UNITED STATES
NUCLEAR WASTE TECHNICAL REVIEW BOARD

FULL BOARD MEETING

The Adolphus Hotel
Sam Rayburn Room
1321 Commerce Street
Dallas, Texas 75202

April 8, 1992

BOARD MEMBERS PRESENT

Dr. Don U. Deere, Chairman, NWTRB
Dr. D. Warner North, Acting Chair
Dr. John E. Cantlon
Dr. Clarence R. Allen
Dr. Patrick A. Domenico
Dr. Donald Langmuir
Dr. John J. McKetta
Dr. Dennis L. Price
Dr. Ellis D. Verink

ALSO PRESENT

Dr. William D. Barnard, Executive Director, NWTRB
Mr. Dennis Condie, Deputy Executive Director, NWTRB
Dr. Leon Reiter, Senior Professional Staff
Dr. Sidney J.S. Parry, Senior Professional Staff
Dr. Sherwood C. Chu, Senior Professional Staff
Dr. Robert W. Luce, Senior Professional Staff
Dr. Carl DiBella, Senior Professional Staff
Mr. Russell K. McFarland, Senior Professional Staff
Dr. Edward J. Cording, Consultant

I N D E X

P R O C E E D I N G S

(8:30 a.m.)

DR. NORTH: I'm Warner North and I'm Acting Chair for the day. I'd like to welcome everybody to this second day of the meeting of the Nuclear Waste Technical Review Board. I hope everybody has had a good night's sleep. I'd like to add in passing my compliments to our staff on the selection of the hotel. Several people have talked to me about this and I'll add my own impression that I think of the facilities we've had in our various meetings, this is one of the best. So, I've enjoyed a good night's sleep and I hope that others feel the same way.

I'd like to comment yesterday's speakers and the teams they represent. I thought we had a very useful day in looking at the Early Site Suitability Evaluation and the Total System Performance Assessment. I was particularly interested in the comments of the two peer reviewers on the Early Site Suitability Evaluation. I thought there were a lot of insightful comments there. There was some concerns certainly that members of the Board have about that study; the small number of experts involved on the DOE team, the fact that the findings have to be one of three levels was something that the peer reviewers expressed themselves on, and also there's the issue of what the assignment was. The ruling of the conditions that had to be addressed in terms of determining which of the three levels of suitability would be the choice. It gives the impression of a rather narrow, legalistic way in which to assess overall risk. It's certainly something that makes me with my background feel a little bit uncomfortable, but on the other hand, I think the accomplishment was assembling a great deal of information that's been assembled in the last five years or so into one place, making it readily available, and having a team of experts assembled within the Department of Energy program and reviewed by another team of experts from within the program, and then finally the peer review from outside. So, there is at least a good nucleus of trying to get the expert judgment assembled, made explicit in written form so everybody can get at it, and now this will be taken out for further public comment and review. And, hopefully, this will be a very useful process for the program in determining where there is agreement and where people disagree with you.

Now, I'd also like to say similar complimentary things about the Total System Performance Assessment. Some of us on the Board have been waiting to see this for a long time and we're delighted there finally is one. And, I think it represents a lot of very good work on the part of a dedi- cated group of people who put it together and I'd like to offer compliments to all of them for the job that they accom- plished. On the other hand, as I sat there through yesterday and listened to it and tried to think about members of the general public who do not have a background in quantitative analysis and how they would react to this material, I thought, gee, this could come across as lots and lots of numerology and lots and lots of assumptions. And, it's hard to find the insights of the kind that we were getting from the ESSE. What is the expert judgment? So, I would hope as this evolves--it's going to go through obviously a lot of further evolution and a lot of review or hopefully strengths will be built upon and weaknesses will be corrected. I hope there will be a lot more emphasis on sensitivity analysis and a lot more emphasis on packaging the insights. What is the story? Not just the number or the model, but the overall set of expert judgment that lies behind that. Can we be assured that the people who did the elicitation and who built the models have really had full and deep communication with the expert community, so that the experts are fully comfortable that what is in the numerology really represents their judgment?

It seems to me that we started that process, but we have quite a long way to go. There are several specific areas where I think a lot could be done in the near-term. And, I hope as we continue in the performance assessment area, we will see some of these areas well covered at up-coming meetings. One of them is volcanism. You had a number of questions on that from members of the Board. Now, what if John Trapp's assumptions were used, why do the numbers come out in that case? It would seem that this is an area which is sufficiently well-defined so that you ought to be able to get the various points of view in the expert community and do a comparison where we go all the way to the complimentary cumulative distribution function bottom line. But, we do so from the various points of view that are out there in the expert community and then we do a comparison and contrast of how much difference these various points of view, models, probabilities on scenarios, and the like represent.

Similarly, I expressed some questions about the exponential distribution used as the input on infiltration on the global climate issue and we had a short discussion that ensued in which people were talking about the effect of additional vegetation if the rainfall were to increase with global climate change and the like. I would really hope that in coming back to that issue we will see a good summary of the story leading into a set of probabilities on various infiltration rates. Maybe you can convince me that an expo- nential distribution is the appropriate way to do it. But, frankly, I doubt it. The exponential distribution is a very, very simple distribution that can be justified against a maximum entropy criterion. But, here's a problem area where we have a great deal of expert judgment on which an enormous amount of work has been done, but obviously we have great uncertainties as to what future climate will be and what the consequences of that might be for infiltration at Yucca Mountain. So, I think the challenge to both the expert community and the modelers is to package up all of those insights in a way that can be readily communicated to the public and yet where you also have the ability to go beyond a set of words and get to the numbers. What are the probabilities of various levels of release that might result from changes in the infiltration? So, those, I believe, are the challenges that the program faces in this area as we go forward.

Now, today, we're going to hear from the Department of Energy further about the Total System Performance Assessment and, in particular, we're going to hear about their plans for integrating this study with the Early Site Suitability Evaluation into the next phase of test prioritization. I think it's clear that the Board is very interested in how these studies are going to be used by the Department of Energy. The program has reached the stage where calculation for the sake of calculation has very limited usefulness. The focus ought to be on managing the program, not just endlessly doing good and interesting scientific investigation. In particular, we would like to see the Department of Energy concentrating on what counts, determining which are the critical issues with respect to early site suitability, and what are the areas of performance assessment that are crucial to important design decisions such as the thermal loading issue. So, really, the focus ought to be on how does the performance assessment area support making choices or prioritization?

We're also interested in DOE's plans for systematic re-examination through performance assessment, site suit-ability evaluation, and test prioritization, and making this an ongoing process. How often are these exercises going to be repeated or are you going to do derivative types of studies? The Board has recommended for quite a number of meetings and reports that performance assessment ought to be an iterative process. And, we feel that the Department of Energy fully supports that point of view and is practicing it, but it would be good to get some of the details. We're also going to be interested in hearing from the State of Nevada on its views with regard to these activities.

Finally, we're going to receive an update on site characterization. Work has entered a new phase and the Board is very interested in the priority that DOE has assigned to surface drilling and the progress being made toward under-ground exploration.

So, with those introductory comments, I'd like to turn it over to Jeremy Boak.

DR. BOAK: I'd like to thank Dr. North for his compliments and, more particularly, for his challenges. I have found that in taking monthly tours to Yucca Mountain with members of the public that trying to describe to them what it is that I am in charge of at the project is a major challenge. I don't have my overheads with me when I'm doing that. So, it's particularly difficult to talk, but I am spared in that way of any of the numerology. I have to put it into fairly average, simple words. I think that the challenge of not only doing iterative performance assessments and getting ahead with those and getting ahead with some kind of interpretation that we can then convey to the public is, in fact, an exciting challenge.

Dr. North has also gone through what our schedule is for today which leaves me relatively little to do except to give a little more detail. The next two talks will be essentially a wrap-up and a projection for performance assessment and then Russ Dyer will try to bring together not only the Total System Performance Assessment, but the site suitability in some of our future activities with regard to the prioritization that Dr. North stressed was extremely important. We agree. And then, in the late morning and early afternoon, we will go into an update on the Site Characterization Program.

With that, I think I'll just introduce Abe Van Luik who will give us a summary of the results of the TSPA with emphasis on comparison between the Sandia calculations and the PNL calculations.

DR. VAN LUIK: Thank you for the introduction. My name is Abraham Van Luik and I work for the M&O. In particular, I work for Intera which is the performance assessment part of the M&O.

Now, when I first put this talk together, I was under the impression that both the Sandia and the PNL speakers were going to just talk about their analysis and that I would come in and say here is where they differ and here is where they were the same. Yesterday, every speaker said this is where we differ and this is where we are the same. So, with your permission, I'd like to flip very quickly through that part of my talk, and if you have a particular point you'd like to raise, of course, stop me, but that way we can finish a little bit early.

The total system assessment or the particular one that we did in '91 was to help start us on the way to an abstraction process which will be used for future total system performance assessments. Jerry Boak, yesterday, used the pyramid which is an analogy of limited usefulness, but the idea is that we need to justify the abstract models we use at the top of the pyramid by exercising lower level models. What we wanted to do for '91 is compare the results from two different modeling approaches and to demonstrate that we knew how to put together a system performance assessment using Complimentary Cumulative Distribution Functions.

For those total system assessments, there were stochastic simulations involved. Doses, as you heard from PNL, were calculated. The saturated-zone as a pathway to the accessible environment. Gas transport releases were calculated, human intrusion, volcanism, tectonism. A more detailed source-term than used in the past was calculated and--we've got too many Cs in here--the Complimentary CDFs were calculated.

We have some caveats, but we're not caveating this to death. It's funny how the program can change your vocabulary because I used to say clubbing things to death, now it's caveating things to death. But, the goal of any total system assessment is to combine estimates of engineered system behavior and fluid transport in the geosphere to evaluate total system performance. One way to evaluate it is by creating a CDF to interpret the results. This exercise was not totally comprehensive and the results are not adequate to support formal higher-level suitability findings. However, they do reflect our current understanding of our limited data.

So, let's get right into the comparison of models and analyses and, like I said, this was covered very well yesterday. So, we'll do it very quickly.

For the source-term models, the two things that were different and of note is that differing distributions of failure time were used and PNL also threw in waste glass, whereas Sandia assumed a spent fuel inventory.

The saturated-zone models of both PNL and SNL were based on the equivalent porous medium conceptualization. PNL did a two-dimensional stochastic representation of the car-bonate and the tuff aquifers separately, while SNL used a one-dimensional stochastic representation of the saturated-zone using averaged properties for both of those, the Czar-necki model for both of those aquifers. And, aquifer is a strong word.

In the unsaturated-zone, both PNL and Sandia used an equivalent continuum model and fracture properties were incorporated in the relative permeability and capillary pressure curves. The real difference is PNL used the deter-ministic two-dimensional vertical slice through the reposi-tory with a single fault zone, while Sandia used six one-dimensional stratigraphic columns from the repository to the water table, with flow simulated stochastically 300 times for each column. And, also, you had a discussion by Mike Wilson yesterday of the "weeps" model. That was a separate analysis done by Sandia.

As far as flux/percolation assumptions, which is probably one of the most important parameters for this mountain, five flux cases ranging from 0 to .5mm/yr were analyzed by PNL, while SNL assumed a range of percolation rates and the explanation is one that you got yesterday justifying the use of the exponential distribution. The idea was that we know that the mountain would be saturated if the flux was too high. So, we skewed things to the left, but you have a point that we need to revisit this. And, I think one of the more interesting things coming out of the surface based testing program is the work on the possible percolation rates. There are things to be learned here, in other words.

When we look at the conclusions, neither PNL nor SNL composite porosity model calculations at lower flux rates resulted in radionuclide transport into the saturated-zone. You've got to crank up the flux in order to get stuff transported to the accessible environment by that pathway.

When we look at the gas flow modeling, the drivers for flow were essentially the same in the two modeling efforts. There was a little technique difference. Transient calculation was performed by PNL while a series of two-dimensional steady-state simulations were used by SNL. Because the travel times were relatively short, the source-term model's release rate of ^{14}C was an important determinant of the cumulative release over 10,000 years. And, as was explained a couple of times yesterday, there was a lot of conservatism in this model. The differences between the results are largely directly related to the three order-of-magnitude differences in the assumed permeabilities. And, again, the surface based testing program is coming in with some very interesting data which Paul said would strongly influence his results. For example, if there is a lot of water in the--not a saturated-zone, but in a near-saturated-zone above the repository, it would reduce everything to lower release levels than we see now. So, the mountain may have a built-in correction for our problem.

Human intrusion assumptions, we went through this in some detail two times yesterday. If a driller hits a container up to--and, this was stochastically determined just how much for each realization--up to the entire content could be brought to the surface or released into the saturated-zone. If the driller missed, some contaminated tuffs were brought to the surface. In the saturated-zone, either the low-flow-rate tuff aquifer or the higher-flow-rate carbonate aquifer was assumed to receive the waste.

The number of holes was either fixed at 17 or inputted as a distribution. The timing of the drilling events, whether or not it hit a container, and the amount of waste mobilized were stochastically determined. The Sandia analysis assumed a spent fuel inventory and the PNL analysis assumed a mix of spent fuel and high-level waste glass. And, basically, for a realization that picked up high-level waste versus spent fuel, there was probably an order-of-magnitude dose difference which is an interesting result in and of itself.

One of the things we learned from this analysis is what are the important parameters. The frequency of drilling was important and this is a result that we've known for some time, but it's still somewhat surprising. The drilling frequency prescription in 40 CFR Part 191--actually, it's part of the guidance, it's not a prescription--resulted in multiple drilling events for the 10,000 year regulatory period. Aqueous releases--and this is no surprise--were dependent on distributions of groundwater velocities and retardation coefficients. And, I think that we heard yester- day that there may be new data coming in on the groundwater velocities in the saturated-zone that may change the way that we view this. Surface releases had little relation to site characteristics except as drilling frequency perhaps may be site-specific.

Basaltic igneous activity modeling, both labs used the same conceptual model, a dike intruding along a plane behind an upward propagating stress crack and it entrains waste as it flows up, releasing waste to the surface. Numer- ous trials--we're talking hundreds to thousands--were used to simulate various dike widths, lengths, and orientations to get a handle on the sensitivity. Dike length and width were found to be important parameters in determining the release. The Sandia analysis used published estimates specific to Yucca Mountain for recurrence rates and this represented the work of Bruce Crowe and also the intrusion probabilities were taken from University of Nevada-Las Vegas work which was sponsored by the state. The PNL analysis, on the other hand, was based on interpretations of literature not specific to Yucca Mountain, but the results were broadly similar which shows there is some robustness in the calculations.

So, now, let's get to the heart of the matter which is to compare the results. The good news is there was no disagreement over how the CCDFs may be combined. As you heard yesterday, there were two slightly dissimilar approaches used, but neither one is thought to be wrong. This is quite a change over five years ago when we were really wrangling over this issue, how do you combine CCDFs? CCDFs include scenario probabilities and parameter uncer- tainties. They're all rolled up into the CCDF, but deter- mining scenario probabilities remains an open question.

Let's go to the Sandia total system result and what I've done is picked one representative result from all the ones that you were shown yesterday. This is the one that assumes a 50/50, namely because they didn't want to do--you know, they were equally likely outcomes. And, I hope that this audience is mature enough not to attach too much importance to the actual numerical value on these charts. The idea was to do basically a sensitivity study using current data and current models. Like I said, composite porosity and weights, they gave it each an equally likely weighted outcome. The main release contributors were the nominal processes. In other words, the volcanism and human intrusion didn't mean that much to the CCDF, but the basic contribution here, credibly the vast majority of it is ^{14}C coming out of the mountain.

You were shown this in quite some detail yesterday. This is the PNL results and there were four pieces to this curve. At the highest probability with the lowest consequence was the human intrusion which missed and just brought contaminated tuff to the surface, not very serious. The second contribution is the release of gaseous ^{14}C. That's this straight portion right here. And, like I said, this came out very much lower than Sandia because a different permeability was used and it's up to the site characterization program to tell us which one is right or if both of them are. The third part of the curve, right here, is the lower-probability, but higher-consequence, which is just the way the curve is constructed, effects from a driller bringing the waste form to the surface or dropping it into the saturated-zone where it was moved into the accessible environment rather rapidly. And, the fourth contribution is from the basaltic volcanism bringing waste form to the surface right here in the very low-probability range. And, you see the EPA boundaries right here. But, this analysis, even though the analysts feel it's quite conservative, didn't get anywhere close to violating the standard. Now, it's interesting, you were briefed not too long ago by the Nuclear Regulatory Commission on its total system assessment in 1990 and this was their result. And, it's interesting that in their analysis, they only included aqueous-pathways and, just like everyone else, the tools are there for the aqueous. They have to be developed for the gaseous. And, we're just about a year ahead of them on that one is all.

Two scenarios dominated the CCDF because of high-assigned probabilities. The reason that the probability comes up to 1 here and .1 here is because that's the probability assigned to the two scenarios that actually contributed to this CCDF. The first one was drilling under non-pluvial climatic conditions assigned to .9 and the flux that they assumed ranged over .1 to 5mm/yr. The second one was drilling under pluvial climatic conditions where they assumed the flux went from 5 to 10mm/yr. And, you can see that these two probabilities add up to almost 1. The cases without drilling because drilling was considered to be so likely were down in the 10^{-6} range--or 10^{-3} to 10^{-4} range, I think is correct, and the plots for those without the drilling look identical to this block, but are just moved down. So, the contribution from the act of drilling itself did not materially alter the CCDF. It was only the probability of 1 assigned to drilling that moved the whole chart up to the top and that's what this is right here. And, I think that you had a good discussion with them when they showed these results.

The non-pluvial case releases were just below the violation points specified by 40 CFR Part 191 and the pluvial cases then obviously were above those violation points. Fracture flow was important to determining releases. In fact, flow vectors at or below 2mm/yr--in other words, when they assumed infiltrations at or below 2mm/yr--did not violate the 40 CFR Part 191 control points. Now, this is a good sensitivity analysis. It points again to the same thing. Your flow velocity is very important to your total result.

Now, courtesy of the EPRI folks, we have something that's hot, not even off the press. You were briefed, I believe it was, last fall by EPRI on their Phase 1 analysis work and they were kind enough for this talk to give me the advance result from the Phase 2 analysis. Now, because their modeling approach is--I wouldn't say radically different, but very different from the other three things that I've just showed you, PNL, SNL, and USNRC, I should mention that the

NRC approach is very much based on the analysis work that was done in 1987 and 1988 by PNL. In fact, it follows it even to the point of using its data tables. So, those three are comparable in approach except the assumptions are different. This one here is very different. General features of the Phase 2 analysis in the report is in publication and it should be out within two months, I believe. Where's Bob Shaw?

MR. SHAW: Yes.

DR. VAN LUIK: Yes, okay. The estimated releases from hydrologic and gaseous pathways, volcanoes, and human intrusion, you'll recognize it's the same list that we followed. They used one expert to designate input for each scientific and engineering field. They represented uncertainties in knowledge, models, and data with discrete distributions, discrete values and probabilities. They used logic trees as tools to specify inputs and to organize release calculations for all combinations of uncertain models and parameters. Calculated CCDFs of release from probability of each combination of models and parameters and from releases given that combination. And then, they calculated releases for 13 nuclides including gaseous Carbon-14. You will only see 12 nuclides on here. That's because one was retarded to the point that it never made it to the chart. The good nuclide.

Now, how is this different from the results that were shown you before? Well, there were improvements made from Phase 1 to Phase 2. A surface model, a surface-water model which Bob Shaw in answer to a question yesterday briefly explained, accounts for precipitation-infiltration using site-specific soil and topography. The source-term model includes unsaturated, wet-drip, and saturated conditions and accounts for both matrix dissolution and elemental solubilities. In other words, there's more sophistication in each of these modules than there was in Phase 1. The hydrologic flow model, while still simple, accounts for two layers, the Topopah Spring and the Calico Hills units, and models non-stationary flux. And, to illustrate, you know, the same thing that we're trying to illustrate, that you use more complex models to justify what's in the simpler models, it was verified with a more detailed code, TOSPAC.

In the EBS model, they applied Weibull Distributions for specific EBS designs and this is basically keying off the conceptual design that's current in the program, but it can be easily--well, probably not easily--but it can be revised for other specific designs and I think you've been briefed already on some of the aspects that are being looked at for altering the design. The gas release calculations incorporated detailed gas flow calculations for a range of possible repository temperatures. And, the human intrusion model, similar to what we've just seen for the others, drilling with water table contamination, drilling with surface contamination, and excavation, and it has a general format that can be revised or extended for further applications. It's a very flexible model.

Specific conclusions from this analysis is that hydrologic pathways lead to the largest releases with the caveat for high levels of release. Gaseous release of Carbon-14 is the predominant contributor, if releases are low. And, you can see on the CCDF that the dominant release in this illustration is the Carbon-14. Volcanoes, earthquakes, and human intrusion do not appear to lead to large releases.

The largest releases are associated with unlikely --and, this is the case where the aqueous-pathway dominates --is associated with unlikely combinations of large fluxes, no diversion of groundwater flow--and I think you have seen before in the PACE-90 results that were presented to you that 2-D models suggested if there's too much water coming into the mountain, it's diverted laterally, no diversion--flooding of part of the repository, and high solubilities and dissolution rates. If all those combinations are taken into account, then aqueous releases dominate. At lower levels of release, EBS design, fracture-matrix coupling, and diversion of groundwater flow affect estimated releases. Factors that are less influential are thermal pulse and potential borehole fractures leading to failure of the air gap.

What did we learn from all of these things? And, by the way, I think that the EPRI model serves a very important purpose of having a totally different and independent look at the behavior of the mountain and it's somewhat heartening that the results are very similar to what we have come out with. Not in the quantitative--you know, you can't compare number versus number, but the general trend is the same.

One thing that we learned--and, I don't know, all of these lessons, we already knew, but it was reiterated by some of the difficulties that we had in specifying data for two different conceptual models. One data set feeds one model, but it may not be sufficient for another model. There's a crucial need for future total system assessments to take the time to create a comprehensive standard set of data and it does take time. Bounding models and their high-release results--and, you saw those--reflect current uncertainty in conceptual models and data sparsity. And, we are counting on the site characterization program to bring us the data to help bring that uncertainty down.

We identified a couple of activities that could be completed without additional site data. In other words, while we're waiting for data to come in, we can exercise the current conceptual models to look at the effects of parameter uncertainty and we could design, using our current models, tests of the importance of conceptual model and process uncertainty. This is kind of repeating what I just said. Performing a total system analysis includes a comprehensive review of assumptions and data. You don't just turn the crank automatically and five minutes later you come out with a new assessment. It would be meaningless. The objectives of this particular total system assessment were achieved. We wanted to demonstrate the capability to do it, we wanted to generate CCDFs, and we wanted to expand beyond all of the previous analyses, not just PACE-90.

The results of this particular TSPA have limited use in programmatic decision-making, but the point is that they do have some use. For example, the ^{14}C calculations, we think, are applicable to any unsaturated site, as long as you take into account the permeabilities for that site. The results of that pathway release calculations suggest con-sideration of a more robust engineered barrier system in order to satisfy the current regulations. Major radio-nuclides of concern with respect to the aqueous release are the fission products which I believe is no surprise, but it's nice to have that reconfirmed.

Now, I brought this document, you know, in a brown paper bag to--I can't let you see it, but now you know it exists. Chapter 11 has a very comprehensive list of all of the data that we thought was important to this analysis where we need the site characterization program to provide more. So, we are looking in depth at the data needs. And, this is just a wrapup, four points.

It would really be nice to have a firm waste-package design and emplacement concept. As you saw, especially for the Carbon-14 calculations which happen to dominate the mountain's releases, the assumptions made about the waste-package failure rate are very important to the results. A statistically meaningful--if you're going to do stochastic simulations, you have to have statistical, meaningful data--set of hydrologic property data is needed for all important stratigraphic units. Data are needed on the scale comparable to the modeling and geochemical data are needed including modifications expected from thermal changes.

