you take a collection of features and put them together in a system, the total sum effect of those features may be quite different than what you would perceive to be the individual effects. So, the collection or the sum or the total being different than the individual impacts of those features.

And, now that I mention it, we did do this evaluation with multi-dimension, as Lee discussed. We looked

at many different aspects of the program and the options were rated on all of those aspects and so what you're seeing here is features that tended to cause or allow options to be rated good overall. But, also because we studied very carefully the individual panels and how they focused in on certain features, this is a very good feature for waste isolation and this is a very good feature for testing. We pulled that information out of the study, as well. So, we can say that some features came out because we can specifically say that this was because of testing, this was because of waste isolation, but in general what I'll be talking about is features that cause an option to do well overall.

As I said, there was a method to the madness of the way in which we put these options together for evaluation. And, what we did initially is basically we tried to define what was an option. You know, what major features can we define to make up these options or configurations. And so initially we defined five major design features that were identified and then various ways in which those features could be incorporated into the options. And, I'll go ahead and take a closer look at those right now just so you have an idea in your head as to what I'm talking about when I talk about major design features. These charts are a few down the road in your package.

What I'm talking about is we listed five major features; means of access, location of accesses; where the test alcove is located on the main test level; excavation methods; and, finally one that's listed here as total number of accesses. What we were really intending to look at and ask is how well the ESF accesses or the portion of the ESF that would be constructed early would integrate well with a potential repository that might be made for that. The kind of a measure for looking at that was with this particular ESF design. If you mated that with a comparable repository, what would be the total number of accesses that you would eventually need to construct in order to make the system work.

So, those are the features and you'll notice the alternative within each of those features range--we tried to restrict the range so that we wouldn't get so many alternatives that we would have to produce an infinite number of options in order to evaluate one against the other. So, what we did try to do was to give reasonable ranges to most of those that we thought needed to be looked at. And, within the context of that, we still--if you wanted to do a direct comparison and, say, create options that had every combination or a permutation of all of these you'd be able to directly compare them in the end, you would still end up with a huge number of options to try to look at. And, so this seemed to

us to require some kind of an initial screening process to get the pool of options down to a reasonable number that sort of sparsely filled this option space, but still we could make very good trade-offs between different combinations of options or different combinations of features.

So, we had a pool of options and that pool was composed of, initially, a look at all of the configurations, ESF and repository configurations, that had been developed throughout the recent history of the program, back to about 1980, I believe. Pulled those out of the files. That created a fairly large number of about 15 repository configurations and I believe 51 different ESF configurations. And, we combined those then with some new options, 24 new options. The new options were specifically created with the new configurations to better mate or better address many of the comments and concerns that we have received since the issuance of the SCP. A lot of those options, some of those concerns, say, were a better integration between ESF and the repository, a larger test area for the main test level. One of the comments in the NRC's site characterization analysis was that they believed that the main test level floor area was too small, that there was a very high potential for test interference. And, so in these new options, we laid out then a much larger area in order to conduct those tests and also

provide additional area for future tests or performance confirmation tests.

The new options were again also specifically created to have combinations of features that didn't appear in these historic ones mainly because of the historic ESF configurations all dealt with the single shaft or two shafts. There weren't, I don't believe, any of the ESF options from a historical perspective that accessed the underground via ramps. So, we wanted to create new configurations that had ramp accesses and shaft/ramp combinations and we even created a few that had ramp/shaft combinations.

So, we then had a large number of options. We had to screen those down and we screened them down in such a way that we tried to fill this option screen and that is to say that we had a certain number of options that would have various combinations of features that would allow us to do these trade-offs. As I mentioned, you couldn't create an option that had every combination or permutation of all these features. You would end up with a huge number. So, we tried to selectively fill out this space and we got all of the dimensions and we had extreme ranges on each one of those dimensions. Once the options themselves were comparatively evaluated on all of these dimensions and we got an overall ranking, we could back out from that as to what kinds of

features potentially caused those rankings to be the way that they were. And, I again emphasize the point that the comparison, of course, was done on a number of dimensions.

Looking at features and trying to identify features, because of the 60.21 requirements, we did focus a little more effort here on postclosure performance. And, the way we did that was during the study we performed some additional performance evaluations and this was done by a team headed by Tom Blejwas who basically pulled out all of the available information that we had collected to date, did not do any new analysis, but tried to collect together the information available from existing analysis, and apply those to various combinations of these features or to look at individual features, say, to look at a shaft versus ramps, and on the overall how they might affect the postclosure performance and all the various aspects. We put that information together in a package and gave it to the postclosure panel so that they could understand that as part of their evaluations. We also used that as kind of keys to looking after the evaluations were done as to whether or not the kinds of features from this analysis that said these might be better from a performance point of view, were indeed those kind of features good from an overall perspective? And, so we did try to make that comparison, as well.

So, as far as looking at the comparison of features, we did the comparison of options or the comparative evaluation of options. We did really a post-evaluation analysis in order to try to extract some information about various features. And, our objective there was, really, to determine which of the alternative forms of these features seemed to contribute best to evaluation, being highly ranked on an overall perspective or if during the panel meetings there were certain features identified as being very good for some, we focused in on those to see whether, indeed, those translated to being also very good as part of an overall evaluation. So, we had a number of ways of trying to identify features and we also made a very conscious effort to identify features that came out in the evaluation as being very good. And, we did identify a number of those. Ones that we hadn't thought of at the beginning came out in the analysis as saying these are really good for postclosure performance or this is a really good feature to enhance the testing programs. So, those, we tried to keep track of and identify and then demonstrate that those, indeed, did fit in to the overall evaluation and were very favorable features.

What I'm going to do now is go through the results. The first thing we did again with this qualitative evaluation based on overall comparative evaluation of options, we tried

to extract out from that which of the major features or subsets of those features tended to be more favorable as far as the ranking of the options. So, we looked at, again, our initial steps, our major design features, and plowed through those to see whether we could glean anything from the overall results as to which ones of those tended to make our options rank higher. We also looked at, again, the features that we specifically included by guidance, and that was guidance that we had at the outset of the study, as I mentioned, that went into formulating the initial options, but also, guidance that we got along the way as to we should have more drifting here or we need to access the Calico Hills in a certain way that fit into the study as we went along and produced the sort of final configurations that we evaluated. So, there was a subset there. Now, for this subset, of course, most of the options contained all of those features and so you couldn't really compare, but the few that didn't--particularly, the base case did not contain a number of those features and so then we had a means of evaluating things against the base case. And then, we tried again to make a listing or identify these features that resulted in the evaluation that we didn't really have any idea existed before the evaluation. They sort of came out or were identified as a result of the evaluation.

What we did then, once we had identified all these

features, is we went back to see whether, indeed, those features had some effect and tried to identify whether they might have some effect on the ranking of the options. And, what we did, as Lee and one of his later viewgraphs showed, we had correlations of different key measures against the overall ranking and we selected the key measures that have higher correlations and we went into those and looked at the factors that related to those key measures, those factors on the influence diagrams, the very important ones, that if they were very favorably rated then would cause a more favorable rating on that key measure. And then, we tried to relate these design features to those key measures, the fact does this design feature--an option have this particular feature, would the expert have said then that that factor would be improved and, therefore, the key measure might have a higher rating and, therefore, this option would be rated higher overall or at least higher on that particular measure. But, that measure then was highly correlated with the overall ranking. And, so it's a--progressive, from the bottom up. Sort of a look at these features to see whether indeed we could substantiate our contention based on this qualitative evaluation that indeed these features did affect the ranking. The fact that an option possessed a certain number of these features didn't cause them to be rated higher. And then, we sort of did a

back check and made a table of--here's the top 20 options. Which ones of all of these features do each one of these contain, and in fact do the highest rated ones contain a lot of these features?

So, those are the basic elements and I'm just going to step through those sort of one at a time. What we'll look first at is, of course, the identification of features in those three categories. The first one of them that we'll discuss is the major design feature and I'll just step through those. You'll recall, say, for the means of access, of course, we had ramps only, shafts only, and the shaft/ramp combinations. So, for the means of access it turned out that if you looked at the top six options, four of those top six options involved options that had accesses by two ramps. It became fairly clear in the discussions that these ramps, options with ramps, were indeed preferred in the overall sense. But, in some instances, particularly in the site characterization, there was a very strong preference on one dimension that we needed a shaft and that was because they felt from the characterization point of view that they needed this vertical profile of overlying rock units on the block. Now, you can get a characterization of the overlying rock units from the ramps, but most of those overlying units you intersect off the block. And, from the hydrologic point of

view and other character-ization testing point of view, they felt that for that particular application that shaft would be preferred. Not only were ramps preferred, but particular locations of ramps and those were particularly the ramps that came in from the east because those tended to be the ones that crossed the units in an aggressive manner. The ones that came in from the north, while desirable, they were somewhat less desirable because they didn't cross the same structural features.

The second one, location of accesses, in order to try to limit the range of possibilities of all of these options, we constructed options or had options in the set that had all of the accesses in the northeast, such as in the SCP or in the base case. We had some that had been all in the southern part of the block and we had a few that had combinations, in other words a split access, one in the north and one in the south. Option 30 is a good example of that.

From the point of view of location of accesses, the thing that seemed to be the big driver of that was what was really the distance between those accesses? In other words, how much ground do you have to excavate in order to connect those up and then do a characterization? Not necessarily whether they were located all in the north or all in the south, but if they were located fairly far apart, they tend to

be more favorable than having two accesses located pretty close together because you didn't see much ground that way. I mean, it came in various dimensions, primarily in the testing, but, of course, as you've noted previously, that cascades over into regulatory approval and that cascades over into viability and it snowballs up. So, in some instances where there's a big preference, that preference tends to get cascaded into a number of dimensions.

Continuing on here, the next one is the location of the MTL itself. After looking at that, we really could not identify anywhere where there was a specific preference to, say, having the MTL in the north or having the MTL in the south. What there was a preference for or what seemed to be something that came out of this was there were some designs that had the flexibility that you could put in either way. Specifically, the 30/13 option because of the split access during your design phase, you could have chosen to put it in the north or in the south or some place in between depending on what your design studies told you was the best thing to do. And, so it had this flexibility of potentially locating it at a number of different places. That seemed to be the kind of favorable thing that promoted those kinds of options. Not necessarily that we had one location or another.

The excavation methods, we looked at a number of

them again for both the shafts and the ramps. Specific construction methods were kind of mixed and matched depending on the option. We couldn't really clearly tell anything, other than those that allowed you to do construction quicker to make up schedules, shorter schedules, less cost. Those were clearly the ones that were mechanically excavated by the accesses and the drifts, the exploratory drifting. Even though in almost all options, of course, there is--if you're going to make small attics or rooms, there would certainly be some construction of--potentially, a drill and blast or one thing or another, but primarily the facility was constructed --or those facilities that were constructed by mechanical means of one form or another were preferred over those that were not. And, this relates primarily to the schedule impacts, getting underground quick, or being able to get the early testing phase done quickly. In many of the options, as we've discussed earlier, it allowed you to do both the Topopah Springs and then the Calico Hills excavations virtually completely in the early time period. And, so that's one reason why this came to be thought as being a preferred feature.

The total number of accesses again depended on how the ESF was mated to a particular repository and how that interface was constructed. It became clear if you look at the

top ranked options that those options have fewer number of total accesses if you include the repository than do the ones that are lower rated. The fewest number of accesses in any option is four and this is because of the requirement you have a separated ventilation system of waste. The waste emplacement, however, is the minus side. So, four is potentially the fewest you can have, but there were options that were six. But, you'll notice the ones in the top 10 are either four or five. There's none in there with six.