That's a wrapup of what is appropriately Chapter 11 in this report. This is the Sandia reports which will be coming to you after it's gone through the internal DOE review, but right now it's under a brown paper wrapper. But, I think that the important thing is that we have reconfirmed what we already knew and there were some things that we did learn from these analyses. If you have no questions, I will turn the time over to Suresh Pahwa.

DR. NORTH: One question for clarification. Is what is in the brown paper bag the same as what was sent to me earlier, the initial Total System Performance Assessment for

Yucca Mountain with a note on it, "do not release this report to anyone"?

DR. VAN LUIK: As long as it's signed anonymous.

DR. NORTH: Okay. So, here's another copy to represent --I appreciate the advance disposition.

DR. REITER: No Chapter 11.

DR. VAN LUIK: There is no Chapter 11? Ha-ha. Does that mean you're not anyone?

DR. NORTH: I must confess, I have a Chapter 11 in mine. It's rather short.

Okay. Other questions? Dr. Cantlon?

DR. VAN LUIK: A point of clarification, the PNL report is about the same size and it does also have a chapter--it's not Chapter 11--that looks at recommendations on data needs.

DR. CANTLON: As the M&O operator, what can you tell us in this first iteration about planning the research program? What are the priorities now? And, assuming that DOE remains under the stringent fiscal constraints, what does that tell you about what needs to be done to move this ahead in terms of site suitability?

DR. VAN LUIK: It feels real good to have iterated once and I'm very happy to say that the exact question you're asking is going to be addressed by the next speaker who also represents the M&O.

DR. CANTLON: Very good.

DR. DOMENICO: In the sense that Intera is in charge of --or contributing to performance assessment now, you've had, let me see, four analyses; three of them showed compliance, NRC showed some violation. Wouldn't you think we could learn a little bit more if you drove each of those to failure so that we can see the things that contribute to failure instead of showing that we can get compliance as we see on that diagram right there? In other words, what are the items that result in failure? To me, this is the--and, the total CCDF, I think, is less useful than the individual ones if you approached it that way. I'd like to see how the system can fail. I'd like to see--I have more faith in the limiting value--if we have a K_d of such and such, we're in trouble here. I will have more faith in that number than the K_d you use to show compliance. I mean, then, I would have a feel.

DR. VAN LUIK: Yes. I think we're in total agreement. In fact, the Sandia analysis picked its distributions wide enough to cause failure for the exact reason that you specify. The nice thing about the EPRI analysis is, I believe, that they tried to be--I think they tried to err on conservative side wherever they made a decision, but they tried to be as realistic as they thought they could get using the expert opinion that was available. So, that's the reason I like the EPRI analysis. It's independent and it's trying to be as realistic as possible, while the Sandia analysis tried to drive the system to failure to learn exactly what is important. And, the PNL analysis falls somewhere in between those two. But, your point is well-taken and I think the Sandia analysis answers that very well.

DR. REITER: Yeah, I have a question and I'm not quite sure if it's correct, but perhaps you could explain. In looking at the different radionuclides that are released and comparing the releases that EPRI had and the one that you had, it seems that your releases or SNL releases were dominated by technetium, perhaps a little selenium and a little iodine. Where, if I look at the EPRI releases, except for the low levels they're dominated by things like uranium, plutonium, neptunium. Similarly, if I remember the NRC releases, they were also dominated by things like plutonium and uranium. Please, correct me if I'm wrong. I'm wonder if this is due, at least in the NRC part, for them taking into account colloidal transport while the SNL told us they did not take it into account. Is there something there or am I misreading it?

DR. VAN LUIK: I know that the NRC calculation did not take into account colloidal transport and, in fact, some of the thinking on colloidal transport is that it actually may be a block, that it would be filtered out by the matrix, unless we have the "weeps" model being the correct model. The difference in the nuclides that are important, I think if you look at the data used for retardation, it would explain a lot of that. And, I think the final answer is not in yet on what the specific retardation coefficients are going to be for Yucca Mountain. But, I think it's more a K_d difference and a range of K_d difference with the uncertainty built into that range. But, colloidal transport has not been looked at and Tom Pigford is looking at colloidal transport from the waste form into the host rock and suggests that, as soon as it hits the host rock, it's going to be a trap rather than an accelerating mechanism. But, the jury is not in on that.

DR. DOMENICO: The source-term used by NRC was not very sophisticated.

DR. VAN LUIK: No.

DR. DOMENICO: I do believe the source-term used by EPRI--and Bob will correct me if I'm wrong--is probably not as sophisticated as the one used in the PNL and the Sandia model. I do believe that the source-term used in those two was the most sophisticated that has been employed to this point. And, the source-term is one of the most important things you've got in those models, obviously. And, Bob, will you comment on the sophistication of that source-term?

MR. SHAW: Yeah, I'm not sure what the word "sophistication" means in this particular case, but I think that our source-term is a fairly detailed source-term in terms of solubility, in terms of the inclusion of isotopes, in terms of various mechanisms that would result in the penetration of the barriers that are present there. I haven't looked in detail at the other two to make a direct comparison. And, as a matter of fact, while I'm here, maybe I'll make a few comments that range on that, as well. It's always difficult to sit in the audience and hear your results presented by someone else. I want to compliment Abe Van Luik on doing an excellent job of doing that. Nonetheless, having sat there, I have a few comments to make. I won't take much time.

As Abe expressed, our emphasis was not on making things conservative, but on being as realistic as we could to try and get a set of results that were credible and realistic. Abe, if you could put back up your next to last slide, I'd comment on that. Conservatism is something that has been defined throughout here and it's never quite clear to me what a conservative assumption is. There are times when you can make what you think is a conservative assumption, but in a systematic analysis that goes through, it turns out to be non-conservative. And, so in that sense, we attempted to make things just as realistic as we could and then used the various trees on the logic diagram to offer other opportunities.

I'm sorry, that's not the one I was looking for.

DR. VAN LUIK: Okay. I was wondering, the next to the last in your part or--

MR. SHAW: No, next to last, period.

DR. VAN LUIK: Oh, okay.

MR. SHAW: At least, I think it was--oops.

DR. VAN LUIK: Lessons learned?

MR. SHAW: Excuse me just a second.

DR. NORTH: Results of this TSPA?

MR. SHAW: The results of this TSPA, yes. That's the one that's at the title.

The first statement I would agree with except I would delete the word "limited" and now I'm referring to the EPRI model, in particular. I think the results of this TSPA have use in programmatic decision-making and should be used, just as I think Jean Younker's results in the ESSE have definite use in programmatic decision-making. And, I believe we've reached the point with the sophistication and in the confidence in these systems that they should be used in decision-making. That is not to say that the results of these should determine what's done, but they should be used by the decision makers as in input, one of confessedly many including finances and other aspects. I think there are some significant improvements that could take place in our analyses. It's noteworthy that none of us have considered anything but a vertical placement of the waste canister and yet, as we have our discussions on canister, one of the predominant aspects of that is the horizontal placements within the drifts. And, yet, none of us has appropriately modeled that particular aspect. And, there certainly is in our results a fairly high sensitivity to the source term and, therefore, the canister and its degradation compared to other things.

The comparison between the models, which was done in a preliminary but very nice fashion here by Abe, I think should be done in a much more detailed fashion between the modelers so that when we look at the particular aspects that result in higher releases, we go back to the details of our models and say are they comparable, are they different, are the differences justified, or should we make changes in each of our models so that we bring them in on a comparable basis? I think these inter-comparisons would be very valuable for the modelers to determine what are the sensitivities and what are the major features that cause these differences.

It's interesting that every one of the CCDFs that Abe presented is on a different scale. Both the X and Y access have different scales and I'm thinking why, you know? One of them goes down to 10^{-8} or something like this in probabilities. And, it seems to me that we could get together and decide if there was a suitable scale that's appropriate and then visually we have the same picture as we go from one CCDF to the other.

One other aspect that was hit on by Paul Kaplan that I think is a very important part of what we should be doing now as we proceed and that's the use of expert judgment. Abe properly emphasized that in our work we used one expert for each of the technical areas and that's because we want to illustrate how this was done, and confessedly, the integration of the various technologies is one of the real challenges that I think all of us have had in trying to bring this together. The interfaces are vital and they really make the difference. And, yet, we've reached a point now where I think grouping people together and using techniques, such as Paul Kaplan did, to elicit expert judgment as a means of understanding the uncertainties that are present in each of the inputs, each of the models, each of the processes is a very valuable path to take and I think you're aware that we have started that process by taking the seismic arena and having a group of experts--Walter Arabasz referred to our meetings we had recently--and we have now conspired with DOE to have a meeting where we will get together and talk about the lessons that we learned from that particular meeting so that we can transmit those to DOE for their use in any future work that they do on expert judgment.

That's a long winded response to Pat's question.

DR. NORTH: Thank you very much.

Any further questions or comments? Staff?

(No response.)

DR. NORTH: Others in the audience?

MR. WILSON: Mike Wilson, Sandia. I wanted to amplify on the response to Leon's question about the NRC calculations. Abe was correct in saying that they did not model colloidal transport. However, they did artificially reduce the retardation of plutonium to sort of try to take colloidal transport into account in a way. That's not a realistic portrayal of colloidal transport, but it is useful as a reminder that if there is something that causes fast transport of plutonium, then you're in big trouble, and we've done calculations like that at Sandia, too. That is why there's the big difference, the retardation of plutonium.

DR. NORTH: I'd like to put on the record a reiteration of a point I made yesterday. I think the issue of fast transport of the actinides is a very, very important one for further work. And, the conclusion you had on lessons learned that the major radionuclide of concern with respect to aqueous release are the fission products ought to carry a caveat that we should continue to investigate potential fast pathways for the actinides and not leave that off our list. There may be a very good story there that convinces us all that colloids are not a problem and complexing with organics is not going to be a problem, but I think that story needs to be developed and documented so that we can really be assured that that area doesn't have unpleasant surprises waiting to come out at some future time.

MR. BOAK: I did want to thank Bob for his comment about scales. In fact, the request that went out to him requesting that he send us his CCDF was an early attempt to try and solve that problem. Unfortunately, the data didn't get together soon enough. So, Abe was stuck with three slides with different scales on them.

DR. NORTH: Okay. I think now we'll go on to our next speaker, Suresh Pahwa.

DR. PAHWA: I'm Suresh Pahwa also with the M&O team from Intera and John--says to make sure that I find out that it is another--representation here.

What I would like to talk about is where do we go from here? Actually, Dr. North gave already a nice overview of my talk earlier, what I wanted to talk about. It's a good summary and we agree whole-heartedly with what you said earlier is that's exactly the direction we want to go and I'm going to fill in a few more blanks of what you said.

What I would like to say about it, just to summarize very briefly, the accomplishments of the performance assessment to date, the general program direction of performance assessment, what is an iterative PA in our opinion, what we think the next PA iteration should be, and what kind of applications did it have within the program. And, we would also like to present a conceptual schedule and it is a conceptual schedule and schematic and we don't know the dates on it. They aren't intended to be commitments at this point in time. What we would like to say is that's a direction that we are thinking about and just a summary of the presentation.

Accomplishments at this point in time. Total system analyses have been done and it's been pointed out in at least three different reports; PACE-89, PACE-90, and now TSPA-91. What was accomplished in that is that we think individual codes have been exercised individually, as well as they have been linked together, and the linked together is--in terms of the source codes with the flow and transport codes--as well as the single codes have been done. So, at this point in time, the various levels of codes, various types of codes have been exercised. Also, in the last TSPA, in this TSP in '91, the two major accomplishments have been the multiple scenarios have been modeled and CCDFs have been generated. We think it's a major step forward in terms of being able to do performance assessment for the sites. Now, we have developed the methodology in terms of modeling multiple scenarios, more than one, and how to generate CCDFs for the site as a whole.

The general PA program direction. We believe very strongly in iterative performance assessment and the next step is to implement the iterative performance assessment and we think we have taken the first step in terms of doing that and we also believe that's really the only way it makes sense in terms of the performance assessment being able to help the program direction. We think that the iteration objective ought to depend upon the program milestones, whatever the program needed at a given point in time. That the calcula- tion exercises should not be done just to run the codes and exercise the codes, but simply--but they ought to have raised specific objective as to what needs to be done. And, this phase ought to take a significant amount of time as to what the site characterization needs are, what design needs are, and what may be regulatory and licensing needs at that point in time.

We also think that the PA should provide direct input to the issue resolution process and to the annotated outline for license application. In the shorter term, it is site suitability determination; in the longer term, it is the license application that we're leaning towards.

We think that within the program, given the resource limitations, the analysis, in order to meet the program milestones and one additional, the tools that are used in order to justify and--the tools that are used in order to meet the licensing application need to be emphasized at this point in time. We're not suggesting that we com- pletely shut down the development activities, but there is a need to re-emphasize and re-prioritize some of the areas within the performance assessment.

What is one performance assessment iteration? We think one performance assessment iteration should consist of exercising all the pertinent levels of the performance assessment models. Let me put this PA pyramid, the hierarchy of models, and in my mind, one iteration is modeling the complete pyramid. And, what I mean by modeling the complete pyramid is the high-level models need to be justified by the lower-level models and the lower-level models need to address the issues that need addressed by the lower-level models. For example, the site characterization needs--answer to the lower-levels and the design answers may come from the sub-system models and one complete set of iteration, all of the levels, is one iteration. Now, that does not mean that each time every model is exercised, but it simply is a complete picture available and you update them as you go along. So, you may have a significant baseline achieved the first time. You simply update whatever percentage needs to be updated with each iteration.

We also believe that the models need to be robust so they can be trusted more, they can be justified and reli-able. If not, you need to use conservatives on wherever it is needed and a significant part of it is sensitivity anal-yses, like Dr. Domenico said. I think that's very important is to see where the system fails, but the first thing is you need to find out is are you in compliance in general terms and the second part is to see where the system fails. And, that is a very useful part of sensitivity analysis. If the system fails in terms of the parameters which may be reasonable, those are the, ditto, prioritization needs. So, I think it is sensitivity is very important in terms of providing input to the program as it moves along.

We believe that the high-level model abstractions must be based on the lower-level processes and detailed conceptual models and that's part of iteration. Like I said earlier, each iteration is one level just trying to do a complete pyramid. It is updating the previous baseline. So, you run both models and both processes where the data have changed or the program priorities have changed. You need to bring that into the model and it does not necessarily mean running 100% of all of the codes every time. We believe the iteration is driven by and the results are provided to the various program elements. You do the iterations again to provide input to the regulatory licensing, to site characterization, to design, and to understand the importance of reduction and uncertainty due to testing. There may be parameter that it doesn't really matter whether there are few dollars to manage it up or down and so you can simply re-prioritize the resource allocations to the ones where it does matter and to be able to make programmatic decisions, such as the one Bob Shaw pointed out about emplacement, thermal loading, and there may be other types.

Well, having given an overview of what a general performance assessment is, what should be done in the next performance assessment iteration? And, we're looking at the program objectives over the next 12 months or so. The types of issues that we're facing right now are ESF design issues; the surface-based testing in progress right now; the thermal loading providing input to the design, to the MRS design; site suitability evaluation going on; the issue resolution and this also includes things like the waste emplacement. And, the issues of resolution is multiple in itself. There are more than one efforts--to resolve more than one issues.

How would we implement it? We would implement by --at this point in time, the number of scenarios having modeled. What you would do is you would look at the broader set of scenarios and try to group them down so you're down to a finite number of scenarios that can be modeled and the parameter--within each group of models--represents multiple scenarios, in turn. And, in effect, just do a smaller way to handle multiple scenarios and reduce it, a lot of problem to a practical problem, and use lower level process models or complex models, if I wanted to call them, to justify abstrac- tions at high-levels and definitely emphasize sensitivity analyses because that is what determines where the program should go.

DR. CANTLON: Before you take that off, as you look at that list under program objectives, ESF design is a very explicit thing, thermal loading is very explicit, site suitability, very explicit. Surface-based testing, though, is a means. It's a different item.

DR. PAHWA: It is.

DR. CANTLON: What specifically are you looking for?

DR. PAHWA: At this point in time, it is a program phase, surface-based testing.

DR. CANTLON: I understand that.

DR. PAHWA: Right. And, there are decisions--in the surface-based testing that can be provided, input from the PA. For example, which parameters should be measured? How important is saturation in various layers? Should the emphasis come under that or is it more important to look at characteristic curves? It could be interference tests. I mean, those are the issues within the program and I--

DR. CANTLON: Okay. That would be useful to have that sort of in the same category as the other in that set.

DR. PAHWA: Okay, point taken.

DR. DYER: Might I add something? Dr. Cantlon, one other thing that we've used to perform the assessment for the surface-based program is trying to insure that whenever we field the test, that test is not going to jeopardize the waste isolation capabilities of the--

DR. CANTLON: Very good. Thank you.

DR. PAHWA: Again, I would like to re-emphasize that this is only a conceptual schedule. It's a schematic and not a commitment of these dates at this point in time, but it is a commitment to the direction represented here. It is a commitment of iterative performance assessment. And, if we stick with the 2001 license application date as the long-term milestone, we think approximately six iterations make sense. We also think that the iterations--and, these are represented over here, complete iterations at approximately 18 months time frame shown here--that during the early period there have been 10 other iterations within site characterization at nine month periods which increased to six month frequency, and when you move on to the design phase, the site characterization iterations go down to nine months and design iterations go up to six months. So, it does change with the program phase and we think that--necessarily being 18 months, they should be tied to the milestones. And, we have looked at this in little more detail since the time of this viewgraph, and the early part, it's maybe somewhat longer than 18 months and it will be somewhat shorter than 18 months at the back end over here, but six iterations is about the right number between now and 2001 and we do think that internal iterations are important, as well, as you move through time.

To summarize what has been done at this point in time, various codes and models have been exercised. The total MGDS system performance has been assessed. It's an initial look at it. The scenarios have been developed at this point in time. The objective is to look at how those scenarios can be used in a meaningful way, in a practical way to assist the performance of the site. And, we are in the process of implementing the iterative performance assessment approach, and as a part of that implementation, it's impor- tant to provide links to various other components of the program. Within the PA program, the emphasis should be increased on the analysis which is providing the input to the other program elements and validation. In effect, preparing rationale and justification for the tools that are being used. A conceptual schedule has been developed and at this point in time the next thing is to identify in detail what should be done for the next iteration. Take down, for example, thermal loading. What can be done? What are the issues to be addressed? What models should be used? What parameters should be varied? And, lay down that in detail. And, that's what we are looking at at this point in time.

DR. NORTH: Thank you. Questions? Russ McFarland?

MR. MCFARLAND: I'm curious about your programmatic objectives on the third from last viewgraph and how they were selected, in particular, in responding to Bob Shaw's comment and the importance of the waste-package definition and emplacement concept and, yet, there's nothing in this list of five items that I can see directly related to that issue. How did you select these programmatic objectives? How did that list come about?

DR. PAHWA: This is not intended to be a complete list at this point in time. This is a conceptual direction pre- sented and they're exactly the program objectives that one would look at. And, the waste emplacement was something that would have to be looked into for the next iteration. I want to make sure that--this is not complete by any means, at all. But, once we do look at the complete list of the program activities next year and the milestones, when we need to prioritize them, it is possible that one cannot address all of those issues. So, it's not a commitment to do all of these or only these.

DR. NORTH: Dr. Cantlon?

DR. CANTLON: To what extent now is this system being set up so that you can back off and look at the total waste management system? Because the inputs on thermal loading feed all the way back to the reactors and the mixing of the fuel, whether or not you're going to have a MRS, and that sort of thing. What's happening to couple that portion into the set?

DR. PAHWA: Right. Yeah. What is being done in parallel with this is the total system analysis and that's being done with the headquarters and this is only the MGDS part, but at the same time the effort is in progress in parallel to look at the broader issue, the entire system, as well. And, if you're asking me in specific questions, I'm not sure I can answer this. Sareen may be able to address that.

DR. SAREEN: One of the things we're doing as part of the total system is developing a total system model that starts with the waste acceptance as it impacts all the way down to the MGDS. An example of the exercise with that model would be a thermal loading, for instance.

DR. CANTLON: Thank you.

DR. NORTH: Other questions? Bill?

DR. BARNARD: In your assessment schedule chart, you've got a series of program phases, one of which is site suitability. Are you implying that you're going to be able to make a judgment about site suitability at the end of 1994?

DR. PAHWA: No. No, this doesn't necessarily mean that, but at this point in time--well, this should be looked at with these program phases. Again, I want to go back to the word "conceptual" on it. At this time, the milestones do show the ACD phase and LAD phase and then a DEIS and a license application after that. Site suitability may come--the final decision on site suitability may come here. But, we think in terms of the emphasis within the program, we may know enough about site suitability that even though it is not finally addressed, it may be of somewhat lower priority within the program than the other phases, but the final decision on site suitability may be somewhere over here.

DR. DOMENICO: Suresh, your thermal loading material, will that lead to what you might consider to be the best strategy for thermal loading? Would that be an ultimate goal of those studies? Because we have end members on that, you know. It's hot, hot and cold, cold and things of that sort.

DR. PAHWA: Right, right. I think our answer to the thermal loading will be the impact from the MGDS performance on thermal loading. It does not reflect the total decision in terms of the cost for the MRS and the scheduling and transportation routes and so forth, but, hopefully, it will provide all the answers that the total system studies would need. So, it may, in effect--we may go through enough study that it may, in effect, be--in terms of looking at different scenarios and that would be the MGDS thermal--the performance assessment role on the whole thing. But, I think the deci- sion ought to be made in terms of the look at a total system.

DR. DOMENICO: Okay, thank you.

DR. NORTH: Bob Shaw?

MR. SHAW: I have a mild concern about the use of the word "iteration" and I'd like to comment on that a little bit. And, I'll just use the EPRI modeling as the nature of the comments. In our Phase 1, we collected together a group of experts and we developed a process and our emphasis there was to show the process works and it illustrated how it could be done. In our first iteration, which I've also called Phase 2 which you heard the results of this morning, we went through some major revisions in the Phase 1 and we have developed one that we think is now realistic and credible and can be used. I not only consider that my first iteration, I consider that my last iteration. And, the sense there is that that was a major--both of us were major efforts; the first one to put it together and the second one in which there were major revisions. I consider now that that model is in a suitable form where it can undergo revisions, it can be modified, and it can be exercised. I do not consider that we're going to have another major exercise to go through and consider the whole scope of the entire model and that's what I would consider to be an iteration. But, rather, I think we will be looking at particular questions that arise and some of them were addressed here this morning. What is the waste canister, what about gaseous release, what about colloidal transport, and in particular, we're very concerned about solubility and the temperature effects and even the chemical form of solubility. But, those are just simply modifications and changes that take place.

My concern is that we think of iteration as a major effort in which we all sit down and start from ground zero again and come back to some big model. Our model can be run in a matter of hours to exercise it, to look at the relative effects of questions and judgments that come along. Meanwhile, having said that, I very much agree with the kind of schedule that Suresh has put up there which indicates approximately an 18 month period for reporting. And, I think that's a suitable time over which changes and revisions would have taken place in most of these models and it would be suitable to upgrade the report to show what those changes were and what their effects were.

DR. NORTH: Thank you. Any further comments or questions?

(No response.)

DR. NORTH: On the interest of time, we ought to push on then. Russ Dyer is our next speaker.

DR. DYER: Following on the talks yesterday and this morning, I'd like to step back. I'm not going to talk specifically about performance assessment and I'm not going to talk specifically about site suitability. But, what I would like to address this morning is how the site characterization program and modifications to the site characterization program can be influenced by the findings, the out of performance assessment, and the out of evaluation, such as the ESSE report.

I'd like to use this as just a talking point to start out with. This shows John Bartlett's engine of evolution in a current form, if you will. We have various parts of the program designed; issue resolution, regulatory issue resolution, performance assessment continuing on converging paths. Underlying everything is the site characterization program. We have these large cycles and we have relatively small cycles in here. We have mechanisms by which we can modify the site characterization program. It is under a configuration control process. There is a control mechanism by which we can add to, change, delete parts of the site characterization program. But, the problem I have, and Carl right now, is that in any one given year in our current climate, we are in an unlimited environment. How do we make sure that the parts of the program that we execute in any one year are the most important parts of the program?