A quick rundown of those features that were included in by guidance. As I noted, these features were included in all the options except for the base case in most cases and the larger main test level was also not included in Option 18. But, if you'll look at the rankings, Option 1 and Option 18 are in the bottom third and so, while you can't attribute that solely to not having these things, certainly it could have been a contributor.

Now, the kind of interesting part is what did we really learn that we didn't have an inkling of before? And, the first one is that we found that an option, particularly Option 30, had a particular feature. It was the only one that had this feature. It was that when we integrated it with the Calico Hills exploration that there was no direct gravity pathway for the Topopah Springs and Calico Hills. This was

because it's all done by ramps. There was no internal shafts or no constructed shafts from the surface that went all the way down to the Calico Hills. This turned out to be a very important feature as far as the postclosure performance people were concerned and that cascaded over into the regulatory approval. Because it was such an important feature for postclosure, it became a very important feature for regulatory approval, it became a very important feature for viability. So, this one turned out to be one that cropped up in a lot of discussions and was pretty much universally agreed upon, it was a very good thing to try to incorporate into the design of an ESF.

The next two here came to light because of the incorporation of the difference between the TSW_1 and the TSW_2, the upper lithophysal zone and the repository horizon in the TSW_2 in the northern end of the block. This allowed the repository A/Es to design a couple of repository concepts that are illustrated in 15 and 16 and their twins, 32 and 33, that allowed you to take advantage of that. And, they took advantage of doing that. It produced two kinds of features that took advantage of that. One was it allowed them to raise the height of the repository further above the water table by a fair amount. The second thing was because of doing that they created this so-called step-block configuration in which

the waste panels were in isolated blocks. This allowed them to isolate major geologic features, such as the Ghost Dance Fault. There were no transections of the Ghost Dance Fault for waste isolation. So, there's no direct connection between waste emplacement areas and the Ghost Dance Fault which then gives you a very much higher confidence in the isolation capability of those panels.

Now, of course, the implementation of these two depend very much on whether or not you can demonstrate that that interface is higher in the northern end than it is currently, I guess, at the base line. So, some confirmatory tests would have to be done in order to incorporate this idea. I think one might say that this is one place where there's probably a strong interface between what we found out in this study and what we can pass on to, say, a test prioritization study. And, that is that we found that, hey, this may be a very important thing you would want to consider in looking at your ESF. Where are these ramps bottomed out, for instance? If we want them to bottom out 200 feet higher than what we had originally scoped out, then we're going to need some very early confirmatory information about that. So, in your test prioritization, you'd want to do some early drill holes in order to move the block, in order to look at this to see whether that is true. So, this is potentially an important

input into the test prioritization study.

The next feature is that those options that had large exposure of rock, both on and off the block, were highly favored. That was implemented at least in 30 and 13, of course, by having two ramps from the east. Most of the ones you can say this about had ramps from the east or in the case of 4 because it had two shafts plus a ramp. The two shafts being widely spaced got you a larger exposure of rock, a vertical cross-section, and also got you horizontal looks because of the ramp. So, this was an important attribute, you might say.

The other one, the final one, which is one that has been discussed earlier or alluded to earlier was those options that had this attribute of being able to characterize both Topopah Springs and Calico Hills in the early time frames fairly completely were those that got ranked very high. So, the fact that you have these sets of twins does not indicate that there's no preference in going to the Calico Hills versus the Topopah Springs. What it indicates is that there's a preference for those options that allows you to do either one or both at the same time.

So, that's the kind of the features that we were able to glean out of the evaluations. What we did subsequent to that--and, again, as I mentioned, we took a look at the key

measures that were identified, the ones that were highly correlated with the overall ranking. We looked at factors on the influence diagrams and then we tried to make an estimate of whether indeed those factors would have been affected by inclusion of these particular features, so that we could get some confidence that, in fact, these features were features that tended to--would be considered preferable and tended to drive an option to the top.

And, as a summary of that, you might say, we have this table which includes the top 10 options and just a sort of a summary of those features that we looked at that are included in each one of these. The first five there are the initial five that we looked at and I've listed here sort of the favorable end of that, namely that compared shafts and ramps here or the number of accesses. It tended to be the lower number of accesses and the mechanically mined accesses and drifts that were preferred over the drill and blast excavation methods. The next here are the ones that I talked about that are in that category of new things that got identified that really made some difference in number of options. And then, finally, these here were the ones that we included in virtually all options by guidance, but were not included in the base case.

You'll notice in these, of course, Option 30 has all

but these two. These two were only included in those step-block repositories, but again it's the kind of a feature that one could include in virtually any option by mating it with that kind of a repository provided you do the early time check to make sure that indeed those contacts are where you think they are for that and where they, in fact, need to be in order to do that kind of a--

DR. DEERE: Larry, I think that's an important point. Of course, Option 30 isn't checked there.

DR. COSTIN: Right.

DR. DEERE: Or 23. But, there would be no difficulty because one is primarily exploratory, but it's in such a position that it wouldn't preclude you in the final design of the repository.

DR. COSTIN: Right. And, you need to know that information up front if you're going to construct ramps because certainly with ramps you need to know where you're going to end up or what grade you're going to use. A shaft is probably a little less important because the shaft will find where that contact is as you excavate the shaft. And, so you could break out any horizon on the shaft or the ramp. If you use too steep a grade and you go down to a lower level, then you're going to end up having to back up and go up to the higher level to do your construction for the repository. So, in the

design of an option like 30, if you want to employ these, you do need that confirmatory information up front and this is why this information then needs to be tested, prioritization tests, or to say here's a piece of information that, while not necessarily aimed at early site suitability, is aimed at something that we need to know quickly.