And, what I would like to share with you this morning--this is a little exercise we have underway to develop a tool which would allow us to re-examine this question at any time that I need to. Last year, we ran through something like 52 different budget exercises, I believe, each of which has a different set of assumptions, a different set of numbers, and each of which requires that we re-examine the prioritization of the program in order to make sure that given that limited set of resources that, out of that, we pick out the most important things to do.

And, I'm going to use this again as a talking point. I'll throw this up. I'm told that my graphics capa-bilities is not that good. But, what we're looking at is essentially a three-dimensional spreadsheet with--I'm going to give you a little more information later about what this face and this face look like. But, in three dimensions what we're building up is something that looks like this which has multiple sheets in here that stack up like so. Major columns of the sheets or the major titles of these individual sheets would be something like ability to detect unsuitable site conditions, provide regulatory assurance, build scientific confidence, maintain constituent confidence, and of course, meet cost and schedule demands and then some aggregate ranked benefit out here. And, what I'm showing here is that this column right here, these rows, would be a listing of tests out of the site characterization plan, studies, activities, aggregates of studies, and we would be able to go through and determine some aggregate ranking which would essentially highlight for us, given a particular set of assumptions, which series of tests would rank highest in the prioritiza-tion scheme given those assumptions. And, I'll set this aside and we'll come back to it in a minute.

This strategy follows from the approach we used in an earlier effort, the test prioritization task force, which we finished up a little over a year ago. If you remember back to that effort, we only looked at one reason for test-ing, if you will, and that was public health and safety. The surrogate we used for that was compliance with the cumulative release standard of 40 CFR 191. And, on this setup, this would fall in this category right here. One thing we realized in the process of doing the TPT was that that's not the only reason to do testing. If compliance with 40 CFR 191 were the only reason to do testing, then we would have no reason to do any of the environmental program. Of course, we know that that's fallacious.

So, let me look at--let me take one of these sheets and the sheet I'm going to take is the first one which is the ability to detect unsuitable site conditions. And, we can use the results out of the ESSE report, identify a series of technical issues across here. We know that we have 106 tests in the site characterization program which make up this side of the matrix and what we want to do is to be able to go through and score the ability of these tests as to their ability to resolve some of these technical issues.

And, we're following essentially the spreadsheet model that Bruce Judd and Steve Mattson developed for the test prioritization task force. In this case, though, the specific attribute we're looking for is the ability to detect unsuitable conditions and we have a series of columns across here which fall out of the 33 technical issues identified in the ESSE report. You'll see the colloidal species as one of the columns on here. So, what we will do is go through the list of tests in the SCP, rank or assign scores to those tests as to the ability of a particular test to resolve an issue, such as colloidal species, based on a ranking scale.

This is tentatively what we're thinking about, something fairly simple. There's a weighting applied to each of the columns here and the weighting again follows the strategy that we used in the test prioritization task force. It's a conditional probability; namely, the probability that the condition is present multiplied by the probability that the site is unsuitable given that the condition is present. This gives a weight which then is multiplied by the score in here and we get an aggregate score over here. And, this provides for one sheet in the ranking matrix. This would provide an indication, a ranking, for how this test would resolve a particular technical issue, give us a value of prioritization for the ability of these tests to address the unsuitability issue. Now, that was an example of what's going on on this face of this three-dimensional matrix.

On the other face of the three dimensional matrix here, we have again listed test, weight, the columns repre- sent major criteria right now. This task has just been kicked off within the last few weeks. Tentatively, what we're looking at is a small list of criteria. Unsuitability, of course, remains a very high priority since Admiral Watkins' directive of, I believe, 1989--December of 1989. That still remains the primary objective of the site characterization program is early determination of site unsuitability if it exists. Public health and safety, of course, is an overriding concern. A realistic concern that I have is cost and schedule. We can plan all the programs we want, but if we cannot implement it, then it's not much use.

Now, this spreadsheet model is a tool and there are a couple of attributes that this tool must have if it's to be of use to me. It's got to be simple. It's got to be something that--probably what I have in mind is a spreadsheet that can run on my PC where if some of the assumptions--for instance, cost and schedule--change in any one of the various budget drills we do, I can go back through and recompute the spreadsheet at any time.

We're putting in place a relatively small--I'm not going to call it a task force. It's more of a kitchen cabinet, a group of experts available that are loading this matrix originally. They represent various technical organizations within the project. These are the fields of expertise that are represented in this body. These people also, besides being essentially cabinet members, if you will, also represent a entree into the technical expertise available at their various institutions. For instance, whenever the issue of a colloidal transport comes up, I fully expect that Everett Springer of Los Alamos will get in contact with whoever he needs to at Los Alamos to help get intelligent information on how these tests, these specific tests, we have in the SCP could help resolve the issue of colloidal transport.

Now, as I said, in order for this tool to be of use to me, it's got to be simple and it's also got to be something that is available in a timely manner. Right now, we're looking at having the fiscal year '93 budget pretty well firmed up by the middle of the summer. So, I need something available immediately by the middle of the summer that addresses how we need to prioritize tests given the fiscal year '93 budget number. So, that means that I'm looking for an initial result, anyway, by the June time frame with the first phase of this particular project; that is the delivery of the tool and the documentation by late summer. This particular effort does not end at that time. This has to be a continuing effort, but I don't intend it to be a continuing task force with monthly meetings, necessarily. What I'm looking at right now is to have something that would be available essentially on-call. Whenever we need to do this exercise, we can reconvene this body, relatively low-level of effort, to re-examine the assumptions that are built into this particular tool.

And, in a simplistic way, this simple tool goes a long ways toward integrating the site characterization program, what we learn out of performance assessment, and what comes out of evaluation efforts, such as the ESSE. Using the ranking matrix type approach, we identify tests that need to be implemented in which case we make sure that there's enough money identified in the budget for the coming year so that the test is implemented, data information flowing out of the tests flows into performance assessment which helps us further define the technical issues across here by feeding to and from the evaluation effort, and of course, sensitivity analysis may help us select individual tests be defining--by helping refine which test would be more useful for resolving these issues.

Use of these results, well, we need to use them, as I said, within the next several months in order to allocate the '93 budget to site studies. We are embarked on a relatively ambitious mission right now to scrub the technical program and this will provide input and interface with this long-range programmatic planning. The third thing I would point out is that this simple spreadsheet model can be used to consider any other priorities. As the priorities' assumptions/constraints that apply to this program change, yearly, monthly, weekly, we can re-examine this spreadsheet, as necessary, to re-examine the validity of the prioritizations.

And, that's all I have. Any questions, sir?

DR. NORTH: Sounds very interesting. I think we will be very anxious to have another presentation on this at the time when it's available, such as our July meeting.

Any questions or comments? John Cantlon.

DR. CANTLON: How much of the budget is amenable to actually move in this kind of an allocated process? What percent, roughly?

DR. DYER: What I'm looking at right here is that part of the site characterization budget which I control which is the one, two, three, which is about 1/4 to 1/3 of the project budget.

DR. NORTH: Dr. Price?

DR. PRICE: I just heard you say you were embarked on an ambitious effort to scrub the technical program. I didn't understand what that meant, at all.

DR. DYER: Oh, I'm sorry. Looking at out-year activities funding profiles that Carl has given a talk, the Mission 2001 talk--I don't know if you want to talk some more about that, Carl, but--

MR. GERTZ: Go ahead. I'll probably add something.

DR. DYER: Okay. But, we're just making sure that we know the major milestones that need to be met for the out years are there. We have to make sure that all of the supporting things hang together, that all the logic ties together, and that's what we're looking at. The last time we did this was based on a slightly different ESF configuration. What we're doing is going back and re-examining with the new ESF configuration, re-examining our planning basis to make sure that things do, in fact, all hang together.

MR. GERTZ: Dennis, that includes about 6,000 activities that are networked and we now want to make sure with our current assumptions that 2001 is still an achievable date, making some assumptions on the budget. We also want to assure that the funding estimate that we have is being under-gone, being looked at now by an independent cost estimating team from the Department. And, of course, we have told you 6.3 billion is the total cost of site characterization, but 1.2 billion of that has been spent, some of it's escalation and some of it involves potential benefits to the state. So, there's about $3.5 to $4 billion of scientific studies between now and 2001. We want to make sure that we've properly allocated funds to them and sequenced the timing of them.

DR. PRICE: It's scrub as in cleanup, not scrub as in do away with?

DR. DYER: That's right.

MR. GERTZ: That is correct. But, certainly, as we look at things and gather new data from the site, if there are tests that no longer seem necessary through a performance assessment analysis or something, then that's another goal and we have a change control process that either add tests or reduces testing and you've heard both sides today--or over the couple of days.

DR. NORTH: Dr. Langmuir?

DR. LANGMUIR: This refers back in part to what Carl said yesterday, that there was an attempt to obtain another $70 million for the program to expand on activities for the underground tests. Looking at the evaluation technical issues to be resolved list, you see that they're essentially all things that will not be resolved effectively without going underground. If, as I think many of us suspect, you won't get the $70 million, you'll be back where you are this year or maybe lower. Do you still intend to prioritize these issues to be resolved this coming year? How are you going to deal with that if that contingency--if that occurs?

DR. DYER: Well, within the ESSE, we have--this is not a complete list. There are 33 technical issues that were identified in the ESSE. This is just a representative sampling.

DR. LANGMUIR: Okay. But, among these are some of the key issues we've seen come up in the performance assessment studies.

DR. DYER: That's correct. Some of which can be addressed from surface-based testing and some of which are better addressed from underground testing. We're not able to get underground. We may have to do the best that we can with what we can get from surface information.

MR. GERTZ: Don, let me put it in perspective. This year, we're going to be spending about $180 million. Next year, our Congressional request is for $240 million. If we get our Congressional request, most of that delta is going towards getting underground, on with the design of the ESF, preparation of procurement specs, and things like that if we get another 70 in addition to the 240. Now, I'm only talking Yucca Mountain, not John Bartlett's total program. If we get another 70, that would bring us up to 315 or 318. In the oversight committee testimony, four different utility groups, being two from the regulatory side and two from the industry side, supported our additional $70 million need. So, I have not discounted that we won't get the additional 70 at this time. And, I hope it's there. If not, with the 240, we're going to emphasize underground with the increased funding that we get.

DR. NORTH: Carl, you had asked for about a minute to make some comments. Do you want to take that now and keep going?

MR. GERTZ: Yeah, okay, I'll do that. Some of it just revolves around just what we summarized on, is that we have started a very aggressive program. We know we need to get underground and that's what the prioritization is going to do. What Russ has pointed out is that given the fact that he's not a cost account manager for ESF, he only is going to get so much money out of the money that we, as a project, divvy up and he wants to make sure he can prioritize the things that he has to do in the testing area. So, that's one thing.

The other issue is just another subject. It's certain you've seen through the total performance assessment and site suitability our concern about Carbon-14 and that's appropriate. But, I want to emphasize to you that we are looking at that. We're looking at operational aspects of maybe releasing that before you put it underground. It wouldn't be a problem if you could release it before you put it underground. There's other ways we're looking at. Engineered barriers, they pointed out, would be an oppor- tunity to mitigate Carbon-14 releases under these regulations and we are working with the regulator, with the EPA as we pointed out yesterday to see if they can become more consis- tent in their Carbon-14 release because right now it's incon- sistent with Clean Air Act and other releases for this par- ticular radionuclide.

DR. NORTH: Would you clarify that about releasing before under--going underground?

MR. GERTZ: Currently, you know--and this is a scenario that's been presented. Currently, if you put pinholes in the fuel rods, release the Carbon-14 without filtering or anything, it would meet all current standards for above ground release, assuming 10mr released to an individual at the site boundary.

DR. NORTH: So, there is a serious proposal to put pinholes in fuel rods?

MR. GERTZ: Not at all. Not at all. What we're trying to point out to our regulators is that it seems inconsistent for health effects to have a certain release requirement for repositories and another for fuel operational facilities.

DR. NORTH: So, what is really going on is a discussion with EPA with regard to the revision of 40 CFR 191 and the treatment of C-14 in that regulation?

MR. GERTZ: Certainly, that's going on, but in the process of doing that, you come up with a logic or scenario that says, gee, if we have trouble meeting in an underground disposal, let's treat it above ground. Let's do something to it above ground so we don't have the problem for future disposal.

DR. NORTH: I think we'd welcome listening to more discussion of what exactly the treatment is if we're going for treatment as opposed to regulatory relief.

MR. GERTZ: Yeah, it's a very conceptual level and I hope we don't--we're not designing facilities or processing activities right now to address that.

DR. NORTH: No pinhole factory?

MR. GERTZ: No, no, not in any plans. But, that is a point that we've pointed out to the regulators that if you were a utility and somehow your fuel--and, they do have defective fuel that releases carbon--if it all was released, it would not be in violation of current standards right now in a poll.

DR. NORTH: Any further questions or comments? Dr. Cording?

DR. CORDING: I was wondering about the comment on the additional funds, 70 million for going underground. If there was a scenario that that total amount weren't available, are there other possibilities of going underground without, say, the full number of boring machines or an initial effort to get underground in the next fiscal year without getting that full funding?

MR. GERTZ: Bill is going to talk about it a little more later when we update you later on the ESF, but let me point out that right now our commitment or the Secretary's commitment is a license application in 2001. And, to us, that involves almost a four TBM operation in order to get underground, both Calico Hills, and get the data you need. So, we've not backed off from a 2001 license application at this time. And, just last week we issued nationally an RFP for the best TBM expertise to help us design the equipment, purchase the equipment, and eventually build the facility. And, throughout that RFP, we have the flexibility to use one, two, three, or four TBMs, or different size TBM, if we choose to do some piloting thing. But, right now, our plans are really to try to do the whole job as we've stated we were going to do it. We'll always look at contingencies depending on where the funds come up.

DR. CORDING: I guess the point would be that you're saying then if you don't get the full funding, then that date has a possibility of slipping. But, the other question would be assuming that you at that point decided that the date had to slip if you didn't have full funding, would there be a possibility with some lesser amount to go underground and get going so that it would minimize the amount of slippage or the necessity of ramping up to accomplish your task later?

MR. GERTZ: Sure. Certainly, one of the scenarios we looked at was just one TBM and start that underground from Exile Hill or wherever. That's one of the things we're looking at. As you're aware, our plans--I think even our baseline plan--it's a sequence start of all four. You don't start all four at once. Obviously, two are halfway down the ramp or so and so it might be a case where instead of sequence plan, you just start the one and wait before you get to number 2, number 3, or number 4.

DR. NORTH: Other questions or comments?

(No response.)

DR. NORTH: At this point, I think we want to take our break. If we could try to be back by 10:30, please.

(Whereupon, a brief recess was taken.)

DR. NORTH: Let's reconvene as quickly as we can, please.

Next item on our agenda is comments from the State of Nevada which will be given by Steve Frishman for the Agency for Nuclear Projects. Steve has promised that he's not going to use any viewgraphs. So, Steve, please go ahead?

MR. FRISHMAN: Thank you, Dr. North. You're right about the viewgraphs. Someone once said we'll do it like the economists do, you just imagine the viewgraphs.

Well, first, I'm here to tell you sort of following a comment that was made yesterday and that's, no, Virginia, there is no Deus Ex Machina. It was explained once. Do I need to explain it again? That's the goddess who comes down in the basket to save everybody from everything.

Russ took a step back just a few minutes ago and I want to take a step even a little farther back and start looking at what this program really is, where the Board sits, where the state sits, where the public sits because what we're seeing--and, I think people have said it in different ways--is we're seeing a growing momentum to build a project rather than what's supposed to be going on which is a very careful scientific investigation of a site to see whether, in fact, it will isolate waste.

Now, the Board has, I believe, a couple of things to remember. One is your original charge which is to evaluate and report on the technical validity of the site characterization program and including transportation. I think Senator Hickey yesterday reminded you of the transportation piece which is a very important one which the Department has for public purposes essentially deferred until 1997/1998 before the public can really get a look at it. And, I think you should well heed his comment yesterday because the public is extremely worried about transportation both in Nevada and nationwide.

There's another thing I think the Board needs to remember in terms of its oversight and review of the technical validity of the DOE's program and that's that, if I'm correct, you go out of business at the end of site characterization. You're not here for licensing.

DR. NORTH: Not true.

UNIDENTIFIED VOICE: One year after.

MR. FRISHMAN: One year after.

UNIDENTIFIED VOICE: After receipt of waste.

DR. NORTH: Yeah, we go out of business when waste is received.

MR. FRISHMAN: Okay. Well, that is essentially--that is, essentially, is the site suitable? That's the question.

DR. NORTH: No, no. It's when waste starts to get delivered.

MR. FRISHMAN: Meaning?

DR. NORTH: I think that's 2010.

MR. FRISHMAN: Well, what that means is a receive and possess.

DR. NORTH: Yeah. At that point, I'm going to be approaching the age of some of our older Board members. I mean, I'm delighted to have John along so that I can make that statement now and I hope I'm going to be in great shape as he is when that time comes. But, we're a long way off.

MR. FRISHMAN: Well, if we all keep flying and if I keep smoking, none of us will be around anyway.

Well, my point is that the technical validity of the work that is going on is your charge and we're seeing a lot of things are developing about how to build it as opposed to whether, in fact, it ought to be built. And, you know, there's a whole progression of documents, a whole set of changes that are going on right now in terms of the development of the program that I think need to be looked at pretty carefully. And, I guess I'm going to be doing a fair amount of talking around it. So, I probably ought to just tell you what the two elements in my bottom line for today are.

One of them is that the Board should be calling for a comprehensive site characterization plan. Whether, in fact, it is the plan announced in the Nuclear Waste Policy Act or not probably doesn't make a great deal of difference. But, there needs to be a comprehensive plan out there that tells you, tells the state, tells the public, tells the industry, tells the consumers how the money is being spent, what it is being spent for, and what the objective really is. The objective up until the end of site characterization, which could be tomorrow or 10 years or 50 years from now, the objective is to determine the suitability of the site.

The last lawsuit that the State of Nevada filed in the 9th Circuit, while the Department proudly advertises we lost, well, we won one big thing and I've listened to the change in the discussion ever since then. What we won was the Court announced that 10 CFR 960, the guidelines called for in Part 112A of the Nuclear Waste Policy Act, are the Secretary's standard of judgment for site suitability. And, we heard Steve Brocoum yesterday talking about the internal arguments about whether the guidelines are valid for use on a single site, which most of the people in the Department felt at the time in 1987 was not true. They felt that the only thing the guidelines were for was comparison of sites. Well, the fact is if the Secretary doesn't have 960 for a standard, he has no standard, whatsoever. So, now, what we're looking at is an application of 960.

I gave you half of the bottom line which is we need a comprehensive site characterization plan of some sort that is reviewable by everyone. The other half of the bottom line is we need a true evaluation of site suitability, one that adheres to 10 CFR 960. You heard yesterday after some rather astute questioning that if you read the letter of the regulation, the site is unsuitable on C-14. We heard at least some hinting that if you read the letter of the regulation relative to groundwater travel time, the site very likely is unsuitable.

Now, the question is, is the program going to focus itself in such a way that it can go directly to the question of whether you meet regulations or not? This is why I said, no, Virginia, there is none because it is most likely that the EPA regulation is not going to significantly change and give the Department what it wants. There may be ways around the C-14 problem and there may be--it may, in fact, be cheaper and easier to try to get around it than go through it. And, maybe that's where the talk ought to be. I know the Board took maybe--had some discomfort in the past when I've talked about whether I think the Board ought to be in the business of looking at the regulations. I still believe even after discussion with most of you, I still believe you should not be in the business of looking at regulations. You should be in the business of looking at the technical validity of the work that's going on.

To me, it is outrageous that the site suitability evaluation would come up in the area of gaseous release and suggest that it's the regulation that's the problem. How do you get that way when you have a group of people who are supposedly doing scientific reviews, objective scientists reviewing the Department's work, reviewing the data on the site, how do you get to a recommendation in a critical regulatory issue that it's the regulation that's the problem, not the site? That's pretty strange to me.

So, I think that the early site suitability evaluation, overall, needs to be redone in the light of a literal reading of the regulations that the Department itself promulgated. The only reason they have problems with interpretation now is that they're trying to apply them to a site that was handed to them with their own encouragement. So, two pieces: site characterization plan that is readily reviewable by all; early site suitability evaluation that, in fact, addresses the regulations and is accessible to all.

I think you've probably all seen the copy of the letter that we sent to John Bartlett regarding the early site suitability evaluation and the fact that it went out as a contractor document, it went out with letters addressed to the principals including the State of Nevada, including this Board, "Dear Reader, please review." It's a legal dodge. The Department interpreted the guidelines to its own purposes in order to keep on the myth of suitability of this site for another about $300 million or $400 million worth a year. And, the Department at the same time escaped the legal liability of having rewritten a promulgated rule. Sooner or later, the Department is going to have to live with that rule or go back through the Administrative Procedures Act process and change that rule. To carry on with a re- and probably mis- interpretation of those guidelines is a disservice to everyone, and everyone, I mean, the people of the country and the world where we do have a major problem to solve. So, I think there should be a call from this Board for both of those two things to happen.

Now, if you look at the early site suitability evaluation, first of all, there are some real process defects in terms of how does the public really get at it, what do your comments mean if you make comments, how do they get fed into the overall issue of site suitability? The Department has done a wonderful job of dodging in the sense of saying that this is one input into the director's decision about whether to continue with this project or not. Others are schedule and budget and so on. Well, the guidelines are the Secretary's standard. Yes, other things can happen. I don't in my wildest dreams think the Secretary, himself, is going to give up. But, I think the Secretary needs to know in very, very clear terms how this site, in fact, faces up to those guidelines.

Now, there's some interesting things that go further with the environmental--or with the early site suitability evaluation. And, that's that it claims to be based both on information from the environmental assessment that was done, from information developed or at least re-interpreted for the site characterization plan, and further new information. You look through the references in there and what you find is that it appears that all the really new information is in the form of internal memos, referenced. Now, if anybody is going to do a review of this document in 90 days, what is the availability of all this new data that is internal memos that are referenced? And, they're essentially memos that went to Jean because she was doing the job. That's one part of the problem with that.

The other is that both the people involved in the internal review and the peer reviewers apparently didn't have access to all the information that's out there. I looked at least or tried to find out where this list of references came from and it appears what it is is each one of the lead reviewers, such as Dwight said he was lead reviewer in one particular area, each one of them was asked to submit hard copy of all of the references they used and thought were relevant. And then, they're all kind of stacked up and the final list of references is the full stack. Well, notably missing from that list are, first, all of the state's comments on the environmental assessment; all of the state's comments on the site characterization plan; and the additional documentation that we have presented to the system even at the level of the Governor to the Secretary regarding the site suitability under 10 CFR 960. Also missing are references to such things as the NRC's site characterization analysis which is the NRC's only reason to even be reviewing this program right now under its own regulations. How does the site characterization plan address and relate to the site characterization analysis? So, what we have is sort of a closed internal system where the Department is feeding itself what it wants to know.

Now, we've asked a set of procedural questions that we're waiting to hear from John Bartlett, waiting to hear his answers to these questions. And, it goes directly to one of the boxes that Russ had in his three-dimensional picture there and that's scientific credibility and public confidence. If the Department is, in fact, married to the idea that the site is not unsuitable, then it should go public in a public process in the course of following the Secretary's directive to do an early site suitability evaluation. It should go forward with that in a public process, not one that is a halfway approach where John Bartlett convenes a group of his selected public in Chicago to talk about a mountain in Nevada. It needs to be fully opened. If, in fact, the Department is married to this idea, the Department should put out a draft report and allow it to be fully reviewed, make all the references available, and let the public, including all of the interested parties, have a clean, clear view of what's going on. And, I would suggest that the Department's interpretation of the guidelines and the Department's sugges-tion that a regulation ought to be changed will not survive that process. And, the reason why it probably won't is because Yucca Mountain very well--it is very likely to not survive the process itself.