So, to conclude, you know, we did identify a number of potentially favorable features and those features were correlated, of course, with the highly ranked options. But, again, as you pointed out, it's notable that no option contained everything. We don't have the perfect option or, at least from the features that we have, one that contains all of those features. It wasn't clear from the start that even if you did identify the whole number of favorable features and combined them all into one option that that option as a system would perform better than an option that may have been missing one or two features. Some synergism may have caused a degradation in performance rather than an enhancement in performance. So, we have to be a little careful about mixing and matching features and, of course, when you get into the design phase and you start doing that, then you have to understand what you're doing when you're fiddling around and tweaking about.

So, I'll sort of conclude my talk and lead into what

Ted is going to talk about and that is where do we go from here? And, that is, so now we may want to do the next iteration, as one might call it, on this. It will be done within the context of engineering design studies. That means that, of course, the design will be subject to a control process and there will be then formal studies done to look at trade-offs of different features, whether or not we would want to incorporate those that have been identified through the study in an option.

And, with that, I'll close or answer questions and allow Ted to complete the story.

MR. PETRIE: It's going to be Al Stevens next, but go ahead if there's any questions.

DR. DEERE: All right. Let's proceed then. Al? I think that was very clear, Larry.

REPORTER: Could you put that a little higher up on your tie, please? Thank you.

DR. STEVENS: You've, in fact, heard most of the things involved in the studies. I'm going to just back up and give some summary comments or insights we gathered, technical and otherwise. I wanted to kind of start with that road map viewgraph that Lee Merkhofer first showed you which you've seen I think in every one of our talks over this past year and use that as a springboard.

To go back to our initial objectives, the first was to identify an ESF configuration you'd like to proceed with and the associated construction methods, to evaluate and rank order a set of options to sort of arrive at the configuration and construction method, and to conduct the process under a qualified QA program. I'll have a few words to say about each of these as I proceed.

As Lee has pointed out, we've used an approach that has successfully incorporated a rather diverse and broad set of factors into the process. And, I've attempted to point out these factors here. They include the very technical questions of site characterization. After all, that's why we're constructing this facility or plan to construct this facility. They include a number of requirements, regulatory requirements and other requirements, that we need to pay attention to and all of those factors were brought into this evaluation. The process accounts for a number of recommendations, both your own and the NRC's. The process also accounted for such factors as environmental and social impacts. Those were cranked in. And, lastly, you heard some of the DOE programmatic factors that were included; schedule, costs, the general institutional kinds of questions. I hope that you've gathered that this is a rather large plateful of factors to pay attention to in this study and I'll let the

evidence speak for itself. It was our intent to account for all those in this evaluation process.

We set out to evaluate a selected set of design features and going through the process, as Larry pointed out to you, a number of additional design features surfaced. He's given you a pretty good look at those. We set out to address a limited set of options. First, we were going to have 12 or 13 and then it expanded to 17 and then it took a much larger leap to 34. That expansion wound up being quite a burden on several of our support groups, especially the A/Es in putting together the supporting details of the schedule and costs. Now, there are a lot of details involved in that matter of scheduling costs, not the least of which is the coordination of the testing with the construction. A great deal of details needed to be worked in order to come up with a realistic schedule for each one of those options, the 34. I emphasize 34 here as compared to 17 because the testing and the impact on the construction schedule was markedly different between the pairs. And, so that was a sizeable effort and a large number of people worked very hard on that and I think in the end in looking back we can say that the process we used proved to be quite robust in handling that large number of options for comparison. I look back and wonder where was it Al Stevens lost control? And, I think it was on August 8 when we

sat with the management panel and they admonished us to look at these two different testing options with each configuration and then turned to me and said, Stevens, can you get that job done under schedules that you've earlier advertised? And, I looked around for some confirmation and generally saw people wanting to say yes. And, so I said, yes. And, that caused us a real struggle. I think we've been successful, but it's been a real struggle. We're now in the process of putting together the report and trying to dig out of that massive record of information all of the details that we've attempted to describe here and get that information into the report. It was not a simple task. It would have been, I think, much easier on us if we could have digested the many other--looked ahead with a little more relaxed schedule as to putting this report together had we had that freedom in the October/ November time frame when we were going through it. We did not have that freedom and so we're still struggling to get that all extracted and into the record.

But, I think we have given Lee Merkhofer even more reason to be rather proud of the methodology that he and Paul basically worked out here and that he was able to handle this massive task in a very organized way. And, notwithstanding the moans and groans of a number of the panel members as they worked very long hours in going through that process, it

turned out to be very thorough and very instructive.

And, the last bullet on my first viewgraph had to do with the requirement to do this process under a qualified QA program. Roy Williams was at our place some time back inquiring about the questions of QA and put some very pointed questions to me about what the cost of QA was and we attempted to answer some of his questions there. Hidden in that is the cost of energy. At the outset, it was--my own energy is what I'm speaking of. A great percentage of my energies, especially in the early stages of this, was literally totally consumed by getting people trained to participate in the effort. And, we had some difficulties there in that some of our participants in the program did not yet have their QA program qualified and they needed to be trained under our programs to participate. Nevertheless, we got that done and we think we learned a few lessons that I'm in the process of advancing to all of the participants in our project about better facilitating the crossing of organizational boundaries in doing common types of things. I think we can say without doubt that the QA program had a place. It is amenable to doing work across boundaries, but there are probably some significant streamlining that may be done there. I think that I had just about everyone in the program trained under our QA system.

Finally, I want to get to some technical insights and I'm not sure that they're all worded well here. So, I want to spend a little bit more time on them. The first point is that variations in the features or options had little effect on waste isolation capability of the site, on the evaluation of that waste isolation capability. And, my evidence for that is embedded in this table that Lee Merkhofer showed you earlier. I need that one on the summary of consequences, Lee. I brought it with me, sorry.

If you look down through this column, that's the postclosure performance, you see that the spread, .017, and the effect of .017 times the EPA releases, and the largest number in here, .023, is not very large. It's just not very large. There are a number of these that have .017. There are a number of them marked fifth and first and a number of them marked fifth who all have .017. A large number of them have that percentage assessed as the fraction of the EPA limit.

Embedded in that set that all have a .017 is a whole range of features including that one feature that--those two features that Larry spoke of for 32 and 33 and 15 and 16. You notice they also are .017. The point here is that there's a large range of features that we've addressed that seem to have not a strong impact on the performance, the evaluation of the performance. We interpret that as a statement by that panel

that the site is really quite robust and will tolerate quite a range of features in there. Even with the factor of raising the elevation of the emplacement horizon at the east end or northeast end of the dipping bed or the dipping Topopah Springs unit to where the groundwater travel time is increased by, I think, 40 or 50%, they still ascribed a .017 value to that. So, from the standpoint of technical insights gained, that's what I mean by this first point. A large range of features which had not a strong evaluation, but nevertheless in the ranking of the options, we paid attention to those values overall. And, panels like: the closure panel; the program viability panel; and the approval panel; did indeed pay attention to those factors in their evaluations.

The second point, variations in features or options had little effect on false positive determinations of the site suitability. That perhaps is not worded well, but let me point out what I'm really looking at here. If you look at the fifth column of this page, you'll see that the difference between .995, okay. This is a probability of "not okay". I want to take the compliment of that. The difference between .995 and .991 gets you well down into this whole list of ranked options. The point is the difference between those is very small. They are all good options. And, therefore, the assertion that the possibility of finding a not good situation

after you've concluded from testing that it is good is--and that's a point of suitability, if you will--related, but nevertheless of suitability--is really not a strong differentiating factor as judged by the panels. So, that's all I wanted to say on that bullet.

The third bullet, I put this down because I want to reflect back on some earlier discussions that came before this Board, the matter of drill and blast versus mechanical mining. In that last table that Larry Costin showed you, the top ranked options had mechanical mining, but still some of them had drill and blast. What I want to do with this bullet is state that there was indeed a good deal of controversy in the testing panel which developed those four different probabilities, early false positive, late false positive, early false negative, and late false negative. There's a significant--some significant party or entity who really are still holding on to the drill and blast approach. This is simply an effort to point out that that's where we are. Nevertheless, the top ranked options did show up as favoring mechanical methods.

If you look at the viewgraph I just had up a few moments ago known as the second biggest one, the performance viewgraph, the performance panel did not issue strong preference for mechanical mining. I believe that is an

outcome of the numbers you see there. Because if you look at that ranking, even those ones that are .017, there's a mix of mechanical mining and drill and blast. That's one of the insights that I see here in examining the information. I think it's fairly clear that we'll proceed with mechanical mining with perhaps some drill and blast in little alcoves and those sorts of things. I'm not close enough to the mining industry to know how you can avoid, totally avoid, the use of drill and blast--

UNIDENTIFIED SPEAKER: Road headers.

DR. STEVENS: Road headers, that might be appropriate. But, I think this effort has passed that factor and has brought us to the conclusion that we will indeed use mechanical mining. And, so that's the purpose of my last bullet, just to bring us to this discussion.

There are lots and lots of other insights that have come out of this and you've heard both Lee in discussion on that and Larry. So, I won't repeat those. So, in some sense, I am, in showing you the viewgraphs, picking on some of the little--kind of the off-normal nuances here, perhaps, but I wanted to tell you that we've addressed them and you've seen the overall results of where we are.

DR. CORDING: A question on that, Al. When you say the preference for drill and blast, what I saw in the presenta-

tions previously that it was principally with regard to the shaft. Is that right? Preference for drill and blast in the shaft?

DR. STEVENS: Yes, yes.

DR. CORDING: And, of course, we've had a lot of discussions on that. And, going back to another question, Larry. Larry presented a statement on shaft was preferred for site characterization. In your presentation, was that preference related to--why was there a preference for the shaft?

MR. PETRIE: May I take on that just for a moment? If I may, I think I'll get to that in my presentation and I'll show you where the shaft is and why it might be a, at least qualitatively preferable--

DR. CORDING: It had to do with the location of it. I was trying to determine whether we were trying to put together the blasting with the--

MR. PETRIE: Drilling and blasting had nothing to do with its location.

DR. CORDING: Okay, fine. All right.

DR. STEVENS: The question of having two ramps with only two accesses for the ESF leaves you with no shaft. If that was a matter that was dealt with in some great detail in the testing panel and it was recognized that there was a great

deal of advantage in having two ramps some distance from each other that traversed in a direction which was nominally normal to the main direction of the north south trending faults of the north south trending faults and so the advantage there for what Larry called the east-going ramps is clear. And, if you take one at the north end and one at the south end, there's considerable advantage there. If you pick an option that has those, then you have no shaft. And, so Ted will have some words to say about how we address that question. Some of those--there were a number of those questions that have come up along the way and they were all balanced out in the evaluation process, but the one that, from which there was lots of discussion and no final answer in the panel because of the limited number of options that we had, was just that and we'll deal with that along the way in subsequent design studies.

DR. COSTIN: I'd like to make just a couple of comments. One was that in my presentation in talking again about the shaft from the testing panels' focus/perspective, they felt that vertical section information on the block was potentially a valuable piece of information to get. And, therefore, they preferred options that had a shaft in them versus ones that didn't, even though with the two ramps you can get that information, but it's all off the block. And, they felt that

getting it on the block was sort of a key thing that put those kind of options just a little bit higher. That's why I made that statement.

The other thing I want to just comment on was to make it clear that when Al is talking about the releases there that those releases are the total releases, both gaseous and aqueous. The features had a more pronounced effect on the aqueous releases than is indicated here because the gaseous ones are so much higher than the aqueous that they kind of swap out those numbers. So, basically, what you're seeing is the gaseous releases.