Now, the clamoring to take care of the C-14 problem is really one of trying to back the regulations off. We've had a long history of this and I talked about this at the last Board meeting in terms of where the Department lays the blame for the fact that it is continuing to be essentially inactive in the area that you are most interested in which is analysis of a site. We've gone through--and I've talked about this before--we've gone through the progression of blaming various institutions. Well, I thought it was great. This is the first time in almost three years that I could sit through a whole meeting and not hear the state bashed even once for having held up the program. And, it's because the fact is we didn't do it. Now, we're moving on to other blame and this came out in the Senate hearing last week very clearly. You know, the state is no longer the problem, the Department is now blaming budget problems. Okay, we saw that. And, we also saw that maybe the most influential committee in the Senate said, well, budget problems aren't a good enough excuse. So then, the Department starts trying to blame the regulators and we have a key Senator who isn't going to let that happen until he had independent evidence that it's the regulators who are the problem. So, we're in this situation of who gets blamed next.

And, I heard an interesting thing from Russ where he talked about site--well, the question came out, you know, if you have budget problems, how much work really is affected by that? Well, I think Russ said about 1/4 to 1/3 is the actual work that is supposed to go on of the Yucca Mountain budget. Well, it's interesting that last year, just 8% of the total project budget put the Yucca Mountain Project on its ear if you'll remember, literally on its ear. What it did was it turned the program around to where it deferred what you people want most and I disagree with you, but what you want most is getting underground. An 8% twist in the budget. So, we have a problem now where the blame keeps getting shifted around. You heard and I think you already have the premonition that they're not getting underground this year or next year, either.

And, now the question is what do they do? Well, we have laid out for years now the necessity for them to do some very serious surface based work to get at the letter of the regulations in terms of disqualification. They have yet to do that. Even that continues to get deferred. The work that's going on right now is looking at matrix flow. It is not looking at the real issue on groundwater travel time which is fracture flow. That's an issue that's going to have to be resolved and if, in fact, can be resolved without getting underground if you want to be conservative about it and get on with the job of trying to solve the big problem, rather than stick it on Yucca Mountain. And, for a relatively small amount of money, you can do that. You don't need to buy four brand new TBMs. And, even if you want to get underground, you can go get smaller TBMs literally off the shelf right now.

So, the approach that we are suggesting is if you don't take our word for it now, get out and do some of the basic geologic and hydrologic investigation that is necessary and write a real site suitability evaluation out of that rather elementary type field work, look at the surface expression of things that are very possibly hydrothermal expressions on the surface, look at those things and try to figure it out. Trench 14 is not the answer. There's lots of that stuff around that nobody wants to look at except a very, very few people. The question is has hydrothermal activity reached the surface or not? A pretty critical question. And, Trench 14 is maybe the most ambiguous of all the things you could look at. It just happened to be the first thing somebody saw one time to start the controversy. Do some drilling, find out how the fracture zones work, find out how those faults work. You can do it without getting underground. You get underground, all that's going to happen is when it rains, it's going to rain on you underground. And, I think almost everybody knows that. And, it's going to take a lot of time, a lot of misery, and a lot of money to find out that you get rained on underground, too. And then, it's going to take a lot of rationalization to figure out, well, that rain is okay.

So, our suggestion is stand back, write a plan for how from the surface you figure out whether you can meet the letter of the regulations, not how you would like the regulations changed, and then go at it in a very simplified geologic field investigation approach. It was said yesterday that the site has been very well mapped. Well, maybe it has, but where's the map? There is no final geologic map that I know of at a scale that shows faults other than those that have been displaced more than six or eight meters--or feet.

I can't remember which. But, there is no fine scaled geo-logic map of the site that we know of. And, if somebody has one, we'd sure like to see it. Do the basic geology and I think that's what the Board should be calling for, much more than trying to figure out how to do it.

Now, there's just one more piece of this puzzle that continues to emerge and that's that it appears to me--and, I've discussed this with some other people--that the more thinking that goes on--not necessarily more data about the site, but the more thinking that goes on--about the site, the closer it's getting to why don't we just engineer this thing and get it over with? The geologic barrier seems to be being pushed farther and farther back in people's minds because you run into the complexities that everybody knew you were going to find. If you remember Jim Asselstine when he was on the Nuclear Regulatory Commission told Ben Ruesche years ago when Ben was looking for some kind of sort of signal of approval from the NRC, Jim Asselstine said just remember, all of these sites--at that time, there were like nine sites out there--all of these sites look better now than they ever will again. And, we're proving that daily right now about Yucca Mountain. The more you think about it, the more you look at the data, the more you try to do your per-formance assessments with essentially imaginary data sets to check your models that you then will have to go back and validate anyway and many of them probably are not vali- datable, the more you look at it, the less likely it is you're going to get to the confidence that you need about the geologic barrier. So, I see this shift going towards the engineered barrier or engineering. Well, that's not what the regulation says. So, let's get realistic about it and are we going to characterize this site to the point where we can compare it to the letter of the regulation or are we going to plow along, continue to spend the money, continue to spend the time, continue to make a solution to the real problem that we have about spent fuel and radioactive waste farther and farther into future generations or are we going to think about how to really solve this problem if we're committed to geologic disposal? Geologic disposal should not fail because of a failed program. If geologic disposal is, in fact, a valid approach, we ought to be out there like the Canadians and like the Swedes trying to determine whether, in fact, it really is a valid approach.

So, that's pretty well where we are right now. I've asked you for two things and they're two things that we're going to keep doing. And, I think in the long run they may be the best things that could be done right now in terms of trying to figure out what the future is for this country dealing with its radioactive waste.

Thank you.

DR. NORTH: Thank you. Questions or comments from the Board members?

(No response.)

MR. FRISHMAN: As expected.

DR. NORTH: I'd like to invite Jean Younker, if she'd like to respond to your comments with regard to the use in the ESSE of the comments from the State of Nevada and the comments from the Nuclear Regulatory Commission. It seems to me you raise a very good point. Those issues definitely ought to be considered and should be part of the material that the expert team reviewed.

MS. YOUNKER: The way the team was put together, we had the members of the team that were actually the people who responded to those comments in the largest part. So, within the collective intelligence of the team, I think we had probably six or seven of the key responders to the state's comments, as well as to the NRC comments on the site characterization plan. So, I think that there's no doubt in my mind that we did consider the comments we received and the responses that we gave to those comments.

Also, since I have the opportunity, let me mention that the complete set of hard copies of all references for the ESSE report were made available to the peer reviewers and they, in fact, did request--we shipped just boxes and boxes of references to most of the peer reviewers and all of those copies are also available to all people who are reviewing the report during the public comment period. So, the references are really available. Steve mentioned there are a few personal communications referenced in the report. That is true and those are written such that those can also be made available, though they certainly have not had, you know, formal technical review like the ones that are published documents.

DR. NORTH: So, it is possible that if some citizen in the state of Nevada wants access to these documents, they are readily available in a local library or through the Department of Energy?

MS. YOUNKER: Right. Yeah, I think the way it was expressed--I'm not sure what it says in the letter--but all of the references are available through your office, Russ. Is that correct?

DR. DYER: Yes. Through--I think it's through Jerry.

MS. YOUNKER: Jerry, you're listed as the contact? Yeah, there is a contact listed, I think, and they are available. We can provide copies.

MR. GERTZ: Okay. And, I'd just like to emphasize that and I think even Steve would reiterate any time anybody has asked for anything, be it the public, the state, or anything, we provide it to them as soon as we can. And, I think that's consistent with our policy in the state. And, this, of course--our view of the ESSE was to provide an opportunity for people to comment and Steve does point out John's director's forum is going to be in Chicago, but at the same time--not the same time, but in May, we hold what we call our--it will be our 23rd, 24th, and 25th public meeting in the state where they're allowed to ask us about anything. We'll have some of the authors for the ESSE there for one on one conversations with the citizens of the state and we think the one on one interaction seems to work best as we've talked to the citizens. So, while certainly Steve makes some points, we'll be eager to address his specific questions on the ESSE when it comes in. We are right now in the process of answering the process letter that was written to John Bartlett and he'll have an answer to that shortly. And, I think this is just an ongoing dialogue that we will continue to have with the state as we move forward on this project.

DR. NORTH: Carl, would either you or Jean like to address any comments to the issue about the letter of the regulations with regard to C-14?

MR. GERTZ: Jean points to me. Well, I think we certainly are addressing C-14 in our dialogues with the EPA. I think that's appropriate. They've asked us to comment on the regulations. Does the C-14 regulation really address public health and safety? To take a literal translation, I think Steve is aware that probably it was promulgated on the basis of a saturated site. I think that's appropriate.

MR. FRISHMAN: Well, first of all, I don't believe that the EPA has asked you to comment on the regulations any more than they've asked anybody else to.

MR. GERTZ: Correct.

MR. FRISHMAN: We're all working off working papers that are said to be for internal use. It's the informal public hearing process that went on with the original promulgation of this rule that got the rule in trouble in the first place. So, yes, anyone is entitled to comment, you know, prior to--you know, in the rule development procedure any way you want to. And, we've all been asked to do it at various levels and we've all taken that informal request at various levels of rigor.

The rule itself, while its considerations were primarily towards a saturated site because that's what people were really thinking about at the time, the rule itself was still, if you'll recall, promulgated as, first of all, a release standard, not a risk standard, and the level of releases were determined, even with some relaxation by the EPA Science Advisory Board, on the basis of what was considered to be achievable by existing or available technology in geologic disposal. And, that's your problem, not the public's problem with a generic rule. And, sooner or later, you're going to face it. But, the original rule was essentially a rule based on what is considered achievable and, in fact, up until about a year and a half or two years ago, the Department was saying we don't care what the standard is, we can live with it. Until you figured out you had a C-14 problem.

DR. DOMENICO: Steve, I'd like to have the honor of being the first Board member to ask you a question in all the years we've been associated.

MR. FRISHMAN: I feel honored. I feel honored, as you do.

DR. DOMENICO: It's not a question as much as a statement and then a question. But, the Carbon-14 is not the only problem that could render this site unsuitable.

MR. FRISHMAN: No.

DR. DOMENICO: If we look at the EPA release standards as a measure of unsuitability, a lack of retardation in those rocks and the absence of a robust unsaturated zone will render this site unsuitable.

MR. FRISHMAN: Absolutely.

DR. DOMENICO: Because we'll have the large inventory nuclides breaking through. An abundance of colloids in the saturated zone in the absence of a robust unsaturated zone will make this site very, very suspect. Colloids, let's face it, they move at the speed of groundwater or faster and they destroy any retardation capabilities.

MR. FRISHMAN: Correct.

DR. DOMENICO: A large flux through the system in the absence of a robust unsaturated zone and with limited retar- dation could render this site unsuitable in the sense of violating the EPA standard. Now, I was referring to those things with the preconceived notion of a 1,000 year engineered barrier. We recognize that in the absence--if we went for a long term barrier, these things mean nothing any more. Right? These things--if we go for a 10,000 year barrier, these things mean nothing. And, I guess you've noted in our reports we have advocated at least investigation of long-term barriers. Also, there are some people who feel that if you keep the repository hot and blow off all the water, these features of breakthrough also mean nothing. How do you feel about that?

MR. FRISHMAN: Well, thank you. You're doing the part that I didn't think I could get into a half an hour ago.

DR. DOMENICO: We didn't rehearse this.

MR. FRISHMAN: No. No, honest. The site is suspect for many, many reasons and, as Pat had laid out, some of the real ones, the C-14, happens to be a very visible one where we're faced right up against a regulation. Now, these other issues are probably the really critical issues for whether the site, in fact, can contain waste or not. And, we have long said and there are others who say that the likelihood of ever resolving those issues is probably pretty small, resolving to the level of--I won't say non-controversy--but even resolving to a level to use the NRC reasonable assurance. It's really suspect whether you can ever get far enough to answering those types of questions.

And, I'll tell you one of the things that you got into yesterday which is kind of interesting and that's that you started off in this direction of saying, well, gee, maybe as a Board we ought to look at the use of expert judgment and look at how it's applied, what's it really doing to the program, and to the scientific drive in the program, if there is such a thing, you know, what is expert judgment really doing in here? You can document it all you want. That doesn't mean it's right.

Well, the Advisory Committee on Nuclear Waste with the NRC is also taking a very hard look at the use of expert judgment. And, at least a couple of members there are very skeptical and they're skeptical in the sense that they have the duty to the NRC. They're trying to figure out what the role of expert judgment really ought to be in the licensing process and they seem to be moving towards saying there's an awful lot of data that is already out there, plus an awful lot that could be collected, to make some judgments without holding up the process of expert judgment solutions as being the proof that is necessary in a licensing process.

Now, the question that's involved there is if it doesn't--you know, if it isn't going to pass muster at the licensing level, why should it pass muster at the Secretary's suitability determination level? And, that's the question and I'll turn the question back. You know, knowing all of those things that you said plus some more that you and I didn't say that we know, I'll pass it back and that's that if it isn't going to pass muster in licensing, why should it even be considered to pass muster at the Secretary's level and why should we spend 10 years and $6.3 billion? That knowing the way DOE programs go, if we've got 10 years and 6.3, we're probably looking at maybe--you know, if we can even put a year on it, by the time things have gone, we may be looking at 20 years and 18. Fairly exemplary of how other big DOE projects have gone.

I think Max has a few things to say to me now.

DR. NORTH: Max, why don't we give you the opportunity?

MR. BLANCHARD: Thank you, Warner.

Steve, I'd like to address your question about the Department's involvement in Carbon-14 issue and I think the one easy way to address this is to look at the National Research Council's report hat came out in 1990 entitled Rethinking High-Level Radioactive Waste Disposal. That particular Board, I think, is probably one of the foremost Boards in the country that has been looking at high-level waste, in addition to this particular Board here today. One of the features that they focus in their abstract is a warning to the people that are governing the program, overseeing the program, and that is at this stage of developing the concept, don't be overly concerned with technical specifications to otherwise end up with inflexibility in the application of the concept, and therefore, not achieving the overall safety goals that you're trying to achieve. And, in their recommendations, they ask--in fact, Recommendation #4, they recommend that the Department should continue to expand its current efforts and become a more responsive player with EPA and the NRC and especially in areas where over-prescription or inflexibility may have crept into and affected the program's goals and concepts as a consequence of early determination of overly specific specifications. And, I think the Carbon-14 issue, as a number of people have authored in technical reports, is a good indication of overly-prescriptive regulations that don't really indeed address the safety of the people.

MR. FRISHMAN: Okay. Well, I guess I can respond to that in a couple of ways. One is that--not to diminish the Board at all, but the Board is just one of the players in this major controversy. And, I don't believe that they have any greater halos than the rest of us do. We've all planted them on our own heads. So, I don't think that just quoting from one book or I can get another book and quote from another book, I don't think that that really gets at the problem.

The other thing is if we turn it around and you want to put a lot of stock in that Board, that Board, if you recall, recommended in the past that sites, such as Yucca Mountain, be looked at very, very carefully before they are ever brought forward as candidates. And, that's the problem that we're dealing with right now. It was not looked at very, very carefully before it was ever brought forward. It's about as complicated a site as you could want to get into. If you go back to the 1980 EIS on geologic disposal and look at what are considered adverse factors about a site, I think there's 18 of them listed on a graph or on a table and Yucca Mountain only has 14 of them. So, if you want to use the National Academy Board, take its admonitions to site selection, as well as maybe its ruminations about regulation.

DR. NORTH: I think before going on to the next speaker, I'd like to make a few remarks myself on the issue of this Board's interaction with the C-14 standard. I back up to reviewing my thinking when I was first on this Board, finding out that there had essentially been no performance assessment done since the '86 versions, and I had the 6500 pages of the SCP delivered to my office. My secretary thought it must be a machine because, surely, no report could come in a box that was that big and weighed so much. And, my concern initially was here is a very costly and elaborate program to characterize a site and are we going to have that program managed in such a way that the performance assessment is going to come at the very end after all that data has been collected and we lose the opportunity to have an early determination of whether the site is, in fact, suitable before we spend all that money? And, it seems to me that issue is still alive and well. And, I'm very pleased at this point with the amount of progress that's been made seeing iterative performance assessment institutionalized with the Department's program and the strong stress that the program now places on determination of site suitability early.

It seems to me on the C-14 issue, it is very important for performance assessment to figure out what is the magnitude of that issue and what are its implications for repository design and maybe even, as we were discussing just before the break, some kind of pre-treatment of spent nuclear fuel. It turns out pinhole was really the wrong word to use. It's more like heat treating. But, still, there are some disconnects here that treating the fuel somewhat differently in the reactor before it goes into the spent nuclear fuel disposal system makes a difference in terms of the early pulse that shows up in the performance assessments. Now, at this point, we've got a lot of differences between the two performance assessments in terms of how serious the C-14 issue is.

I think it's very important for this Board to strongly encourage the Department of Energy to continue this kind of performance assessment to illuminate the consequences in these various areas, C-14 being one, retardation of radio- nuclides being another, to see what the magnitude of these technical issues is. It certainly is not within our statu- tory charter to be advising with regard to the revision of the regulations. But, it seems to me we can serve a very important purpose that is definitely within our statutory charter to try to see illuminated the technical consequences as they must be measured against the regulations whether this is in fine detail the letter of the regulation or more gener- ally. I also feel that it is incumbent on us as appointees of the president to try to clarify these issues for the Amer- ican public. So, I hope we don't just look at the letter of the regulation, but we try to also portray does this make sense? Is it consistent with other regulations? How much is it doing to protect public health and safety? But, then, EPA and others who have the responsibility for revision of the regulations have to engage in that process. Our statutory charter is simply to try to illuminate these issues and write at least two reports a year to Congress.

MR. FRISHMAN: If I may, just briefly, air the private discussion that I've had with a number of members here and that's where I differ with what Warner said. It's that I believe your job is to make sure the Department of Energy is protecting the health and safety of the public and that's where we differ.

DR. NORTH: Well, I'm not sure we do. I believe that's a very important part of our job. But, I think the way we can do that is essentially illumination of these issues by finding out what the consequences of the proposed program are through performance assessment, ESSE, and similar analytical exercises so that we have a basis for planning and making decisions before all these funds get committed.

MR. FRISHMAN: Okay. And, I go that far and, as you know--and, I don't want to belabor this--I think where we differ is in my view of what agency's project you are over-seeing. And, certainly, you're entitled to look at problems the Department may be having in meeting what are considered to be health and safety standards from some other agencies. And, I think, yes, it's realistic and reasonable to be look-ing at it from that standpoint. Where I differ is when you, in your reports to the Congress and to the Secretary, start discussing the business of the regulatory agency as opposed to the agency that you're overseeing.

DR. NORTH: Bob Shaw?

MR. SHAW: Thank you. Although the Board doesn't have a charter to necessarily look at the regulatory aspects of this, it's clear that the regulatory issues are a keen and important part of all this and, in particular, the EPA issues. And, Steve Frishman has spoken to particularly Carbon-14 and a few other issues regarding that, too. I wanted to make sure that the Board is aware of recent activities with regard to the EPA and the high-level waste criteria and particularly the workshops that EPRI has sponsored both in September and in February, workshops designed to look in detail at the issues, identify the issues, and supply technical input to the EPA regarding these issues. There's been a widespread participation in these including the Environmental Evaluation Group of the State of Nevada, Nye County--I'm sorry, from the State of New Mexico. Nye County from Nevada has sent participants, the National Resources Defense Council, NRC, the ACNW, TRB representatives have been there, DOE has been there--all three portions of DOE, both OCRWM and the defense area and the environmental groups within DOE--and GAO and OMB. And, I've really been pleased with the widespread participation we've had.

And, one of the issues that certainly has arisen there is Carbon-14 and I think it's important to understand that although there are some people who attended these who are very concerned about the stringency, in and of itself. And, David Okrent is a very outspoken proponent of saying that compared to other EPA standards, these are much more stringent. Although that element is present, the widespread approach that's being taken in these is to say what are the crucial technical issues? And, when it comes to Carbon-14, the crucial issue is that the basis upon which it was developed was a wet site in which Carbon-14 would be transported in the liquid medium. When you look at the gaseous release, the problem is not to the individual who would absorb Carbon-14 as the result of the gaseous release, it's the fact that the billions of people throughout the planet will absorb on the order of six micro rems per year, and when you multiply that by billions of people, you get more than the two and a half million rems that's limited. But, the health consequences when you really look at this are almost insignificant. I bring that up as one example. You can look at the Safe Drinking Water Act and its application to the high-level waste criteria and come to somewhat similar kinds of conclusions about whether it's appropriate or not. But, I think those are the key issues and the right way to look at it.

We have offered to assist EPA and, by the way, EPA has been a very active participant in these workshops and I think as a result of that they have now come to DOE for assistance and the DOE is responding to questions that EPA has raised. There is a lot of both technical and, of course, political aspects in what's going on, but I think the crucial issue is that there is a lot of activity and a lot of consideration of EPA about whether the criteria are appropriate at this particular time and I think it's an exciting venture.

Thank you, Warner.

MR. FRISHMAN: I'd only add that I participated for a while in that same process and came to the conclusion after the first large gathering that the issues were sufficiently well-aired and the controversy was sufficiently well-known, that it's time for EPA to go to a rulemaking. And, I wrote to Bob Williams who is managing the EPRI project and told him that I thought that the meeting was fine. The meeting was maybe the last time we all needed to get together to wring our hands over the perceived and real problems and we should all encourage the Environmental Protection Agency to propose a rule rather than have this ongoing essentially ex parte type activity going on. I think we all know the issue well enough. Let's all go on record in rulemaking and we'll find out where we are, as opposed to what I believe the EPRI process slowly leads to. And, I hear it from Bob and he lists off everyone who participated except maybe the State of Nevada. In fact, we did half the time. As once again, something a little holier than the rest of the system. Well, that's not the way it's supposed to work. The way it's supposed to work is we talk about what the problems are, we recognize them, we go on record in a rulemaking, and we leave it to the agency whose jurisdiction it is to sort it out. And, I think we have a proposed piece of legislation right now that says to do that. And, what it says is you take all of subpart (b) of 40 CFR 191 that was remanded and reinstate with the exception of the two issues that the Court dealt with in the remand; two issues being one of process and the other of groundwater protection. And, I think we--the process problem gets solved automatically by proposing a new rule. Groundwater protection, I think as Bob mentioned, we see that the EPA is moving in a direction and the EPA is not going to answer the bigger question that's involved in that about underground injection controls and that's fine, but EPA can readily solve the two problems that the Court had and the only reason we're arguing about C-14 relative to EPA right now is because the Court remanded the entire subpart (b) rather than just telling the Environmental Protection Agency to fix two things. Otherwise, it wouldn't be an open issue.

DR. NORTH: I think at this point we're going to close this section of our agenda and go on to the next section on site characterization update. We're running about 25 minutes behind.

Our next speaker is William Simecka. Do I have that pronounced correctly?

DR. SIMECKA: That's correct.

DR. NORTH: Do you think you can complete your presentation on the order of 45 minutes or so or do we want to take an early lunch? What would be your preference, to go right ahead?

DR. SIMECKA: Depends on how many questions I get.

DR. NORTH: Okay. We can often give you a lot of questions. So, why don't we try to go through it and maybe we'll hold the questions until after lunch.

DR. SIMECKA: All right. Well, as the director of engineering at the Yucca Mountain Project, I visualize my function as to being very responsive to the site characterization program in providing the design and the construction of whatever facilities they need on a time scale that they need it.

I will discuss the following topics, but I will change the order a little bit to make it flow better, I believe. I'm going to first discuss the ESF mission constraints, review the Title I design, review what process changes we've made to the Title I, and then pick up on the ESF activities during '92, plan for '93, and the planned repository activities. Then, I will address the status of the NWTRB recommendations as a result of your September 1991 meeting that relate to the ESF. And then, I will answer a few questions that you informally asked me to address.