The kinds of features that we were talking about did have some effect on the aqueous releases, but the important effect was that they increased the confidence that those releases would be low and that increase in confidence then gets translated over into things like regulatory approval. So, those probabilities of regulatory approval then become higher and the cascading effect of those kinds of features throughout the different measures was fairly clear.

DR. CORDING: That was one of the points I was wondering as to whether you--as to what--the reason for the shaft concern was to be not so much that the shaft is vertical, but that it is on the block.

DR. COSTIN: Right.

DR. CORDING: And, if there's other types of drifting that--

DR. COSTIN: It gets you information. It gets you information above the Topopah Springs on the block. Okay? That was the key discriminator there.

DR. CORDING: So, there might be some consideration of possibilities of being on the block with shafts or with something coming off of ramps, too. That's another type of option.

DR. COSTIN: That's right.

DR. DEERE: I'm sure these are things we'll probably be asking Ted about and let's put it to him. Ted Petrie?

MR. PETRIE: Again, I'm Ted Petrie, Acting Director of the Engineering and Development Division. I'm going to talk to you a little about the activities in order to resume our design activities.

As I mentioned a bit earlier, we got some guidance from the director of OCRWM as to how we should proceed. I'd like to point out that he did not give us a specific option to proceed with. But, he did give us some guidance as to how we should proceed. He said we should conduct design studies focusing on favorable features of the highest ranked ESF alternatives. We should proceed with design studying based on post-1988 data and that does not mean we ignore earlier data,

but we use whatever is most recent.

The ESF Alternative Study of the Calico Hills provided a flexibility to penetrate the Calico Hills unit in the first phase as an aid to evaluating site suitability as soon as possible. So, when we looked at the higher ranked options that clearly says that you look at the higher numbered options.

And, thirdly, prepare plans for the phased approach to design, development, and ESF implementation in order to preserve flexibility and to take advantage of findings as data acquisition proceeds. I'll be discussing how we have, at least initially, planned our phasing to take that into account.

Steve, were you going to say a couple of words?

MR. BROCOUM: I just wanted to amplify a little bit on his guidance of February 12. John Bartlett put a lot of thought into this and it took him several weeks to come up with this guidance. He was very concerned for defining the basis of proceeding now and the basis of actually proceeding with Title II. After a lot of thought, he decided the things he needed to proceed with Title II were the following. He decided he needed the Calico Hills risk/benefit analysis which is complete; the ESF Alternative Study which will not be complete until June 30 of this year, the final report; the

implementation of the applicable ESF requirements documents as described in the management assistance improvement plan--this particular phase is under the responsibility of the office of systems and compliance, Dwight Shelor's shop--and finally, after those requirements are in place--those are scheduled to be in place on July 31--the revision of a Title I design. After he has those four things, he will be at the point that he can decide to proceed with Title II. So, therefore, he hasn't made a final decision.

His basis in this interim decision to proceed now includes the following. The completion of the Calico Hills risk/benefit study which is complete; the availability of the summary information in the findings of the ESF Alternative Study which was completed recently by Sandia; the recommendations from the structural geology engineering panel of the TRB which were attached to your letter of December 12 to Dr. Bartlett; and, the results of three meetings that Dr. Bartlett had with members of OGD to discuss the status of the ESF activities. So, this was very important for Dr. Bartlett to establish his bases.

Finally, so it's clear how we are intending to proceed, I would like to offer his memo or his guidance for the record. Okay? I only have one copy, unfortunately, but I think it should be in the record.

MR. PETRIE: Well, I'm going to address these issues by looking at the highest higher ranked options and just see what we can do.

DR. NORTH: Before that slide disappears, I'd like to offer a comment repeating what I said yesterday with respect to preserving flexibility. I think as performance assessment proceeds, one of the issues to be studied further is the importance of the saturated zone. And, I hope we don't rule out at any time in the near future the possibility of underground exploration down below the Calico Hills to get more data in that area.

MR. PETRIE: Okay. That's going to be up to the test community and we hear you.

So, at any rate, let's look at the three higher ranked options. We've got Option 23 and you'll see numbers, #1, 2, and 3, 4, 6, 8, 7. Those are to indicate phases of design and construction. For example, Phase 1 would include drilling from the surface down to the Topopah Springs or to the--rather to the access, the cutoff, as we're going down to Calico Hills. Phase 1 is in here. Phase 2 goes out to the Calico Hills. Phase 3 is the square section of Calico Hills. Four and so on. So, that's our phased approach that we have. And, I guess, that's about all I really wanted to point out on this one.

Now, let's take a look at 24, another one of the higher ranked options, and again we have divided this into construction--they're really construction phases, as well as design phases, the idea being that you can do primary construction and then make a decision as to the way you want to proceed from there on. And, again, you see the other phases of the various construction areas. This particular option has one shaft running from Calico Hills up to the surface, another one between Calico Hills and Topopah Springs. You've got the ramp options here. One goes to the northeast and one goes to the north.

Let me put up Option 30. And, again, these are broken up into the various phases. Phase 1 is the surface facilities in the northeast. Phase 2 is access to the breakoff to Calico Hills. Phase 3 is the southern access on the east side. Phase 4, this goes down to the Calico Hills breakoff. And, then, 5 and 6 get us down to the Calico Hills and some of this Calico Hills exploration. Obviously, when we made this, we had some sequence in mind. The point is that if you decide when you get down to here that you don't like that sequence, you can change.

So, having said all that, let's look at an option or another option, the reference design concept for commencing the study. And, you'll see this picks up many of the features

of all the three things we discussed before. And, I'll go into some detail. One thing I wanted you to notice is that there is a--we've moved the main test level from the south to the north and there is a shaft, a vertical shaft, in the north section. This shaft is at the location of a ventilation shaft from one of the previous designs. It's our intent that that shaft should be designed and constructed only if we found that we did not get sufficient data in our traverse of this ramp and this ramp to satisfy the testing with regard to the strata over the repository area.

And then, this just lists the proposed design phases that we just looked at and just tells you what they are in a prose sense.

And then, one other little chart I wanted to show you is this comparison then of the features or the elements that are in the top options and what we have now, we call a design study concept. And, you can see the north ramp from the east is in all four of them. The south ramp from the east is in these two. North ramp to the Calico Hills is in this, this, and this. South ramp to Calico Hills, here and here. You see the main run then, the full length of Calico Hills level, is accomplished in the design study concept. The Calico Hills, Part A, is included in 24 and 23, Part B is 23 and 24. Because really all we've done here, we did it in two

pieces. So, this is really identical to it. And, the full length Topopah Springs versus the 2/3 length, you find in 23 and 24 we've gone 2/3 the length in the Topopah Springs. Whereas in the design study concept and the 30, we go the full length. And, there is a full length shaft in the north surface to Calico Hills and in our design concept we have a design only shaft for construction, if necessary. Then, going a little further, you see these are the elements that are, if you like, omitted from the design study concept. And, that is we don't--we're not going to do any work regarding MTL test area in the south. The north ramp from the north, I think I pointed it out to you in one of the diagrams where it came in. And, the raised bore shaft between Topopah Springs and Calico Hills, at least qualitatively this is considered to be a negative aspect of any option. So, this would probably never be done in any event. And, as Al pointed out, having the two ramps at widely divergent points allows more access to the rock in the ground.

And, having looked at all that and saying these are the things we were missing, let me just go back to the design concept from which we are going to be performing our trace studies over the next six months and let you take one more look at that. And, if there's any questions, I'll answer them.

DR. DEERE: I guess an alternative for that shaft, could it perhaps be a raised boring from the test area? In other words, coming off of what now is #9 or #8?

MR. PETRIE: Yes. Let me answer the question. There will be a trace study performed on the location of this shaft. Right now, it's shown right on the periphery of the repository. That is to say that that is the preferred location from a ventilation standpoint. Okay? But, we will do a trace study to determine if we could move this more somewhat and still meet the requirements of the ventilation people and whatever other requirements there are. And, in any event, I'm pretty sure we'll be ready to bore. At this point, we're not thinking about drill and blast.

DR. CORDING: You know, looking at those ramps, what is the possibility to consider taking one of those ramps down? For example, like the south ramp? Is the south ramp going to be used during the--would that be used during the actual operation of the facility? It would be used for access, is that right?

MR. PETRIE: Yes. All of the accesses you see here would be--one would be the waste ramp and one would be the walk ramp.

DR. CORDING: I was just wondering about the possibility of coming down on a flatter grade and then taking a--

basically, coming into the repository with an additional 180 degree loop which brought you over the repository down in. I don't know, there may be some other considerations there, but something that you would get you over the repository at a flatter angle by way of the ramps or one of the ramps. It lengthens the ramp, but it flattens it also. Or, you come down and just loop right over and then come in, say, from the opposite side. It makes additional length, but it's a flatter grade. And, the other thing is it puts you over more of the actual area directly above the repository.

MR. PETRIE: These are some of the things that we can study during the trade study--

DR. CORDING: Sure. I mean, it's just a possibility and maybe there's some negatives to that certainly.

MR. MCFARLAND: Ted, did you just say it would be included in the trade study?

MR. PETRIE: Well, I certainly can put it in there and I don't--we are going to look at various ways of getting this grade at some reasonable level. You know, I suspect that would be one of them.

MR. MCFARLAND: It was ruled out early in the study as being not technically feasible or too costly. I don't know what the argument about that was.

MR. PETRIE: You mean this was, what he just suggested

was ruled out?

MR. MCFARLAND: No, no. In the ESF document, I think Larry might recall that the comment was made that no attempt would be made to do an access similar to--

DR. COSTIN: I don't remember.

MR. MCFARLAND: The next question. Will you include that type of option in the trade study?

MR. PETRIE: Well, the A/E is going to evaluate how this should be constructed. All the features he's going to look at, I'm not sure.

DR. REITER: Does 6 include the option to Calico Hills about looking at Abandoned Wash, Step #6?

MR. PETRIE: Yes. Yeah, Abandoned Wash is right around in there. Actually, the Ghost Dance Fault breaks up in this area and becomes--and, they change the name. So, the uneducated would say, hey, that's the Ghost Chance Fault. I'm one of the uneducated, by the way.

DR. STEVENS: Both the 4 and the 6 cut that at different elevations, I believe.

DR. DEERE: We'll have five crosses in the Ghost Dance with this layout, I think, at the two different levels. Yes.

UNIDENTIFIED SPEAKER: And, at different offsets.

MR. PETRIE: Okay.

DR. DEERE: Okay. Thank you very much.

MR. PETRIE: Let me just see if I have anything else I wanted to mention to you. This is just a few generic things that you probably all know. The design study will be conducted to develop an integrated preliminary reference design using project controlled requirements. The study will evaluate favorable features of highest ranked options. G/A drawings will be produced based on reference design. OCRWM will develop a set of ESF requirements which is part of their management systems improvement strategy. So, what I'm really telling you is we have a set of requirements documents and we're going to have them under control, be working with them during the first five or six months of the study. At that point, we're going to swap over to the management systems improvement strategy requirements. But, the point is the design will always be under control. And, they will be conducting a design review against those final baseline requirements.

The Title I design summary report will be transmitted to OCRWM along with the plan for a phased Title II design and implementation. In other words, the Title I design has to be essentially complete. So, we need to be able to evaluate what the total power requirements are, total ventilation requirements, and then in the Title II we can go more into this phased approach I was discussing, where we'll

do final designs on different phases, as consistent with that construction schedule. Then, OCRWM will accept the ESF configuration, Title I design summary report, and its implementation plan. And, that's really where John Bartlett says, yes, you've done what I want you to do or he sends us back to the drawing board.