First, the ESF missions and constraint. Just as a review, I view the ESF mission as to provide access to the geological horizons to enable testing in that underground laboratory which will enable in situ data to be developed or generated to evaluate the barriers in the geological units. And, of course, obtain information for potential repository design. Contrary to some people who believe we are building a repository, we are not, but it is just common sense that we have to do an ACD for a repository starting this October and they need inputs. So, wherever the ESF has an intersection with the future or the potential repository, we must address that.

We do have constraints that we are living with. First of all, of course, we should not compromise the waste isolation capability of the site. And, in those areas that would become a part of the--permanently become a part of the potential repository, we must design those and construct them to repository standards. Of course, we must facilitate the acquisition of the data that's necessary for site characterization, as well as the repository design and ESF design. And, we have to limit the number of exploratory boreholes, shafts, or ramps in the geological repository operation area to what extent that's practicable.

There are physical interfaces with the repository and ESF. For example, of course, the ramps, we believe probably would become the potential repository main accesses. The Topopah Springs drift also, and of course, the ground control measure that we install in ESF, they either may remain in place or they must be easily removed or maintained if they're going to become a part of the permanent repository.

A review of the Title I design. As you recall, you're probably all aware of this, this is the reference design that we used in Title I and does include, of course, a loop down to Calico Hills as shown here. And, I won't spend any time on that unless there are questions.

Now, the extent of the drifting in that reference design is shown here. 14.4 miles, now we all know that's a lot of miles of excavation. I will point out, however, that we view this as an incremental type of a system, situation. We may not excavate all of that. If the site characterization program says we don't have to because, as Russ pointed out, if because of cost effectiveness and other considerations, we may not want or need to examine all those areas that is represented by this 14.4 miles. We are using a phase design approach which I'll show you later and obviously we will use a phase construction approach depending on what the needs of the site characterization program is or are.

Now, the excavations in the reference design are shown here as far as the diameter. I know there is a question with regard to the diameters and we do have a ramp study starting in July and will be finished by the end of this fiscal year to determine what are the ramp diameters. And, I'll talk about those a little bit later.

What are the in-process design changes that have occurred from Title I to Title II? A couple of things. We've changed the radius of curvature in the north ramp--obviously, also we'll have that in the south ramp--to about 1,000 feet which will enable us to eliminate the tangential conveyor drifts that were in there and it will allow a more workable conveyor arrangement at the north and the south ramp. Also, based on the results of a review of the core data, we have picked the north end of the repository on the east side to be about 140 feet higher than we originally had placed it which, of course, lessens the gradient to about 6.7 degrees in the north ramp. This will be confirmed by a borehole at the place where the repository--I mean, the north ramp enters the repository block.

ESF activities for '92, as you know, we had a considerable reduction in our funding for ESF this year and we are doing a limited first access site preparation package. It's going on right now. That design package, we call 1A. I'll show you what's in that in a moment. Also, this year, we are developing the key plans, such as operation, maintenance, and construction management plans and determining the seismic design criteria for ESF permanent potential repository structures. They said those things that might become a permanent part of the repository, we do have to design those to the seismic standard for a repository.

We have divided the design effort into 10 packages. It is a design we call the phased design approach. Dr. Bartlett views this as sort of an evolutionary thing. When we accomplish certain portions of the design and the construction, if we find out that the site characterization program should change as a result of what we've found out in that particular phase, we may decide to do something differently in the next phase. But, it's-- our job in the design is to have these packages available for that construction strategy change. In your book, I've provided an ESF arrangement just to show you which are those packages, those design packages.

Now, I mentioned earlier that we split the first design package into two, Package A and B and the one that's being designed right now is the site prep package at the north portal. And, Package B will include the surface facil- ities. I'll show you what's in that one. We're not design- ing any buildings in that one at this juncture. 1A includes these: portal access road, pad, ramp highwall including the TBM launching chamber, all pad, electrical and water systems.

For '93, the ESF activities are these. We will continue the Title II design and we'll also begin some con- struction. The Title II design, we'll design the first access buildings and surface facilities. That is that 1B package. We'll initiate the Title II design for the second access which will be the south. We'll also initiate Title II for first access ramp. That is your Package 2 in your list. We will start those facilities that we have designed, the construction of those facilities that we have designed in Package 1A and maybe some for 1B. And, of course, perform the site prep and the highwall blasting at the north portal.

The planned repository activities are shown here for '92. We call them pre-ACD studies. We will be doing the ramp sizing study, waste emplacement mode study, as well as the repository horizon/gradient study.

DR. NORTH: I think those are studies we'd like to find out more about both in terms of their content and in terms of their timing. Will that be covered by others later?

DR. SIMECKA: I'll cover the ramp study, sizing study, but I hadn't intended to go over the waste emplacement mode or the repository horizon--well, the repository horizon/ gradient study is--part of that is being done right now. Excuse me?

DR. NORTH: I think given this is an exploratory facil- ity and given the many questions and concerns the Board has raised about engineered barriers, more robust container, we'd be very interested in finding out what the waste emplacement mode study entails, as well as the ramp sizing study, to see to what extent some of our concerns in that area are being addressed. I mean, as one example, if you're going to use a large cask, you might want to use a rail system to get it down there and that would mean grades of less than 1 or 2%.

DR. SIMECKA: That's correct.

DR. NORTH: As I understand it, you've assumed rubber tire vehicles. So--

DR. SIMECKA: Not necessarily. That's still open for question.

DR. NORTH: The point I'd like to raise for you is there are a lot of details like that where we'd be interested in knowing more about what studies you are doing and which details are getting examined, and therefore, what we might expect to hear from you in late fiscal year '92 before commitments are made with respect to ESF plans.

DR. SIMECKA: Okay. I'd be glad to do that. I think some of your questions may be answered when I talk about the ramp study.

You talked about some of your recommendations as a result of the September 1991 meeting. As far as ESF is concerned, we felt your recommendations could be divided in two aspects; ramp sizing and access to geological features. You requested that we look at smaller diameter tunnels; that is in the 16 to 20 foot size category with the idea that you would subsequently enlarge them if you needed to for the repository. And, we are doing this study--I'll cover that a little bit more. RSN is the lead participant with support from the M&O and they're doing that the latter part of this summer.

The second thing is you said that you were concerned about providing early access to important geological features including Calico Hills unit and the Ghost Dance Fault. We are considering a development sequence and construction sequence that will provide a balance between our desire to get early access to MTL, as well as the Calico Hills.

Now, the four TBMs I show here is based on trying to meet the 2001 and those will not be procured in a lump sum. I mean all at once. Our procurement process will allow us to choose which is the best way to do it. We may buy a hole in the ground which means that we may not develop--buy all of the--or the constructor may not buy all of the TBMs, at all; may do fewer. But, this is our baseline and that's what I've got in here.

Now, the development sequence is that the excavation in the north ramp would proceed to the Topopah Springs level, past MTL location, and through the Ghost Dance Fault, and can do that in approximately 21 weeks after the TBM cranks up at the north portal. And, the south ramp would be excavated just beyond Calico Hills' turnout and then start down to Calico Hills as soon as possible. Then, after you start the Calico Hills' ramp, then the other TBM will continue on to the through-point at the Topopah Springs level.

One other question, you asked about the potential impact of thermal loading on the ESF design. Sandia Laboratories has recently completed a preliminary far-field thermal mechanical analysis of the ESF drifts that would be part of the potential repository. They're currently preparing that report. We just got preliminary data and the AE. We'll use the results of this study during the design of the subsurface openings scheduled for '93 and '94.

Now, you have in your document there two results there. I won't go over them in any detail, but basically these show that the change in the normal stress that you would find in the north ramp main access and the east-west exploratory drift is a very small percentage of the total ultimate strength of the rock. So, we don't think there would be any problem associated with that. Now, the emplacement drifts, it could be a different story, but this is all we've done, so far.

You asked about the design transition from RSN to the M&O. The M&O has developed a transition plan to take over the design from RSN for the ESF starting 1 October and this is just the things that they are now doing to get ready for that.

The other question had to do with our procurement plans for the subcontractor that would be working for REECo who is the constructor. That the REECo, because they have lost a lot of their TBM experienced people, has decided that the subcontractor, that is the best that they could find for ESF construction, is the one we ought to have and so that's the purpose of the RFP that has gone out this last Monday. The contractor will report to REECo who is the constructor. We've put options in there of Government furnished equipment, subcontractor procured equipment, or subcontractor furnished equipment, and RFP does not preclude any one of these options. So, the decision on whether we go with a hole in the ground or GFE equipment is yet to be made.

You also asked about the role of Morrison-Knudsen. They will be the subsurface designer as of 1 October for ESF. They also will be providing construction management support to the DOE in managing all the field construction activities. And, of course, they are slated to be the repository subsurface designer.

You also asked about the Colorado School of Mines. Well, you know Colorado School of Mines has been working with us for some time. They are the leading experts in mechanical excavation equipment and so they've been doing a number of things for us. They've developed a set of preliminary specifications for the TBM which if it went out for procurement, we would use these. If it went out--if we decided to go to the hole in the ground, then we could provide these as information. But, we thought we ought to develop those specifications. They are determining the physical properties of welded tuff and predicting mechanical excavation performance with their laboratory tests. And, of course, they also are helping the surface-based testing program in laboratory testing of coring and reaming bits of various designs.

And, that ends my discussion. You asked about the ramp sizing. The aspects of ramp sizing are that we must consider in my view are, of course, the ventilation and safety aspects of both the ESF and the repository. And, that may dictate what size the ramp should be, as well as the TBM. Also, there's cost effectiveness considerations of how much it costs to enlarge the ramps and what equipment would do that, mechanical excavation equipment would do that, and that will incur some extra costs. Also, the ground support that's already in there for the ESF, we've got to make sure that we assess the cost of pulling that ground support out if we have to enlarge, if that's necessary. So, all those factors are being incorporated in this ramp sizing study that's going on.

And, I don't know if that answers all your questions, but those are a few of the things that I think will dictate the decision on ramp size.

DR. NORTH: Thank you. It looks as if we do have time for questions before lunch.

Dr. Deere?

DR. DEERE: One question I have. Where your north ramp is scheduled to cross the Ghost Dance Fault in a relatively short time after you've started, isn't that in an area where the fault has had very limited displacement?

DR. SIMECKA: I'm afraid I can't answer that question. Can anybody help me on it? Yes?

MR. DUDLEY: I'm Bill Dudley of the USGS. Yes, at the north ramp location, there's displacement of--I'm not absolutely sure--I'd say on the order of perhaps 10 meters and that displacement does increase to the south. So that at that first location there would be very limited displacement.

DR. DEERE: Then, I have a follow-on question. What formation would that be in or which horizon where you would make the crossing of the Ghost Dance Fault?

DR. SIMECKA: Topopah Springs, TSW_2. Isn't that correct? It's the drift that's doing it, main drift. It's the main drift of ESF.

DR. DEERE: Okay. Because we had once talked about the advisability of crossing it at a higher elevation.

DR. SIMECKA: I understand.

DR. DEERE: And, were looking perhaps at a cross drift or some manner to get into that area, as well. We felt strongly that we really had to see the Ghost Dance Fault in about three different positions.

DR. SIMECKA: Well, that could be done off of the north ramp or the--

DR. DEERE: There certainly was a possibility of it, Bill.

DR. SIMECKA: Yeah. We--

DR. DEERE: North ramp, a shallow shaft, a raise, and then maybe something.

DR. SIMECKA: I'm not aware. That hasn't been looked at and decided upon at this juncture. So, that's something for us to look at.

DR. NORTH: Dr. Cording?

DR. CORDING: There's a study we had received, I think it was September meeting, regarding alternatives for TBM use, different TBMs, different TBMs, different sequences. It was a very preliminary sort of study and it didn't involve a lot of detailed cost information. But, that did at least begin to look at some of the alternatives for scheduling and moving TBMS, the number of TBMs, through the system. Has there been more work done in this area? The last we had was the four TBM concept. It seems that that is still basically the same as we received from our September briefing. Is there further work being done on looking at alternatives for sequencing and costing for the schedule, of course, for the TBMs?

DR. SIMECKA: That particular one assumed--I mean, I should say the baseline assumes four TBM and that's due to speeding up the process to meet the 2001. So, we're still at this juncture planning on using four TBMs. However, if the site characterization program dictated that we do this in an incremental way and we are relieved of the 2001 or our strategy would be that that was not critical, we could do it with a fewer number of TBMs. And, the way we would sequence that would depend on the site characterization program and, of course, be limited by available funds. But, that has not been--the four TBMs is just our baseline, but depending on the planning that's going on for the 2001 and whether we get approval for that sort of a funding profile, we will change those.

DR. CORDING: It seems to me that this is something that regardless of the funding profile needs to be looked at and it needs to have flexibility built into it so it can handle different funding possibilities that are certain to arise.

DR. SIMECKA: That's right.

DR. CORDING: That the four TBMs and other equipment like mobile miners and all operating for this length of project is a large number of machines.

DR. SIMECKA: They sure are.

DR. CORDING: There's a lot of startup. There's a machine that goes down and has to stop and then wait for a side drift to be excavated. There's these sorts of interfaces that slow the process, and once a machine is mobilized and is efficiently operating, it's going to make a lot more distance and progress than you can make even with two machines in some cases. I mean, if you can get one machine going as early as possible and get it through the facility, it can do much more than trying to mobilize and demobilize machines and operate with more. So, that there's a real benefit here to being able to get one machine going and not be in a situation where you're trying to put all of the machines in in a short period of time and get the work accomplished in a very short period of time. And, it seems to me that some of the sequencing, whether it's four machines, three or whatever number, that some of the sequencing needs to be looked at with a good cost schedule estimate and looking at some alternatives. Right now, regardless of what we think the present cost schedule is in regard to--or regardless of what we think the funding is at present, we need to go forward, I think, with some alternatives on this and looking at what really is most efficient.

DR. SIMECKA: Maybe I misrepresented it, but we don't intend to buy all four of those. We wait until we get the money to buy all four. As soon as we've got adequate funds, we will buy one. If we've got adequate funds to buy two, we'll buy two, and so on. So, our intention is to get a TBM on as soon as possible, as soon as we can get the money to do that. We haven't had the money this year, of course, because we got cut severely. Next year, we can develop everything to get ready to buy the TBMs by getting the specs and getting the subcontractor on board and et cetera. So, as a matter of practicality, we will be sequentially buying either the capability or buying the machines in a sequential fashion.

DR. CORDING: I guess part of the point is that we need to look at alternatives to the four machine concept and the sequence that's laid out in the base plan. Whether one is only doing it incrementally or not, I think there's some alternatives there that need to be investigated and looked at and that ties into size also.

DR. SIMECKA: No, I understand.

DR. CORDING: For example, being able to run the same size machine from the surface through the Calico Hills is a possibility when one looks at the sizing. So, that would change the way you organize the TBM setup.

DR. SIMECKA: Absolutely. We are doing that on a continuing basis. We have not decided on 25' or 18'. We haven't done that yet. So, you are absolutely right. We intend to do that because we do have to remain flexible, based on what the site characterization program demands. So, we will do that.

DR. DEERE: Don Deere. As a participant just a week ago at the hearing of the committee on Energy and Natural Resources of the Senate, I think the point was made that we certainly have to maintain flexibility. Whether or not the funding will be available is always a question and they certainly put a question to what could be made available.

I think Dr. Cording's point that your goal of four with the idea that we will do one and then we'll do a second one and a third one and four when we can, maybe should be looked at. If we are going to have to have reduced funding, then we realistically have to look at a longer schedule.

DR. SIMECKA: Absolutely. Absolutely.

DR. DEERE: Once we start looking at that, they you say, well my goal isn't four, my goal is only a total of three or maybe two.

DR. SIMECKA: Absolutely. No, I agree with 100 percent because there is no sense of buying those machines if they are not necessary. So, we will buy whatever is absolutely necessary to meet our schedule. We have to remain flexible as long as we don't know what the future budget is. So, you are absolutely right.

MR. GERTZ: I just wanted to reiterate that. You and I have talked and I have seen one of your earlier reports and I concur with most of your thoughts.

I think when we bring on our contractor, our excavation contractor, part of the contract certainly is for technical support and I am sure he will be providing us some very important input along with M-K as our construction manager to devise some of these alternatives. That will be occurring just after the first of the fiscal year, in October.

So, I think the combination of M-K helping us as our construction manager, bringing on our underground excavator with technical support early on, we are not just buying equipment, we are buying some big thinking, we hope too, and some input with this RFP and then we can start developing. We can say, gee, if we get so much money, what is the best way to do it? With one machine? Two machines? Three machines? Four machines? Things along those lines.

We are just not at this point in time putting a lot of effort in it for various reasons.

DR. CORDING: Carl, would your plan be to have the construction contractor select the machines and purchase the machines themselves?

MR. GERTZ: We have provided that option in the RFP right now that he can use existing machines that he may have. He may propose to buy new machines. He may propose that they be government furnished machines and he would take them over and operate them or any other permutations. We are looking for his expertise. One as far as the RFP, and two when he comes on board as what he thinks as we hope is the world's top underground tunnel contractor what he can bring to the party, so to speak. All those are options and I don't know what is the best one right now.

DR. CORDING: The basis for selection of the construction contractor, what is that? How will you go about making the decision as to which proposer is selected?

MR. GERTZ: We don't have anyone from REECo right now, but it is a standard RFP. It has a list of criteria in it. I think it talks about capability and experience. I don't think cost is a very heavy factor in it all, because we look at it to be a cost type reimbursable contract because of the uncertainties and scientific aspects of the excavation. I think we are just looking for technical qualifications.

DR. SIMECKA: It's a two phased where the first phase is the technical qualifications of the offerors and those that make the qualification cut will then be asked to give a price. They will price out the tasks that have been outlined in the RFP. We can't talk about it, even if I knew I couldn't talk about it, because the RFP is on the street.

MR. GERTZ: Ed, we will get you a copy of the RFP and we would appreciate any comments you might have on it.

DR. CORDING: In other words, there will be a technical proposal and an evaluation.

MR. GERTZ: Yes, sir.

DR. CORDING: And then there will be cost evaluation.

MR. GERTZ: I don't have the details right in front of me, but we will get Federal Expressed a copy of the RFP and any comments you might have on it we would sure appreciate it. While we simultaneously released it to the offerors, we are also reviewing it in different aspects of the project. So, as things change, we will probably have an amendment to the RFP.

DR. DOMENICO: When you are not sure how much money you have, if you have to purchase your own machines at about $10 million each, I am hearing, isn't it kind of difficult for someone to respond to an RFP, unless the cost is based just on the 14 miles and how much it is going to cost to do it and do it anyway you want. Is that how it is arranged?

DR. SIMECKA: Well, as far as costs they will have to respond to proposed tasks and how much would it cost to do those tasks. We are not saying that we are going to do those tasks in the way that they are stated. But, they are used as a screening criteria to select the best one. But, they will have to respond to what the assumed tasks are.

MR. GERTZ: Pat, it is not like a fixed price contract. What we are using those costs for is to help evaluate the capability of those contractors, not to hold them to those costs because we may not have $10 million available to buy a machine or something like that. So, we are looking for his ideas as how we can excavate.

DR. DOMENICO: Do you have an idea of what your anticipated total costs would be?

DR. SIMECKA: For that sub-contractor?

DR. DOMENICO: For that RFP, yes.

MR. GERTZ: I think it is quoted in the area of $100 million, approximately.

DR. DOMENICO: Approximately.

DR. LUCE: Luce, with the TRB staff. I just have a small question and that is in the evaluation for the tunnel diameter design, is it being considered that these canisters may be totally horizontally emplaced and lodged there?

DR. SIMECKA: The canister total weight, size and so forth will be looked at of course. What we have to do is make sure the access ramps are large enough for the waste transporter with its cargo to be able to go through those openings. And yes, that is being considered. As far as the large canister is concerned, we hope to look at that too, and see whether that puts a limitation on it. So, yes, the answer is we are looking at all of those. There is horizontal emplacement, vertical emplacement and drift emplacement all have to be looked at.

DR. CORDING: Will you be looking at the possibility of changing ramp slopes? For example, if one were to be using rail transporters going to flat enough grade to handle rail, it also has some benefits for construction of the tunnel and

TBM operation?

DR. SIMECKA: We are looking at rail versus rubber tire. I understand that one of the foreign countries has a rail transport that is able to negotiate much steeper gradients by having some kind of a center rail that grips. So, if rail turns out to be the preferred one, why surely we can use it.

DR. CORDING: Would the cog railway sort of approach be for that steeper gradient?

DR. SIMECKA: As I say, the technology has been proven that they can do that. If we choose to use rail, then the gradient, we might be able to navigate is much larger than what is now considered the rule of thumb.

Does that answer your question? We are looking at both.

DR. CORDING: Well, I think it does. I think there are two things. One is most of the rail systems are designed for the flat gradient.

DR. SIMECKA: That's correct.

DR. CORDING: The first point was, can we look at that as a possibility. The other point would be then to say, well if looking at the possibility of going to steeper gradients with a different system, but it would seem to me that looking at the flat gradient with the standard rail might be a good thing to look at for both ramps.

DR. SIMECKA: The south one is much lower, of course, less than two degrees.

DR. CORDING: I know that the south ramp is already rail capable.

DR. SIMECKA: That's correct.

MR. GERTZ: Eventually we are going to have one ramp to emplace waste and the other ramp to take out rock. They are both not going to be used for waste. So, certainly under some schemes the repository with a 6 percent ramp and a 1 percent ramp would be a very operational repository.

DR. CORDING: Presently, is the south ramp, I'm trying to recall, is that the waste ramp?

MR. GERTZ: Right now, in our reference case the south ramp is for taking tuff out, not for putting waste in.

DR. SIMECKA: But that can be changed.

MR. GERTZ: That can be changed. That is not an irrevocable decision at all. That is our current case. We are contemplating and thinking is there an option to make the south ramp emplacement.

DR. NORTH: Carl, they may have problems if you are not at the microphone.

DR. SIMECKA: I thought he was going to make a speech.

MR. BULLOCK: Dick Bullock from RSN. Even with the 140 feet raise in elevation, even the emplacement drifts could be in the range of 4.5 percent. So we are getting closer all the time. I think Climax runs trains at 3.5 percent now with very heavy loads. So, you are almost there. Thank you.

DR. NORTH: Further questions?

(No audible response.)

DR. NORTH: We are about a few minutes into our designated lunch hour, but not many. It is always amazing to me when we come out close to on schedule at the end of a busy morning like this. Why don't we see if we can resume about 1:20 p.m.

(Whereupon, a lunch recess was had off the record.)

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

(1:20 p.m.)

DR. NORTH: Let us resume for the afternoon session, with Dr. Russell Dyer on Surface-Based Testing Drilling Program Review.

DR. DYER: What we have in mind for the next hours is a rather ambitious presentation on the part of Uel Clanton and myself. This will be a tag team presentation looking at the scope of the surface-based testing programs, specifically the drilling program.

We have broken it down into two components, one of which is the programmatic planning phase and the second is the technical part of the program. Now, I am going to fast forward here to a graphic in Uel's talk which is the combined drilling schedule. For those of you using the handouts, this is the next to the last graphic in Uel's presentation. And, I regret to say on this scale, it is virtually unreadable. There is a copy, a wall copy, on the board in the back and for the board members, in the back of Volume I, and it is supposed to be in Volume II, but it is in Volume I, in the very back is an 11" x 17" color-coded copy of the drilling schedule.

What I would like to walk you through in my part of the presentation is what each of these little bars mean, why we are doing them and where they are, both as a part of the program and also as a specific location in space and time.

Dwight Hoxie and Bill Dudley mentioned yesterday or alluded to the fact that the drilling program essentially has two components to it, one of which is a feature-based program which is looking at specific features trying to understand specific faults, for instance specific zones of interest. And the second part of the program is more a statistical part of the program. This was identified in the PA presentations both yesterday and this morning, as being needed to acquire the statistical information required for input to a performance assessment. What I am going to go through as I walk through the drilling program, is what parts of the program feed different parts of either the systematic program or the feature-based program.

Uel will kill me if I don't say this, and I also learned this word with Abe this morning is caveats. What you see before you is a snapshot in time. This is a planning basis. I have virtually no confidence that we are going to have this same drilling schedule in about three months. This is based on assumptions about funding levels; it is based on assumptions about test prioritization. As the program matures we continually update this particular drilling schedule that you see. So, what you see is a snapshot at this point in time.

What I would like to show here is a take-off on a slide that Carl often uses, which is a listing of the number of boreholes involved in the surfaced-based program. What we are going to concentrate on is these top two categories. These are slightly different numbers than you may have seen from Carl before. We went back and recounted and you'll see the difference and the reason for the difference in a little while.

The point I would like to make is like Paul Harvey says, this is not the whole story. The rest of the story is out here in the last two columns, which is that a significant number or a significant part of this program, of these total numbers of drillholes is already in place. And what we are looking at for the rest of the surface-based program is what is out here in the planned column. And the numbers look pretty overwhelming, 267 shallow drillholes less than a thousand feet. That seems like an enormous number until you realize that about 200 of these are essentially postholes, that are three to five foot deep dug with a posthole digger, yet we count them in the drilling program. The ones that I am going to concentrate on mostly are things that we would call deep drillholes, that is greater than a thousand feet.

This didn't reproduce all that well, but what the intent of this graphic was, is to indicate the total scope of the surface-based primarily drilling program. And what we have here is the outline, the conceptual perimeter drift boundary. We have taken topography off. There seemed to be enough confusing markers on there to start out with. This is the outline of the conceptual perimeter drift boundary. This would be the north ramp, the main ESF test level south ramp of the exploratory studies facility. This is what we call the boundary of the controlled area here. Things annotated in the dark filled in taco chips are the existing boreholes within the program. Things that are not filled in, that is the open upside down deltas, are the planned drillholes.

Of course, the objective of this program is not to drill a certain number of drillholes. The objective is to answer some specific questions. The drillholes give us access down, allow us to field test, which allow us to answer those questions.

Within this total suite of boreholes here, and perhaps if you use this as a key to try to interpret what is on the drilling schedule that you have, you'll see that there are holes that are coated with various prefixes. Some of the prefixes may be UZ, N, G, SD. This slide gives you essentially the decoder ring to interpret what each of those prefixes mean and gives you an idea of the magnitude of the program associated with each of those particular activities.

Let me take the neutron holes for instance, unsaturated zone, infiltration studies of Alan Flint. Those are prefixed with an N. Those are completed through a dry drilling process. They are relatively shallow holes. The name of the activity that they support, that is the actual scientific test is looking at the natural infiltration. The transfer function between precipitation at the surface and flux through the mountain in the near surface. There are 30 holes planned in that particular activity. Depth range is on the order of 60 to 300 feet. These are relatively shallow near surface studies.

The study plan that controls this particular scientific investigation is given in the right column, and this indicates the status of the study plan. NRC means that this is a study plan that has been through the DOE review and approval process. It has been sent to the NRC. In some cases, the NRC has not gone through the complete review cycle, but in all cases that NRC is listed, these have gone through all the DOE approval process. So, these study plans are still in preparation at various places within the project.

The last column out here indicates the participant responsible for the scientific investigations that take place in these boreholes.

The next column down would be the unsaturated zone holes. As you can see, there is a smaller number of these holes, only 16 of them, yet these are relatively deep. They are 1,700 to 2,700 feet deep. And these also are dry drilled. These would be drilled with the LM-300 or similar technology which Uel will tell you much more about shortly.

Geologic drillholes, a check means that all the holes need to be drilled with a dry drilling technique. I have one category of holes, the G holes, where there are some that are scheduled to be drilled with dry drilling, some that don't need dry drilling and we can drill those with conditional wet technology if needed. So that is what the anomalous symbol here means.

The statistical drillholes, just statistical drillholes again a suite of deep holes dry drilled about 12 of them, again 1,800 to 2,500 feet deep.

Now what I would like to do is to walk through in some detail a sampling of various parts of the drilling and testing program. The two things I would like to concentrate on is the geographic distribution of individual drillholes associated with a particular part of the program. And also to give you some information in tabular format which you could use as a reference base, essentially which explains for each part of the program what the objective of the program is, what information needs are satisfied by this particular part of the surface-based program, what related analyses or tests are done in this suite of boreholes. How many boreholes that we have as part of the program, and we have both the planned and the existing boreholes and a snapshot, a simplified version, if you will of the drilling schedule associated with this part of the program. This schedule should be consistent with what you see on the master schedule in your handouts for the board or in your unreadable printout for the members of the audience.

The first one I would like to take you through is one that is active right now, we have been actively drilling the neutron holes since last fall. We had, as I said, 30 boreholes planned for new boreholes. We completed seven of them. We may be up to eight now. The holes that we are sinking right now take about two days to drill and it seems like I am always one or two holes behind when I am giving talks because it only takes about two or three days to drill a hole, skid the rig and drill the next hole.

This is the drilling schedule that we are looking at right now for the remainder of '93. I would point out that there are 76 existing holes already as part of this program, there will be the sum total of about 106.

As I mentioned earlier, this part of the program, the emphasis of this part of the program is to try to understand the physical mechanisms by which precipitation would go from the ground surface or the surface of the rock, transfer down through a near-surface environment down into a deeper part of Yucca Mountain, to understand this transfer function, if you will.

These are some of the other related analyses or tests associated with natural infiltration. Tritium profiling, Alan also is doing that. The water budget studies, looking at essentially trying to understand a mass balance if we can for how much water comes in, how much water goes out and where is it partitioned within the system.

This is the geographic distribution. The key to these particular graphics, again we are showing conceptual perimeter drift boundary. This is the road that if you remember from your visits out to the site, this would be Forty Mile Wash running right along through here. This is where the road dips down in Forty Mile Wash and crosses--I'm sorry, this is not Forty Mile Wash. Yes, this is Forty Mile Wash. I'm sorry. Coming up to, let's see, this would be Exile Hill in this area right here, road along Exile Hill.

The sub-dock where we store equipment is located right about here. This was the ESF-1, ESF-2 shaft locations up here. Whenever you take the road up to the crest of Yucca Mountain, just to set you in physical space here, you follow this road and our general stop is up here at the south end of the conceptual perimeter drift boundary in here. The little markers with no symbol on them, no annotation next to them, are existing boreholes. The ones that have an annotation next to them, N36, N37, are the ones that are planned in the current phase of the program. The ones that we have completed to date are N54, N55, down in here and N11, 15, 16 and 17 up in here, N37 here. I think that is all of them. So you get some idea of what the rest of the program for this physical year consists of.

And this is the format that I am going to follow for the rest of the presentation. I am not going to try to go through everything, but what I want to do is hit some of the highlights.

Dr. Domenico.

DR. DOMENICO: Russ, that is the extent of drilling the repository block that we are seeing right there?

DR. DYER: No.

DR. DOMENICO: No? You have got more planned?

DR. DYER: This is only for the neutron holes.

DR. DOMENICO: Neutron holes.

DR. DYER: These are for the shallow neutron holes. The deepest of these holes is around 300 feet.

DR. DOMENICO: Are you going to run into or have you run into any difficulty with NRC in drilling the block itself?

DR. DYER: Well, as we mentioned earlier whenever the question came up about the association between performance assessment and the surface-based testing program. Every one of the holes that we field, we do an impact analysis on to look at the potential impacts of that particular hole on the waste isolation characteristics of the repository block.

DR. CORDING: Russ, just a quick question. Could you summarize, perhaps as you go, the type of equipment and whether you are coring on these holes?

DR. DYER: Okay. For the neutron holes we are using and Uel will tell you more about this. This shows an ODEX type system, with dual wall circulation, dry drilled, continuous cored. I think we are getting core recovery rates of 95 percent or so. It depends on the hole.

The next part of the program I would like to talk about is the deep unsaturated zone program which is getting a lot of attention right now. UZ-16 is our first deep, dry drilled borehole. This will be drilled with the LM-300. UZ-16 is located to the south and east of the conceptual perimeter drift boundary in this area right here. This shows the lateral extent, the geographic extent of the unsaturated zone drilling program. I put the trace of the north and south ramps of the main test level of ESF on here, just to give you some idea of what kind of volume of rock we are sampling both with ESF and with the drilling program.

The specific information about the UZ program, UZ-16 is also a multi-purpose hole, I guess I would say. It is continuous cored, so we will have a complete suite of dry drilled samples available through the sample management facility for all investigators. There is a series of information needs that are going to be at least partially satisfied through UZ-16 and the other parts of the UZ program, including the in situ moisture condition close to the conceptual perimeter drift boundary. We have a few UZ holes within the conceptual perimeter drift boundary, but most of them are located outside of the drift boundary.

The hydrologic properties, moisture conditions in the unsaturated zone and of course the advantage of a borehole here is that you are sampling the third dimension. ESF is going to do a very good job of sampling on a particular stratigraphic horizon. But, in order to get the three dimensional information, we are going need some boreholes in the vicinity of the conceptual perimeter drift.

Let's see, we have got 16 holes planned for this program. There are no existing holes because this is a new technology that we brought on line, the deep dry drilling technology which we will talk about is new. As I said, the first borehole UZ-16 we intend to spud later this month. We are looking at around the 25th or so, I think. The 25th or the 27th for initiated drilling. That is going to be about a 1,600 feet deep hole. I believe it bottoms in the Calico Hills.

Let me point out one other thing here while I have this up. There are some parts of the UZ program, namely the 9 series, hole 9, 9a and 9b that are specifically designed to look at--it is a multi-well test package to look at gaseous inter-connectivity between the wells. So that is going to be a follow on series of tests in this series of wells, the 9 series, which is using one of the UZ holes, or a suite of the UZ holes.

Geologic holes. These are the G holes. Again these are relatively deep holes. They may be dry drilled, they may be conventionally wet drilled. The primary purpose of these is to determine vertical lateral variability within holes, the stratigraphic horizon. There are 15 existing holes, G holes. There are only four new holes planned. This is the current drilling schedule. If you look again at the conceptual perimeter drift boundary, the planned holes are G-5, which we talked about a little earlier as being targeted perhaps to be a very deep hole tagging the Paleozoic in the vicinity of the large hydraulic gradient to the north. G-6, which would be over in the vicinity of the north and west of the potential repository. G-7, located down to the south in this area. And, a fourth hole G-8, which we have not established a firm location for, yet.

The systematic drilling program, geostatistical drillholes, what is annotated or prefixed with SD on the drilling schedule is that suite of holes that are specifically designed to provide statistical information to support performance assessments. So, rather than depending explicitly on feature-based drilling and if you are drilling something that is an obvious feature, there is something a little different about it to start out with, what you want to understand is what the average properties of the particular medium may be. So, this is a series of programs that is based on statistical sampling of the three dimensional volume within the conceptual perimeter drift boundary.

There is also a series of holes that have a much smaller spacing, which is to examine whether or not this spacing provides you representativeness that would also be observed at smaller scale. So, this is a test that as to the adequacy of the larger scale sampling.

There is a total of 12 holes scheduled within the systematic drilling program. Here is information about it. Again, this is all continuous cored, dry drilled, relatively deep holes and here is the schedule. I believe this is about the last hole in the drilling program in October of 1997, based on the schedule that you see on the board in the back.

This program also provides information in support of design. And in support of ESF design, of course we need some essentially exploratory boreholes, if you will, to provide information about rock properties in advance of placing the ramps in place. And here is the conceptual perimeter drift boundary again, the south and the north ramp access. And a suite of boreholes whose primary mission in life is to provide design information for these excavators, here, for the ESF construction.

Here is our current drilling schedule to support this. There is one thing in here that is a little bit confusing perhaps. NRG-6 which is the deep borehole at the north end, at the end of the north ramp, is conveniently located close to one of the proposed SD boreholes, SD-1. What we have done is to consolidate SD-1 in this particular drillhole, so we will be drilling one hole here which will fulfill the functions of both the statistical program and also to provide design information for ESF ramp. Eleven boreholes altogether here.

Now the drilling schedule you have is based on a lot of assumptions. It is based on assumptions about drilling rates, which have not been validated yet. Not at Yucca Mountain. So there is quite a bit of enlightened guess work, if you will, that are in those drilling schedule. They are also based on assumed target depths that could change if we change parts of the program. And, I bring this up because Dr. Domenico alluded to this yesterday. One of the comments that came out of the Hydrology Peer Review Team about a year ago was that we needed more information from below the water table. Most of the WT holes, water table holes that we have currently on the program are currently scheduled to go, not very far into the below the water table that is primarily into the tuff aquifer.

We have got eight new boreholes planned as part of this program. If we change the target depth for some of these holes, of course, that is going to change the drilling schedule somewhat. It is going to take more resources to drill things deeper. Here are the existing boreholes, again those with no annotation on them, mostly located well away from the conceptual perimeter drift boundary. Those with annotations on them are the proposed new part of the drilling program.

DR. DEERE: Excuse, could you point out once more the new ones, the deep ones that would go through the carbonate aquifer, or do you know those as yet?

DR. DYER: Well, of these, I don't think any particularly would go to the carbonate aquifer. We might go into the--well, actually, Dr. Dudley? No? None?

DR. DUDLEY: The plans are too uncertain.

DR. DYER: We will probably deepen some of these. I am not sure exactly how far we would deepen them. It may be that we may wish for some of them to penetrate the Paleozoic. We have a couple of wells that are targeted for the Paleozoic. They are mostly the G holes. But, right now in our plans, none of the WT holes are targeted for the Paleozoic. But, it may change, of course.

DR. NORTH: I would think it would be useful to explore further the value of the information you might get from going down into the carbonate aquifers. I would think WT-19 and 20 would be the obvious candidates, because they are going to be down gradient from the repository and that is the area where you might like to learn what is down there.

DR. DYER: That's true. The only well we currently have that penetrates the Paleozoic, is P-1, which is located, let me see if I have got this right, I think it is right about in here.

DR. DEERE: Isn't that the one that has the 50 foot sub-artisan level after you hit the contact?

DR. DYER: Dr. Dudley says yes. Dr. Hoxie says yes. We consent.

DR. DEERE: I just don't see how you can walk away from it and say we have one indication of it and that is it. That to me is an important part of your frame work.

DR. DYER: I agree. As I said, this is our snapshot in time right now. We know there are some changes that need to be made to this, we just haven't got them all filtered through the system yet.

DR. LANGMUIR: Are these two inch holes? What are the diameter of these holes?

DR. DYER: I'm sorry?

DR. LANGMUIR: What are the diameter of these holes?

DR. DYER: For the WT holes, those are 12 1/4 inch holes.

DR. LANGMUIR: Might some be used as monitoring holes later on if the site is approved?

DR. DYER: Oh, absolutely.

DR. LANGMUIR: Was that the intent that you keep them for that?

DR. DYER: Yes. Some would be monitoring holes. If they have no use as a monitoring hole, then are committed to go back in and seal all of these.

DR. DOMENICO: Russ, one more. In view of the new theories on the origin of the gradient, the large gradient, are there any geologic holes planned in the vicinity of that gradient to see if it coincides with the pinch out of the Eleana shale, because that is kind of a new idea?

DR. DYER: Well, G-5 right now, we are still struggling with exactly where that might be. One suggestion is to drill it right in the middle of the gradient to test the possibility that it is a drain. There is a, I don't have it on here, but there is a suite of geophysical surveys that will be run this summer that will also try to help acquire information that will help us locate G-5.

One question that often comes us is what parts of the surface-based program can be modified or changed based on the underground program, the greatly expanded underground program. I think perhaps you have noticed so far that the bulk of the drilling program that we have scheduled so far lies outside the volume of rock that is sampled by the ESF, the underground ESF. There are some other tests, however, which in fact may well be satisfied by an underground facility rather than a drilling program. Although it is a relatively trivial part of the program, let me throw this one up just as an example. This is drilling associated with resolving the calcite silica issue. Again, conceptual perimeter drift boundary. This is the Exile Hill area right in here. Trench 14 lies right in here. And one of the ideas in the study plan, John Stuckless' study plan, was that if upon deepening of Trench 14, the information was still ambiguous as to what the origin of those materials might be, it might be necessary to put in some angled holes to sample the Bow Ridge fault system and the associated vein system at a greater depth.

So these holes were built into the program some years ago. Of course, since we modified the concept of ESF, we now have in our program, in our plans, a very large borehole that would go right through here and that is the north ramp to the ESF, which essentially goes right under Trench 14. So this, of course, gives us the at depth, essentially the exposure of the Bow Ridge fault system and the associated vein system.

I am not going to go throw these out of the book just yet, but I must say that these do not have a very high priority whenever it comes to funding.

Leon.

DR. REITER: Leon Reiter. How would you respond to Steve Frishman's argument this morning that they are hydrothermal deposits. Perhaps Trench 14 is the least significant of them.

DR. DYER: I guess I am a little puzzled by that. Two years ago Trench 14 was the most obvious example of it. And now it seems to be the most ambiguous example of it. So, Trench 14 is only part of the program to look at the origin of the calcite deposits in the vicinity of the potential repository.

DR. REITER: So you are not restricting yourself to this one hole?

DR. DYER: Oh, absolutely not.

MR. GERTZ: Leon, let me add also, the National Academy Panel on coupled process looked at many suficial deposits. It wasn't focused just on Trench 16. It was the wide ranging examination. I have just been told officially that they intend to provide us that report to my staff at 12:30 on Monday at the St. Tropez in Las Vegas. So, we will hear more about it then.

But certainly their approach to the problem was much more than Trench 14 and that is even why the name of their Panel was called a Coupled Process Panel.

DR. DYER: The last one of these information pairs I would like to go through with you today is the one for artificial infiltration. I do it for primarily one reason, which is to explain what appears to be a horrendous number here, 232 boreholes. However, what I would point out is that the majority of these holes are going to be about 5 feet deep. So we are talking essentially about postholes. And 232 postholes, well actually it is about 140 postholes, that is a reasonable fence. We are not talking about a large resource commitment that is part of the drilling program here, even though the number looks to be horrendously large.

The purpose of this particular study is to under controlled conditions, apply water at the surface, essentially a sprinkler field and examine the response of the near surface at depth, with time as a function of how much water is applied. So again, this is a control experiment trying to calibrate what we see through the natural infiltration studies. Again, this is part of Al Flint's study.

DR. CANTLON: And that map there is the location?

DR. DYER: That's right. And what I have on here, the two symbols here, we didn't want to plot all 232 drillholes on here. What we have is clusters of large and small plots which have several sampling holes and distribution of sampling holes in there to which will be applied some sprinklers, essentially.

The solid block diamonds are the large simulation plots. The open deltas are the small plots. Just the location of the small plots, we didn't attempt to plot every small hole in here. Some of the holes may be as deep as 50 feet, but those are in the minority.

I think now that you have seen the logic here, unless you have questions about specific parts of the program, I was going to skip through the rest of it and get down to the conclusion, in order to give you a little more time, because he has some very interesting information to share with you about the development of the drilling technology.

The surface-based testing program is in part based on drillholes. That is one way that we acquire access into the subsurface. There is also a component of the program that looks at basic surface mapping, trenching, geophysical techniques, etc. But, the part of the program that I am describing to you today is based on the integrated drilling program. The purpose of this program is to acquire information for site characterization or suitability evaluations or performance assessments and also for design functions.

One of the positive attributes of this surface-based program is it provides us information about a three dimensional volume of rock. A large volume of rock, that we don't get entirely from an ESF. It also, if the current drilling schedule holds us, provides us information in a relatively timely manner. Right now we are scheduled to have completed the drilling program in March of '98. That's is what you see on the schedule back there. That of course, is dependent on funds materializing when we think they will, ESF testing, at least with the scenario we had in mind whenever we put the drilling schedule together. ESF testing was scheduled for September of '97.

The tests themselves, that follow on after the drilling program, are designed to provide a greater understanding of the water and gas flow processes within the mountain. If you remember back to the results of the test prioritization task force approximately a year ago, there were three things that ranked highest in categories of things for which we had uncertainty. One was Carbon-14. A second was those processes by which aqueous flow and transport, if you will, and gaseous flow and transport. These are the types of information needs driving this part of the program.

Finally, water table evaluations in conjunction with the geologic studies. This will provide, if you will, a continuous stream of information which will feed the iterative performance assessments. We intend, as I talked about this morning, there is going to be a delicate give and take here as the program matures, as we acquire information through the testing process, we will also be doing modifications of the testing process. Some tests may be emphasized. Some new tests may be identified. But, this cannot be a static program. This has to be a dynamic program to respond to our evolving state of knowledge.

That concludes my presentation.

DR. DOMENICO: Are all the holes going to be 12 inches or so in diameter?

DR. DYER: No. Well, let's take for instance the neutron holes, which we have I think seven drilled now. They are 5 1/2 inches in diameter.

DR. DOMENICO: What size of the holes will you be collecting core? What will be their diameter?

DR. DYER: We are collecting, well we have got it out of the 5 1/2 inch holes and we will be getting it out of the larger holes.

DR. DOMENICO: Are you going to do a 12 inch core?

DR. DYER: No. No. It is not 12 inch core.

DR. DOMENICO: Okay, you would be doing it first then. What size will the core be?

DR. DYER: 2.4 inch.

DR. DOMENICO: Okay. I was just wondering if you would get some big cores with those big REECO rigs. Are you using the REECO rigs?

DR. DYER: Well, for some part of the drilling program we may. Whenever we sank JF-3 in January, we used a REECO rig. We skidded on a REECO rig there. It was a conventional wet drilled hole.

DR. LANGMUIR: It looks as if all of your deeper holes are going outside the repository block, as it makes sense. But, there has been some discussion, has there not of possibly needing more rock volume for the ultimate repository and perhaps expand it going beyond that block. To what extent is that being considered in your choice of deep holes outside the existing block?

DR. DYER: Well, I don't have one that specifically culls out the deep holes. But, this of course is based on our current understanding of characterizing a particular block of rock. If we need to change the area in which we are emphasizing the characterization we will modify the drilling program accordingly.

Dr. Barnard.

DR. BARNARD: Maybe a related question is are there any measures that you take specifically for those holes on block that you don't do for the ones off block? In other words, are you going to be doing things off block that may jeopardize your chances later on if you need to expand?

DR. DYER: No. Every hole we are putting in is site of the characterization program whether it is on the block or off the block. We do an evaluation as to what the impacts of waste isolation might be.

Obviously if the hole is down gradient each of the repository block, then the threat that it would pose to a potential repository is somewhat lesser. But, the data collection procedures are exactly the same, whether or not one is on or off the block. The information acquired should have the same pedigree no matter where one puts in the hole.

DR. LANGMUIR: Russ, Langmuir again. Looking at your planned drilling activities table, I don't see any activities which identify gas studies. In other words the existing composition and ages of gases in the unsat zone and going on down will be very interesting in connection with what we are trying to do.

DR. DRYER: Al Yang's studies, the UZ-9 series. It is part of the UZ program UZ-9, 9a and 9b form a series of three holes which are dedicated to Al.

DR. LANGMUIR: Is that enough? Just three holes?

DR. DYER: No. Al also will do some sampling in some of the other UZ holes. He is one of the first users of the UZ series of holes.

DR. PRICE: Did you look at the ESF and ask the question, how can I use it to minimize the number of holes I might have to drill?

DR. DYER: Not thoroughly. That is something we need to go back and do. But, part of the problem of course, is that much of the information that we are trying to acquire lies below or above the ESF horizon. We still have those information needs above and below the repository horizon.

We have gone back and done some relatively quick studies, trying to identify things that can be satisfied through in situ testing in the ESF. But, I don't see a whole lot of things that we can move out.

DR. PRICE: Do you have an intention to take a harder look at the ESF with that regard?

DR. DYER: Well, absolutely. We need to, as I said, as we get more information through this program, as the design matures, we have got to go back and re-evaluate the basis for this on, I won't say a continual basis, but at least on a periodic basis.

DR. PRICE: And did I understand your previous answer to the question that once you are committed to your drilling program, the option or alternative to change the block size may then be set by that drilling program?