MR. BROCOUM: I just need to make one comment at this point. Once John reaches that and he approves resumption, he still has one other hurdle to go through internally in DOE. That hurdle is called the Energy Systems Acquisition Advisory Board that he has to meet with and that will be done in September. In order to prepare to meet with that Board, he also has to submit a cost estimate, so that it will be an independent cost estimate review done, also, internal in DOE. So, there are some internal things that we need to go through to get this design resumed for Title II.

MR. MCFARLAND: Do you have anticipated dates on these--

MR. BROCOUM: The guidance I'm putting in the record has those dates for all those things.

MR. PETRIE: And, the next couple of viewgraphs indicate some of the major dates.

And, all I can say is we're in for a very busy six months. Commencing design study in February. Issue the requirements documents the last day in March. G/As and draft

revised summary report for the first access complete, 5/30/91. Design review of first access in June of '91. We get the ESAS report noting any changes or findings on June 30. Summary report for the second access complete, July 31. Design review for the second access in August of 1991. And, we complete the design review against the OCRWM/ESF requirement documents around the end of August. We go in with our plan to Title I, 9/3, and resume ESF Title II Design, October 1.

DR. DEERE: You have a busy schedule. But, it certainly appears that the studies over the past 12 months have led you into a study now, but you have a much firmer understanding, I feel, and much firmer backup of decision making processes.

MR. PETRIE: That's absolutely right. I think we're proceeding on a solid basis at this point.

DR. DEERE: I would ask you to comment a little bit about your option, the one that you're calling the reference design concept. It has the phased construction which does several things for you, but it also does a few things against you. Any contractor looking at this, to bid a job--and this to be built--or any owner would look real hard at why he's not doing parallel construction with 1 and 3 because they're--you know, they don't have to come one after the other. But he has to make a decision that I want the whole thing, therefore, I will

do it and the most efficient way as to do parallel construction. The way we have it now, you're probably a little bit in series. You do one and you evaluate and then you go on. So, what this is doing is costing time and time is a little bit of money. But, it gives you flexibility.

MR. PETRIE: Right.

DR. DEERE: So, it's probably worthwhile.

MR. PETRIE: And, you know, if everything worked out real well and we'd get all the money we ever wanted, we might do these simultaneously. We want to plan it so that no matter what happens, it will give us as much flexibility as we can to do it.

MR. BROCOUM: It was very important when John was providing us guidance that we incorporate the latest information before we proceed to the next phase. So, actually, he suggested a series of check points. At the end of each of those phases would be a check point. We wouldn't proceed beyond that check point until we're sure that we've incorporated the information and made any changes that need to be made further on down the line. That was a very important consideration on this part.

DR. DEERE: Yes. He wasn't disagreeing, but just pointing out--

MR. PETRIE: This is not going to be done as cheaply as

it can. That's the bottom line.

DR. DEERE: If you do the whole thing, but if you have to stop at a point, you're doing it the cheapest way.

DR. CORDING: Schedule may be more important than cost is.

MR. PETRIE: We have to weigh those. Well, I think that's the end of our prepared presentation, Don, unless there's some questions.

DR. DEERE: Okay. Very good. We'll be able to meet and talk a little bit then, just those few of us involved in the testing. We've already done a little over coffee there. So, it won't take very long. But, I think I would thank all of the presenters. They certainly have done a very good job, I think, putting their data in a way that we can see what's been done and we reasonably well understand it, maybe not every member or every consultant or professional staff or member of the Board, but at least one or two of them have understood the different portions. So, thank you for the effort in organizing this. We think it's a big step forward.

And, Max, I will turn it over to you.

MR. BLANCHARD: Thank you, Don. We appreciate the opportunity to meet with you including the audience here and discuss these topics, as you know.

I have a couple of things I'd like to point out.

One is I received a phone call this morning from Carl and you all have heard this particular facility referred to with different acronyms and there were some leading names going into the beginning of this week that would be renaming the facility since a shaft is no longer necessarily part of it. And, I think we started the week with underground test facility, underground test laboratory, or exploratory lab facility. However, a dark horse seemed to have evolved over the last day or two and it seems like the leading acronym remains the same. ESF with the substitution of shaft by the word "study", exploratory study facility seems to be the one that--

DR. CORDING: I was going to recommend that you change "shaft" to "slope". It's a very common mining term for that type of ramp.

MR. BLANCHARD: Two other things I'd like to point out. One is for the benefit of those who are planning to go to the High Level Waste Management Conference at the end of April and the first of May. It's a five day conference at Caesar's Palace. The American Society of Civil Engineers now has the brochure out and if you don't happen to have one which describes the five day conference, please see me. We'll be glad to make sure that a copy is distributed to you.

Also, we've recently developed an agreement with the

"Radioactive Waste Management and Nuclear Fuel Cycle Journal" to produce a special issue on summarizing our present state of knowledge on the processes and the mechanisms that affect Yucca Mountain including assessing their impact on performance assessment if a repository was built there. And, this journal has issued this week a call for papers. The deadline for the call was July 1, 1991. And, it's expected that the final manuscripts would be submitted in early '92 with a publication date late in '82. Anybody wanting copies for the call for paper, see me. I have a few with me and I'll be glad to make sure that you all get copies.

That's all I have, Don.

DR. DEERE: Okay. Thank you very much.

So, let's meet over here briefly to talk about testing.

(Whereupon, the meeting was adjourned.)

CERTIFICATE

This is to certify that the attached proceedings before:

UNITED STATES NUCLEAR WASTE TECHNICAL REVIEW BOARD

In the Matter of:

STRUCTURAL GEOLOGY & GEOENGINEERING

and

HYDROGEOLOGY & GEOCHEMISTRY

JOINT PANEL MEETING

Location: DENVER, COLORADO Date: MARCH 7, 1991 was held as herein appears, and that this is the original transcript thereof for the file of the Board.

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