DR. DYER: No. I don't think that is necessarily true. We are putting the same care into holes we drill outside of the conceptual perimeter drift boundary as inside the conceptual perimeter drift boundary. If at some time in the future it is necessary to modify that boundary, either expand or shrink that boundary, I think we would still have the same level of information available taking the same care in the holes that we drilled inside and outside the perimeter boundary.

DR. LANGMUIR: Russ, one more. Looking at your drilling activity table again, obviously you have specific functions for each hole as identified. One of the powerful things about a time-line activity such as this should be and presumably will be, is that when the hydrologist's putting this hole down, the geochemist is there to collect the water sample, to do chemistry on. And the man who is in it in gases is collecting gases. So, you have that flexibility no matter what the specific main function might be in any one hole. And that is important to the program.

DR. DYER: That is absolutely right.

We sent out a letter to all PIs within the program and said we are going to make the UZ-16 hole available. Testing community, what are your needs? If you have specific needs for a test, that is, if you cannot do your test if somebody else has done something else in the hole before you, let us know what your requirements are, then what we have to do is to build up a test sequencing program and make sure that we minimize test interference and that we are able to accommodate all or at least most of the investigators that plan to acquire information in a given hole.

DR. LANGMUIR: In that same vein, are all these holes required? In other words, couldn't--is it conceivable that much of the information available from some could be obtained from others at the same time they are being done?

DR. DYER: That may turn out to be true. However, I guess I would be reluctant to buy into that at this early stage. I encourage you to ask me that question in about three years.

DR. LUCE: Luce, Board staff. What sorts of procedures are necessary if in drilling a hole, in the midst of drilling a hole you discover that it is not quite in the right place or you are discovering something that requires a change in position? I mean, how easy is it to pull out of the hole and move to a more suitable site?

DR. DYER: Well I can give you our experience based on what we have done in the neutron holes. And, to get the paper work in place to accommodate that has taken a few days. As long as it is not a major change in objective, if you are still searching for the same target horizon, but let's say the initial hole that you had planned to put in happened to be on the perimeter of a tortoise study area, you need to move the hole 30 feet to get it out of--true story, just to move it over and you still have the same objectives, it is relatively simple to get that through the system.

DR. LUCE: But couldn't one save a couple of days by having some guidelines in place that if certain things happen, it could be decided on the spot by people authorized to make that sort of decision?

DR. DYER: Yes, it could be and that is something we need to work toward is to give the people in the field the appropriate level of responsibility and authority to make decisions up to a certain level, make and implement decisions up to a certain level.

MR. GERTZ: Russ, this is Gertz. What Russ is describing is essentially our change control process. And right now in the field as we are drilling and doing pads, we have change board meetings. In fact Winn Wilson had eight of them last week to change different aspects of either building a pad or drilling a hole and appropriate people are buying off. But, in the regulatory environment we operate, it must be controlled, because the original designer of an engineering facility or a study, needs to buy in on any changes to his design, or else you invalidate the original design. And we have to have a traceability of that.

So, while it might appear, it doesn't matter to move the hole 30 feet, we need to make sure that it is all documented, that everybody that has bought off on the original location, buys off on the new one. We can do it in the field and we have been doing it, we have been drilling out there five months out there and moving holes here and there and moving pads here and there and redesigning pads and the system works. But, it is certainly a little more cumbersome than other systems you might be used to.

DR. LANGMUIR: A question for Carl, Langmuir again, or Russ on this one.

I am impressed that quality assurance doesn't slow that process down. I mean the fact that they bought into a generic--

DR. DYER: They are involved in there.

DR. LANGMUIR: So they are quick to respond, then?

MR. GERTZ: They are on-site.

DR. DYER: It's in there.

MR. GERTZ: They are part of that change board and we have to have their "buy into the change" that the appropriate design or scientific requester agrees with the change. And also, it doesn't affect waste isolation or it doesn't affect any other test that is planned across the program. And all those analyses have to be done before the change can be approved. But they are right on site buying into the process today. That's consistent with a sound quality assurance program.

DR. LANGMUIR: It's come a long way.

MR. GERTZ: Yes. They are part of the system.

DR. NORTH: Max, you had a comment or question?

MR. BLANCHARD: Yeah. I would like to help address Bob Luce's question.

We have a procedure on the books which addresses what you do if you encounter an unusual geological or hydrological occurrence. That procedure is there partly because it is just prudent to make sure that if you have encountered something that you didn't expect, that you sit back and don't ignore it and decide well, should I proceed or should I not proceed? Should I do something different?

But the procedure is also there because when you look at the NRC licensing process that has been used for siting activities for nuclear power plants, there is some special provisions that require the applicant to make sure that they don't ignore otherwise telegraphic signs that they should have been aware of. Also, it is there to protect everybody involved where they may make a mistake in identification for the origin of a process or a feature and then just continue on and not realize that effectively what that feature was trying to tell the people. And they just because of time or money they went ahead and assumed it was a certain origin when it wasn't.

We are not anxious to get into those kinds of situations and in order to prevent them from happening from the outset a few years ago, we developed this procedure. It is in place now. I don't think we have used it because we haven't encountered a condition that would cause us to use it. But, I am sure as we proceed through site characterization, there will be times when we need to decide, this is enough of an unusual feature; let's sit back and analyze it before we move forward.

DR. NORTH: Leon.

DR. REITER: Russ, maybe you have answered this in a different way, but I wonder if you would look at it in this perspective?

We heard the early site suitability evaluation report beforehand, and they had some recommendations and Pat Domenico talked about some early problematic things that might occur. With the focus on early site suitability and the focus on identifying things that might render the site unsuitable and knowing that as soon as we can, what contribution does the surface base testing add aside from the general knowledge base? Are there some specific--like for instance, the early site suitability report, I think, correct me if I am wrong Jean, I think they said that one of the most important things was identification of fast paths. There may have been other features also.

So, in this context of early recognition of things that might lead to this qualification of the site, how can the surface program help us?

DR. DYER: Okay. Let's take for instance part of the program that has been going for awhile. You remember back to the January meeting, I gave a presentation of some early information from Al Flint's natural infiltration program.

The information that I presented showed a distribution, it was presented in several ways but let's call it moisture content; the profile of moisture content in the rock as a function of depth. What we saw was that there was a systematic increase in moisture content within the Tiva Canyon down to a certain level. And then within the unbedded portion of the Paintbrush things changed systematically an then we saw a systematic variation within the Topopah Springs. All of which suggested that if fractures were there they were not continuous. That is, you did not have a continuous fast path system.

Now, what we are seeing from what I know of the follow on holes that Al has drilled, is that that was not unique to that hole. That seems to be an indicator and seems to be consistent with what we are observing elsewhere throughout the system, which would suggest at least in the near surface, that you don't have continuous fast pathways; continuous connected fracture flow. You don't see a record of such a process in the geologic system.

UZ-16, the first deep drillhole that we will put in, is going to be acquiring core which will allow us to make the same observations, but all the way from the surface to the Calico Hills. Again, we will look, at the systematic distribution of moisture contents, other hydrologic properties. I think this is a direct response to both the test prioritization task force of last year and this year's ESSE report, we just gain a better understanding of the processes by which moisture would flow through the mountain.

DR. NORTH: Max.

MR. BLANCHARD: I would like to help answer Leon Reiter's question. And that is, I think the test from either the Calico Hills or the Topopah Springs through the exploratory shaft facility, won't really tell us very much about how the bedded tuff between the Tiva Canyon and Topopah Springs functions. Whether or not there is a capillary barrier; whether or not that unit acts to basically limit the rate at which water infiltrates through the fractures in the Topopah Spring.

I think that is very important like Russ mentioned. But even more so when you start talking about the "what if" scenarios when climate changes. So there I think you can only really get an understanding of the function of water flow and how that rock unit in the bedded tuff right beneath the Tiva Canyon functions. That has to come from surface-based drilling program, as I see it, because, you want that function to be the same throughout the boundary, everywhere within the boundary of the potential perimeter drift. And you won't get that spatially understanding without a drilling program that does that.

MR. BOAK: I would like to add one more voice in support of that contention. One of the things we spent a good deal of time the last day and a half talking about with respect to performance assessment of a site was this question of what is the percolation flux from the repository to the water table.

Perhaps far more important than the information about climate, about how much rainfall will there be, is the questions about how much of that rainfall will get into the mountain and make it to the repository.

We think that well may be even more important to understand. One of the things Alan said he got out of his first well, in fact as a consequence of a slight mess up in the well, was information that enabled him to calibrate every other well he had done far better than he had before. He essentially revitalized an old data set, which helped him to confirm the existence of this saturation boundary throughout a large part of the site. And that information might now well have come from any other process but surface-based testing.

DR. NORTH: Dr. Cording.

DR. CORDING: I think there is one other aspect that I have felt that the underground program would assist in. That is that from the surface-based testing you often don't know what you have in the way of vertical joints in the vicinity of those holes. And it seems to me that a lot of these features that you are looking for in terms of moisture content and distributions that are taking place in the profile, are going to be very much influenced by proximity to faults and joint systems. And that the ability to know where those are are going to be more easily handled in the underground facility.

I am just wondering and I recognize that you are principally exploring at two levels the Calico Hills and repository level. But the ramps are coming down through other formations. I recognize also that that is principally at the edges of the facility, but it seems to me that some testing, when one goes through with these different formations at different levels, then you get into a variety of fracture type conditions that testing across different series of these fractures would be a major benefit to the understanding of the entire flow system and would give you things that you couldn't find with the surface based testing itself.

And I am not sure how much one can transfer tests in the surface-based program to the underground, but it seems to me that there is more opportunity than was previously available to do these sorts of tests. Are we talking about adding an increment to doing these sorts of underground tests? Are they going to be done at all, or are they going to be a transfer of tests from surface based program to the underground program?

DR. DYER: A little of all of the above. I absolutely agree with you that a vertical borehole is a very poor way to sample a vertical feature such as what most of the fractures are going to be.

What we have to have is an integrated program which consists of both a surface-based component and an underground component. Some of the tests if you will, some of the observational tests that are appropriate on the surface are also appropriate underneath. Some of the surface fracture mapping, for instance, will take place at the surface and it will also take place underground.

The magnitude of what is needed underground, I think we are still wrestling with. There is going to be some level that is going to be required just as a basic mapping exercise to start out with. It may be that we need to expand on the information, but from what we understand of our information needs right now, based on the demands from performance assessment and other users, the program that we have in place is programmed to design to fulfill those information needs.

DR. CORDING: One example, Russ, might be for example going in an area you are in a certain lithology you want to evaluate. You see certain fracture pattern and you decide we are going to go in and put in some angle holes across that feature from platforms within the EFS facility.

DR. DYER: Sure. I mean there is a drilling component of the program from within the ESF.

MR. GERTZ: You may not be aware of it, but we have extensive testing planned along the ramps and in the ESF right now. I mean, that is part of our program. The debate is do we have to add a lot more or what? That is part of the program right now.

DR. NORTH: Any further questions? Dr. Deere.

DR. DEERE: Well, I think I would just like to reinforce what Dr. Cording has said. We have said it in the past that a ramp gives you these opportunities. And we want to make sure that the opportunities that you are planning on taking advantage of include possibility to do some drilling.

DR. DYER: Absolutely.

MR. GERTZ: In fact there are some planned already. It is not just the opportunity. We have some planned.

DR. DEERE: Yes. But, you need the opportunity to do it where you cross something and you need to get more information so you go after it with a short adit to follow it or step aside perhaps and try to cross it farther down the reach for additional testing or to correlate the in situ.

But the overall three dimensional exploration program which combines what you get from the surface testing and what you can get from the subsurface exploration, I think is the ideal situation. Our point of view is that both are needed.

DR. DYER: I agree completely. No argument.

DR. PRICE: Russ, when you are making this holey mountain, how do you go about doing it? Do you have competitive bid and sell it by the hole or how is it accomplished?

DR. DYER: Well, that is an option, I must say. Right now we have been using and in the past we used REECO drillers. It is possible in the future that we may wish to go to some other mechanism.

I am interested in getting information. I am not interested in running a drilling program.

MR. GERTZ: Let me add a little bit, because that is kind of a project management type decision, and we have an opportunity at the Nevada Test Site, where we have a contractor who has done a lot of on-site drilling and has lots of drills that we can borrow for a week or a month or whatever. Crews that we can borrow if we just need them for two or three weeks. So, we have made a management decision, and since we are operating under federal procurement laws and Davis-Bacon, you have to pay the same no matter what whether you use a REECO or a non-REECO person. So, we have decided to use a contractor that is in place and we will continue to use that for most all of the site characterization program. REECO may subcontract other things, but right now--

DR. PRICE: So, you have one constant available source and you send them here and you send them there?

MR. GERTZ: That's correct. When he is not working on Yucca Mountain, maybe those people are over working on the underground Nevada Test Program, the bomb program. So we can draw off that labor pool. There are 8,000 workers at the site working on the nation's deterrent program. So we have a pool of equipment and people that we are able to draw on. It has worked pretty effectively right now.

National policy may dictate that that program dwindle down a bit and certainly it is. But, we are trying to take advantage of having that resource next door to us right now.

DR. NORTH: Bill Barnard.

DR. BARNARD: Bill Barnard, Board staff.

Russ, what is the approximate cost of the six year drilling program. Do you have any idea?

DR. DYER: As we have laid it out on the schedule back there with four rigs running, that is about $50 million a year for I think it is a little over three years. It is what about $200 million?

DR. CLANTON: Yes, $200 million.

DR. BARNARD: But that is for the whole program?

DR. DYER: That is for the whole program. Correct. And, the annual cost will depend on how much drilling we do.

DR. NORTH: Any further questions or comments?

MR. GERTZ: I would just like to pass on one thing. There were some discussions about exploring beyond the perimeter drift. Some drillholes will get us that information. Certainly, when we get underground with our big excavations, we intend maybe to get the best insight as we go up to what we perceive to be a barrier in the perimeter. We might make some decision as to do we want to go further and see if there is still good rock or where we stand. That is one of our big focuses when we get underground.

DR. NORTH: Dr. Clanton is going to use 35mm slides. Let's see if my head is in the way.

Question?

DR. LUCE: Luce, the staff for the Board.

I was curious about the answer that you gave to Dr. Price about a single cost for drilling or rate per hour or something like that.

MR. GERTZ: I can perhaps answer that. You want to know what we are paying per hour?

DR. LUCE: I don't care about the cost. It just seemed I had never heard of that sort of thing. I just wanted a little clarification.

MR. GERTZ: That was what I was trying to say, when you have a driller or an operating engineer or labor under Davis-Bacon laws you have to pay prevailing wages. The law says what you pay for that guy to do the work, no matter what contract you are under at the time. That is all I was saying is we are operating under Davis-Bacon laws on this project. It is state Davis-Bacon.

DR. LUCE: It is more than just wages per hour. It is also the terms of the drilling or something isn't? How many people and--

MR. GERTZ: Oh, yes. But in essence we are using an M&O contractor and it is a cost contractor. We are not in effect bidding out holes or anything right now. We ask them to drill a hole and we are paying the cost for what it takes to do it. So, if he has to stop while the scientists gather some data, that is all included in the cost. We don't have to go through contract changes or anything like that.

DR. NORTH: Could we turn the lights down a bit.

DR. CLANTON: I am Chief of the Site Investigations Branch. What I usually tell the people when they ask me what I do, I say, well I am in the area where the rubber meets the road. The planning, the procedures, the requirements documents have all been written and I and the people in my branch work with the PIs, the scientists securing the information. I am that integrating link between the REECO Raytheon and M&O people who are actually out in the field digging the trench, drilling the borehole.

I would like to point out that today I will be talking about three different types of data and there will be an icon on most of the slides that tell you whether it is soft data like a cloud, hard data like a brick wall, or for illustration purposes only. For those areas where the information is soft or for illustration purposes only, please realize that is what it is.

Our story begins about four years ago. We had a drilling workshop. We had PIs invited in and the question was, what do you want? What do you need to do the science you need to do to characterize Yucca Mountain? We also had members of the drilling industry there; oil, construction, water, mining. And the idea was to let everyone understand what the needs were and how could we obtain that information.

So, as you would expect, there was a fairly wide variety of requirements, but when we nailed down perhaps the two end members, what we found was that some of the scientists needed core as close to in situ conditions as possible. These are the people that we have already heard about today. The people trying to study the geochemistry;

the moisture content in the core; gas present in the mountain. If you drill a borehole with mud either water based or oil based with chemical added to control whatever, then all of a sudden, you lose what you are trying to understand. What is the in situ condition of the mountain?

On the other end of the spectrum, we had the people who wanted to study in situ, put instrumentation downhole, packers downhole, pull samples of the moisture, the gases present in the mountain. These people wanted a clean borehole, no mud pack on the wall. They would like to be able to run a TV camera down the borehole, take super high resolution photographs of the borehole wall. What do the fractures look like in place? It may not be quite as good as a TBM hole, but at least you have got eyeballs at depth in the hole.

Both of these things are pretty significant drivers. The first question that we asked was to the oil industry representatives, the people that make their living working in the oil patch. We turned to them and said can you help? The oil industry people, the rig builders and so forth said, well you have some rather unique and severe requirements. We have neither the technology or the techniques to help you in characterizing Yucca Mountain.

In the usual words of Las Vegas, the people folded. We turned then to the people that do water wells and so on using the ODEX system. You may or may not be familiar with it. It is a rather unusual drilling technique developed originally to drill in unconsolidated sediments.

The people commented that well they might be able to core dry instead of the way they normally do it. They could then also perhaps ream down a larger borehole, but since the drilling technique that they use carries the casing with it as they drill, they would not be able to produce the clean borehole that you could look at. And since the casing is kind of an integral part of the drilling program pulling it out might not be all that easy.

So, the other problem that they said was the technique is typically designed for lose material. When they got into the harder rocks it didn't work too well. Equipment problems. Rates dropped. So, in effect, the ODEX people said we have an idea, but we really cannot help. We cannot get the depth you need and the hole that we finish would not be suitable for the testing that you want. But, perhaps we could get dry core.

It has been said that when a man is drowning he will grasp for the smallest straw. The question was again repeated for the mining industry. We did not grasp straw. Instead we got a rather remarkable individual by the name of Alan Lang. He kind of does it his way, incredibly innovative. He is the person that started Lang Exploratory Drilling, one of the better exploratory drilling type companies around now, primarily in the area of mining. He innovates. So, he said, well there may be a way.

The requirements that came out over the next few minutes, said well the drilling rigs that are normally available in the mining industry are too small to drill the boreholes you need to drill. They do not have the horsepower or the capability. But, perhaps the concept is there.

The reaming bits that we would have to use would have to be designed to run dry. The technology would have to be developed or adapted. A coring bit also would have to be developed and in effect a totally new drilling and coring concept would have to be developed.

What was proposed was a drilling system that was a 3X plus enlargement of the largest mining rig in existence at the time. In contrast to the more conventional oil patch rig that most of us are familiar with, this system has no kelly, no turntable. It is a top-head drive. The conventional oil patch rig uses collars on the drill string to push the bit into the ground. Because the borehole diameters that we are dealing with here that capability does not exist. So, the rig is designed, the common rig, the top-head drive rig that is used in the mining industry has the capability to push, to pull and to rotate or push rotate, pull rotate in contrast to the usual oil patch rig. You can pull, you can rotate, you cannot push. The weight of the collars do the pushing for you.

In a borehole that is air only, no mud to help keep the borehole open, that capability to push and to pull and to rotate is critical to get in and out of the hole.

The suggestion is dual wall, reverse circulation. Why? One of the requirements, one of the needs by the PIs is to keep from plating the borehole wall with the cuttings. The dual wall system uses a pipe within a pipe. The high pressure air comes down to clean the inner and outer pipe across the bit face. The cuttings then are sucked back up that center pipe to the surface so there are no cuttings then that are blown up then around the bit. No cutting movement between the string bit and borehole wall. It is clean all the way.

The other item that was suggested by Alan in the meeting, if you made an open center bit, it might be possible then to leave the drilling string in the hole, drop the core rod, core bit down through the string and core ahead some distance, pull core using the mining technique, the wireline core retrieval. Core ahead. Ream ahead. Core ahead. Ream ahead.

At the time we didn't know really what polycrystalline diamond composite bits were, but again, that is part of the development process that we have gone through. We have burned up a lot of bits but this is about where we are today.

The other item was the alternate cone-reaming bits. We will talk more about that in detail.

Lang was our only hope. He was convincing. He laid out a program. A developmental program. Working with him a little bit, he been planning on building a rig, a 120 rig, a rig with 120,000 pound pull back capacity for some period of time. He did not have an incentive. DOE provided the incentive. We said, you build a rig, we will lease it. We will test the concept and the tools. Then, oh, by the way, if it works we will probably use the 120 rig and drill what were then the prototype boreholes around the exploratory shafts.

The rig was built. We started using it testing the concept, testing the tools, and then it became time to put a contract on the street for a rig big enough to do the total drilling program, the 3,000 foot dry borehole.

One of the questions that was asked earlier was, how did you buy the LM-300? What you see on the slide here in blue with the exception of this one, actually the 40 feet here should have been in blue, the information listed in blue there essentially was the specification in the contract that went on the street sole source to Lang Exploratory Drilling to build an LM-300 rig. The rig was more than three times larger than anything that had ever been built for the mining industry. We said we want two engines on there. We want to have a pull back capacity of about 240,000 pounds. The weight of the string in the hole with some reserve for pulling it out and so on down through here. We asked for 40 feet to be able to stack dual core rods over here. And, we said we would like a hole in the floor so that we could put 24 inch pipe through. The items in parenthesis here is the product that he delivered.

The contract was a sole source contract. It was a fixed price contract. It was originally set up to be delivered in 60 days and we would have probably made it except the people making the cylinder, the hydraulic cylinders that drive it 77 feet long, came in about two months late. An incredible engineering achievement.

The information is hard. Here it is. It is built. Here it is. Oh, one of the requirements by the way that was not on the other slide, was you had to be able to drive it from place to place. So, here it is driving from place to place in Utah. Front end to back end it is 100 feet long. It weighs 267,020 pounds, we think. And, you can drive it down the road. There are ten axles, singles on the front, singles on the rear, tag axles. The tag axle can be removed and duals here. If you are running down the road those of you with CB's and hear something talking about a 28 wheeler coming down the road, you had better part. That is 267,000 pounds coming your way.

There are some states where you cannot get a permit to drive it on the highway. And so, what I show you here is the LM-300, sucked up under an even larger piece of equipment. If you notice in the front right here, this is the puller truck. This is the pusher truck back there. And this one talks to this one by radio, since this one can't see where they are going.

DR. LANGMUIR: How do you handle a curve in the road?

DR. CLANTON: How do you handle a curve in the road? Boy, you are good straight man.

In about this area here and in the area right about here you see kind of what looks like a little fence. If you look closely here and here and here and so on like this, these are hydraulic cylinders that can be actuated from the people riding here and here. And the unit can be driven down the road, but even in a large wide road, they need it all.

Here it is being transported in to the test site.

From the front to the back of the truck, bumper to bumper it is 310 feet long. For those of you who are football fans from about the front wheels here and the back wheels there that is about where the goal line would be.

DR. CANTLON: What's the use?

DR. CLANTON: I'm sorry, what's the use?

DR. CANTLON: What is the use of that? What is it?

DR. CLANTON: This is a transporter designed to carry large loads like the LM-300, reactor vessels and things like that from point A to B. These people are also out of Salt Lake City.

Here is a shot of the LM-300 during the first shakedown in Utah. In this particular view, the pipe rack is empty; the core rod rack is almost empty. There are four units here. There are almost 2,000 feet of core rod hanging in the finger board. There is a little over 2,000 feet of 9 5/8ths dual wall pipe in the hole for scale. There is one of the guys working on the pipe rack. The front of the LM-300 is right about here. The back end is here. This is the cat walk and so on like that in the area over here; the compressors.

A little bit of a close up. In this particular sequence we are coming out of the hole pulling the dual wall pipe out of the hole here. Here is a chunk of the dual wall pipe. It is 20 feet long. It weighs 60 pounds to the foot. That is 1,200 pounds there. The pipe handling system is here. This comes down picks up the pipe, brings it up, rotates it, swings it around on the top head drive and then puts it in or out of the hole as it may be.

Another shot now, here is the top-head drive driven up and down by the hydraulic cylinders on the back and some two inch diameter cable. In contrast again to the normal oil patch drill rig, the end of the pipe right here screws on. The top-head drive is spun up into the other end of the pipe being held in the clamps in the floor. The rig is run from the console.

Let's review quickly in case you kind of didn't follow what I was saying in the past. The cartoon shows here the dual wall system in place with the bit down here. What we have done now is started to core. This part of the drill string is disconnected at the top, left sitting/hanging in the hole and we come inside that pipe then with a core rod and here is the core catcher and so on. You core in a series of ten foot intervals, drop a wire latch in here like this, pick up the core barrel, pull it out, exchange it for a new core barrel and drop back in and continue to drill in about 40 foot lengths.

Why do we quit at 40 foot lengths? The core rod is a bit limber, 3 3/4 inches in diameter. And as you begin to advance there is some tendency to deviate. And when it deviates to the point that when you start the reaming cycle that we will see in a moment and start producing new "core" by the core coming up inside of the reaming bit, then we plug up, we have a problem. You don't want to do that.

Here is an example of what the hardware actually looks like laid out on the racks. Here is the 20 foot length, the dual wall pipe, the bit down here. Notice six roller cones. And in this particular scenario every other cone points in and one points out.

The bit is different than what you would normally see as a regular tri-cone bit. The bit is shrouded up here and that shroud helps control the air flow at the bit face and to return it out the dual wall string. Shown in this configuration is the reaming cycle. Here is the reaming bit. Now coming down through that dual wall pipe through the reaming bit and coring ahead in ten foot intervals. Smaller diameter here, 9 1/2, this is 12 1/4. This one shows the 2.4 inch diameter core CHD-101 system. This configuration shows the 134 system, 3.3 inch diameter core. These are the carbonado bits, the ones that we will talk about a little more in detail. This one is a matrix bit. And again, we will talk more about those in just a minute.

Here we are pulling core at the Berrick-Mercer location in Utah, a working gold mine.

Here we are, we pulled the core and we are reading to ream down. Here perhaps is the heart of the system. The core rod is pulled out of the hole and stacked in 40 foot lengths in the rig. You hook up again to the dual wall system. The high pressure comes down between the inner and outer walls across the bit face. This arrow is in the wrong place. Then, the cuttings and the return air is sucked to the surface. The intent is to try not to pressurize this area. The conventional drilling that takes place while we are pulling the core, will inject some cuttings, some air into the formation here. The reaming cycle, hopefully will take most of that out and produce a very clean, slick borehole with minimal contamination.

We move now to Colorado School of Mines and some of the testing that they have done for us. Here are a few of the bits that have been tested in the lab. The bits here are the PDC, the polycrystalline diamond composite bits. We will talk more about them in a few moments. The bits, I believe are the thermally stable diamonds that we have tried. The one here and the one back here are the matrix, carbonado bits that we have tried. Each of them have worked some better than others. We will cover a little more detail on each of those.

You see here again the 134 or the 3.3 inch diameter coring bits. The smaller ones here now are the 101 2.4 inch diameter bits.

This is hard data. I am super proud of this data. And again part of the information here is primarily from the testing that has gone on at Colorado School of Mines. If I had plotted the other dimension on there, what you would have seen was beginning at this point and ending up right about here would have been the matrix bits.

When we started the drilling program we went to industry and we said what do you think will work? And the comment we got back was whatever works, this is best. We burned up an awful lot of bits like this. Penetration rates ran from less than a foot an hour to maybe up to about four feet an hour. And, finally, we got a gentleman by the name of Mr. Wally Swenson in, who holds some of the basic patents on the wireline system by the way, to come in and make some suggestions. He said, gee, if you go back to the carbonado design bits that we used before we had the matrix bits and if you made them this way, you cut the water courses/air courses this way, they might work better. But remember we are doing this dry. No water. No foam. No mud. Air only down the hole. So, when the original carbonado bit showed up and we started cutting like that, we were really happy.

When we finished Apache Leap, some of us who are just normally paranoid said, gee, I wonder what that bit would do in TSW-2, the rock that we are going to have to deal with at the site. So, what we found was that the penetration rates dropped by roughly half. So, we went back to the industry and we said, can you help us a little more. They came up with what they called the improved carbonado bit. We will see some photos of that in a minute. At the same time, we said well how about those new polycrystalline diamonds?

Will they help? The drilling industry, the bit industry said, well gee, we normally run those wet and we have problems keeping them cool; they heat up and fail. And, oh by the way they are impact sensitive, so they work super well in salt formations where they don't load/unload hit things hard and then hit things soft or empty like fractures lithophysal and we don't think they will work. But if you have money, we will take, we will build it. So, we went to work with the people.

At the moment, the bit that we will probably use when we start 16, will be one of these. At the moment I am not willing to abandon the improved carbide for a couple of reasons. We may trouble with this bit at deeper depths. The impact, the fracture that we have to drill, the lithophysal zones that we have to drill may make bit life here very short. We have already figured out that in some of the bits that have been designed for us, bit life is short. It lasts all of about one foot. The PDCs just go to pieces.

But, notice what we have done here. Ideally what we need to do is keep bit weight as low as possible. A 2,000 pound bit weight on the original design there, we get five feet an hour. That heats up the core, heats up the formation, requires a longer stabilization time of the borehole, potentially drives out some of the moisture present in the core, in the formation. But with 2,000 pounds on the bit now, we are getting rates up around 75 feet an hour. This again is from the set up at Colorado School of Mines, an extremely rigid, tough set up. The numbers that we get here are the best that we will ever see. And if anything, when we get to the field they will be less.

But, notice that on the original designs and even on the improved designs, no matter what you pushed, you could only get maybe 40 feet an hour or so. And at these bit weights, bit life is very brief. So at 2,000 or maybe 3,000 pound bit weight, we are talking potentially from the lab penetration rates on the order of 75 to 100 feet an hour.

This is what the improved carbonado bit looks like, or as we sometimes refer to it, as the double dimple bit. Here we are using typically about four, maybe three stones per carat, even the carbonado bit where the diamond does not have uniform cleavage plains across the surface, but is more like kind of an aggregate of smaller diamonds all inter grown; a very tough diamond. But to get the aggressive cutting structure that we need and to protect the diamond, we have used the matrix here to build up around it to make the bit cut a little more efficiently. But, unfortunately not well enough.

We move now to the PDCs, the polycrystalline diamond composite. The one on the right here as 3/8ths inch diameter PDCs. In the one up in here, like this, you can see that the darker area is about 30,000ths of an inch of man-grown diamond on a carbide slug.

In this particular design, you notice that the ramp going in behind the PDC is fairly sharp, fairly abrupt. This bit cut quite well, but it also was extremely rough. And you can see the broached diamonds here and here, both on the outside of the bit and on the inside of the bit here and here like so. The ones on the inside dress the core, make it nice and smooth. The ones on the outside hold gauge for the bit. You do not want to wedge into the hole. But up here, if you notice, what we have done is lost one of those PDCs. In fact if you look we have lost one here, we have lost one here. We have cracked one here, we have lost part of one there and part of one here. That is what we mean about impact sensitive.

Thermally sensitive, if they do not cool, if they get over about 750 degrees centigrade they fail for you. If you load them, unload them incorrectly, then they will also fracture and fail.

These are two of the earlier bits. Once we saw the failure like that and like this for instance, where that back support has been moved away, the fracture like you see coming across here, the load has not worn the edge of the PDC right here, but it has moved the support area back here for the PDC causing failure across here. When you look at a bit like this and you see the same orientation of failure also across this one on most of the cutters there, you say the failure is trying to tell us something. So, the new bits provide as support here a larger and somewhat arched ramp to help us survive.

Closeups again. Here you can see the PDC cutter very well. The 30,000ths of an inch diamond grown on the surface. You can see right here a little bit of wear right along the edge of the diamond, but some of them still look fairly good and here is one of the failures over here.

Another example, we have lost the PDC here and you can see where the formation now has abraded away the support in behind the PDC and again, this gives you a clue as to what your type of failure is.

We are now at the Colorado School of Mines, and what we are showing here is one of the alternating cone reaming bits on the test machine. This is the same diameter, the same set up that we would have on the rig. The equipment is instrumented. Here is a chunk of TSW-2 cast in concrete, bolted to the frame and the bit is in the process of being run into the rock where various parameters are measured.

The example here and I am not knocking Dresser or Security, but the bit we asked them to drill is the open center bit so that we can come in and core down through it, delivery time is four to six months. The cost per bit is

$6,000 to $7,000. And, we ran this bit on the machine we could cut about 50 feet an hour, no matter how well we pushed.

Here is a bit that Lang built in about four days. They bought bits that were in inventory around the states. They built the bits. We used this one in the field, and also shipped it into Colorado School of Mines. We noticed a difference in the profile of the bottom of the hole where we drilled into the rock at Colorado School of Mines. Notice the table right up here, we'll back up one. Less well developed table there.

Then, while Lang was looking around, he happened to find that gee there was a pretty good inventory in some of these areas of people who had bought bits, intended to use them, didn't get a chance to use them, they were a little bit too small. Being an innovative individual, he said, hey, why don't we turn every other cone, one in and one out. We have the curve then that we can cut. Everybody saved some money. We can buy the bits at a quarter on the dollar versus normal bits.

This design violates all of the theory and practice of bit design, roller cone bit design, but it works. We have bands with yellow here. What happens on the left-hand side over here, this is 30 rpm, halfway through 45 rpm. The right-hand side is 50 rpm. On the bits that is supposed to work, no matter what you pushed, no matter how much weight you put on the bits, way in excess of what the bit was designed for, oh well, I'll be generous, maybe 50 feet an hour.

The bit that should not have worked cuts like gangbusters. Here it is at 30 rpm, 45 and over here at 60 rpm, same load for 20,000 pounds here, no matter what you did the best you could hope for, 15 feet or so an hour. Essentially the same bit with alternating cones flipped around you are drilling 100 feet an hour. An innovative individual.

What does the latest product look like? You are looking at it right here. This one is a little weird. If you notice four of them are pointed in and two of them are pointed out. The major work is carried by the four here. These are cutting that inter space next to where we ream. In about another week or so, I could tell you what this one cuts. We have high hopes. And if this one works as good as what we have tested to date, this will be the bit that goes in the first borehole.

Now, notice one of the things that I have been telling you as we go along. The bits that we are using, the rig that we are using, the dual wall pipe that we are using, everything that we are using is essentially prototype. You can't go to the grocery store and buy another can of beans if what you are talking about is a drill bit or a coring bit. It is new technology. We are pushing the state-of-the-art.

The information, the graphs that I showed you is information that even the people building the bits do not have. We share that information that we pay for that we get by contract from Colorado School of Mines with the bit companies. We have 110,000 feet of core that we have to drill or bore during site characterization. The cost of drilling is quite high as we will talk about in a minute. So, I need a bit that will cut as efficiently and as fast as possible, consistent with the requirements of the PIs.

Apache Leap drilling, where did the time go? What we show here in color on the pie chart is the time spent at Apache Leap drilling. Seventeen percent of the time at Apache Leap was spent coring. So, if we look down here and say based on what we have learned to date using the PDC bits, what is the potential improvement that we will get?

Well, we ought to be able to at least cut that by half on the core rod trip time going in and out of the hole. We ought to be able to save about 50 percent there. Periodically we pull the dual wall bits to look to the reaming bits to see how they are surviving. So here is the time spent in this and what you see is that I have given you no time over here for the reaming bit. There is a reason for that. I can probably gut feeling right now, based on the testing that has been done to date, say that I should be able to cut that by roughly 50 percent. But until Ozdemir and Friant finish up the test next week or this week, I really won't know what that total savings in time will be.

But notice, that even if I save what I show here, and even if I get a 50 percent increase in the reaming cycle, the total time that I saved down here is probably only 20 percent or so of the time that we saw at Apache Leap.

Now, what makes drilling on the test site expensive? It has already been mentioned. It is union. We pay union rates. It is division of labor and so forth. And so when I bring the LM-300 out or the Stratmaster out and start drilling, this is the crew that I will have on board the rig.

Now, if we are running two rigs, then some of the people over here can be schizo between two rigs. They can support both rigs. But, if I am running only one rig, I get all of those people.

Lang runs the rig, the LM-300 as they did in the shake down with four people. The people do double duty. If you need an electrician, boom, one of them is it. If you need a welding mechanic, one of them is it. On the test site, I do not have that luxury.

The REECO drilling engineering sector and down here this group of people, these are the SMF people, the sample management facility people that take the core as it comes out of ground. Take it into the trailer, do the log in, do the packaging for the people like Alan Flint and so on. One of the things that--I may have one extra person in here. But the other thing that I would share with you is that I may not have enough in there because what we have seen already working at the site on the neutron holes is when I can drill 75 feet an hour with the present bits that I am using in the field. These people are really hustling. If I can do that with the 300 or a little better, I am probably going to need twice that many people down here. It takes that long to bring everything in.

Here is the infamous drilling schedule that is on the back wall. A question earlier here is what is the cost of doing business? An LM-300 rig running, our Stratmaster rig running, LM-300 is up here the dry drilling, the wet drilling down, the deep holes, the G holes. If I am drilling up in here 24 hours a day seven days a week, REECO and Raytheon costs are a million a month. So, 50 million, 50 million, 50 million, and if you did this, you are eating up the better part of 50 million. Especially, when you consider the activities here and here and here, this activity, activity, activity, these are single daylight crews.

Now, there is one other thing that I can share with you. The bar right here in 93 shows procurement of a second rig, a second LM-300 style rig, a rig to drill dry. It also shows down here procurement of rigs 3 and 4. So rig 3 would be delivered here and rig 4 would be delivered down here.

We have had a bunch of people come in and say, well, now that we have seen them do it, we would love to build the next rig for you. But, when we say how much for the rig? They say, well, ball park plus or minus a million or so, $4 million and six months to build.

If you want to accelerate the drilling schedule, more money here or here does not buy you anything. You need the money back here. You need to order all three rigs. You need to gain the benefit of ordering three of each as the individual buys and builds it, rather than ordering one up here and then a year later two more.

What you see here is a shot of Lang's newest rig. It is the LM-300E, E for economy. They also cheat a little bit. Instead of having a 300,000 pound pull back capacity mast here they have this one set up so that they can come down with the draw works, hook on and pull too. This rig is rated for 500,000 pound pull back capacity.

What will it do? Well this is up at the Berrick location. They are drilling a water well up there. It is 2,000 feet deep. It is 31 inches in diameter.

In times past, when they have had the 120 rig up there drilling, the best rate that they had ever achieved drilled to that depth, that diameter, set 20 inch casing, set gravel pack, grout in, completed as a water well, on the pad, off the pad was 50 days. The typical time ran between 55 and 60 days. With this rig, 2,000 feet, 31 inches in diameter, 20 inch pipe set in the ground driving away from it, 20 days. If all you want at the site is a borehole, we can give it to you and give it to you quick. This is wet. It is not dry.

The thing to remember is we are not just drilling a hole. We are providing samples from the mountain as close to the in situ conditions as possible. We are also providing a borehole into the mountain a miniature TBM vertical hole into the mountain, as it were, 12 1/4 inches in diameter, clean borehole wall that the people can look at with a video camera, people can set instrumentation in, analyze in situ conditions in the mountain from any depth within the borehole.

Thank you.

DR. NORTH: Thank you. That was very interesting. Any comments or questions?

Let's see. Bob Luce in the back.

DR. LUCE: This is a little bit of a speculative question and it has nothing to do with your very fine presentation here. Since it is speculative, you don't have to answer it. But, I was moved by Bob Shaw's discussion of their performance assessment where they use realistic scenarios. So, I would like to know in your experience, do you know any drillers, and this is perhaps to add a little reality to the Pacific Northwest Laboratory's performance assessment, are there any driller that you can imagine on this rig on any rigs that you have seen in your past that would hit a nuclear waste canister and hang around for 40 hours still drilling?

DR. CLANTON: There might be some attempt abandon the rig in place. The only way I would see anybody hanging around is if they did not know it was there and they did not have geiger counter or scintillation counter in place. Yeah, they might hang around. But, when they started seeing pieces of steel come up, I would imagine most of the people would start scratching heads and wondering what was going on.

DR. LANGMUIR: Are we talking about an act of Congress to change the union control on this system so we could actually get a competitive bid and just the number of people needed to do these kinds of jobs? Does Congress have to do something about it?

DR. CLANTON: I will defer to my boss.

MR. GERTZ: I think this country has a long tradition of the Davis-Bacon laws for heavy construction and federal works along with the work rules that go with them. So, you would be talking about that. I think there is a history around the country of right to work states and issues like that.

Nevada--Tom you know more about the labor laws in Nevada or not. So, it is not only act of Congress but it is state laws too.

DR. LANGMUIR: Just for curiosity, so I can be angry about my taxes, how much more is it costing than it should? Is it three times as much?

MR. GERTZ: That depends on "than it should". I guess I am not going to answer it, because, how much more does an american car cost "than it should" or something?

SENATOR HICKEY: First of all, this is kind of an unwelcome intrusion as you are well aware how many Nevadans feel about it. The unwelcome remarks has to do with what we consider a prevailing wage in an area, which is the state law. That prevailing wage has been set by those workers that are in place at the Nevada Test Site, not located at the Yucca Mountain project. That prevailing wage, happens to, if you wanted to appeal it, you could, but it would come into play at the Yucca Mountain project. I would suggest politically that you are tampering with a very desperate and highly visible subject. And that is why you brought me up.

DR. NORTH: Thank you for that illumination.

MR. GERTZ: I would like to add something though, based on a real life experience or at least the people that I have talked to in England and I was over there where they are doing the same type of hole. They are going 5,000 feet.

They are doing it under what they call regulatory requirements. Full RCRA, full American religious freedom, full archeology type study. It's cost them 10 million dollars to do one hole 5,000 feet deep, 12 inches in diameter and these are using the North Sea drillers, the guys that have done the best oil drilling they can. But working under the regime of a regulatory environment, that is what it is costing them.

They feel frustrated with it sometimes, much like when Don and I were talking to the U.S. Senate Committee, I think the U.S. Senate Committee felt frustrated with the cost of doing business in this country. But, it is in accordance with many of the rules we have set up in this country.

MR. MCFARLAND: May I offer a clarification perhaps and a question. Isn't the question that Dr. Langmuir raised, one not of prevailing labor rates, but work rules that are negotiated between the contractor REECO and the unions as to the number of the size and loading of the crew on a particular piece of equipment?

MR. GERTZ: Certainly, that is part of the collective bargaining agreement that they have worked at. Sure. But, there are other things that require us to add cost in doing business. That is just part of the way we work in this country.

DR. DOMENICO: I enjoyed your talk as usual.

DR. CLANTON: Thank you.

DR. DOMENICO: I gather those rigs belong to the United States of America when we get them, is that correct?

DR. CLANTON: That is correct.

DR. DOMENICO: Will the be sold when this project is completed?

DR. CLANTON: Personal opinion. I would guess that assuming that site characterization finds the mountain acceptable, that there will be a host of questions that will be raised which will require additional drilling during the life of the repository. Part of that activity may be to construct monitoring boreholes around the repository area. In fact many of the boreholes that we are drilling for site characterization, I would suspect may well survive the next 100 or maybe 1,000 years or so as a monitoring location to see how the repository is performing over a long period of time.

DR. DOMENICO: Thank you.

DR. CLANTON: The rigs at some point in time will be obsolete, will become surplus. I know that if Lang could buy it back right now, they would love to have it. They are making money hand over fist with their 300E, making enough money that they have already convinced their parent company to pony up the money to build a second one.

MR. GERTZ: Let me just add one other major, not major but philosophy on that. All this equipment is bought with the nuclear waste fund and we are committed to keep track of that property, we do audits of the property in fact we are going to USGS next week to do an audit of all property that they are using. Anything that is sold, and we had sold some from the BWIPP project, that money goes back into the nuclear waste fund. So we keep track of it all and people watch us keep track of it all.

DR. DOMENICO: I didn't suggest someone was going to try to steal one of those rigs. I don't think you can do that very easily.

MR. GERTZ: I understand. But once again, there is an extensive amount of, not extensive, there is an expensive system just to keep track of the property. We can't commingle it with other federal property.

DR. LANGMUIR: I was involved in the activities which led ultimately to the design of these things, at least in the sense that I was party to the problems that the geologists foresaw in trying to find good samples and the geochemistry we are involved in. I would imagine that they are delighted with this, but I would be curious what kind of feed back you have gotten from them on any limitations they see in this equipment in terms of sampling their gas samples, their fluid samples and so on from those holes, the rock samples. Are they totally delighted in every sense or are there any problems that were made?

DR. CLANTON: For the most part, the people that I am aware of are super happy with what we have developed. The big unknown really is how long is it going to take to drill the boreholes? And, at the moment, the only people that I know of that have some "concern" about the dry drilling that we are planning to do are those people who have just written in and said we would like the borehole to be within a one-quarter of degree of vertical.

Now the 9 5/8ths dual wall string is exceedingly stiff, as you would guess, pipe within a pipe. It will deflect, but not like the convention oil drilling rod and so on like this. Consequently, about the best that we can do is set up the rig initially, set the surface casing, and point the drill in the way we want it to go. We do not have the capability either space or equipment with this dual wall system to do any directional drilling.

The people have indicated that they can probably accept the borehole up to 3 and maybe 5 degrees off vertical. But they would like to be as close to vertical as possible. That is the intent we will try to give them that information.

In fact, what we have already discussed here, the low bit weights, the high rates of penetration, both of those in coring and in reaming should insure a straight hole.

We have one experience at Apache Leap where we drilled and then ran a deviation log at the end of the borehole. We were 16 feet off from vertical at 1,700 feet. And when you looked--when you plotted back the survey, we started crooked at the top. We started about that far off center at the surface casing. And what we saw is in effect is the initial deviation was essentially maintained to depth.

So, the borehole the people seem to be very happy with. We ran a video in the borehole at Apache Leap. It looks magnificent. It looks like a borehole. You can see the fractures in the wall. You can see the lithophysae, the fragments of wall rock that are stripped and dumped into the Ash Flow tuff. You can take the core. You can take the video. You can lay it out and it is just one for one right through it.

DR. LANGMUIR: One more. Do we need tunnel boring machines? Can we just get a big enough one of these guys, of course you can't make it horizontal. What is the largest hole you can make going straight down with a device like this?

DR. CLANTON: The limitation on the rig is five feet. I am serious. Five feet in diameter. The hole in the floor is five feet. We could put a five foot bit on it if necessary and drill a five foot hole. We do not have the bits. But, at 31 inches Lang is already getting close. But again, they build up a roller cone bit. It is not a tri-cone, it is about a 20 or 30 cone bit. It is wet, but they are moving down.

DR. CANTLON: Is there some thought about some modification of this bit configuration for the emplacement holes? Dry drilling of the emplacement holes?

DR. CLANTON: At the moment we have not considered that. My cup runneth over already. And, I haven't been looking for other problems to solve. But, certainly, when this is developed there is a high probability.

The interesting thing that comes out of this and I have talked to Ozdemir and so on, it looks like what we have learned. And the thing that continues to surprise, me the bit companies, the people that make their living selling bits don't have the information that we are currently getting. One would take a look at based on what we know now and the tri-cone bit that is kind of the standard of the industry since the turn of the century almost, it says if you really went back in there and looked at that and maybe did a little reshaping on those tri-cones, you might have a bit that blows the competition totally out of the water.

The center of that bit, if the point of those cones does not cut well for us, then it is not cutting well for the oil industry. Now, what do you want to do? Drill fast? Sell bits?

DR. CORDING: Are you with the LM-300, will that be doing all of the drilling, or are you still going to use the 120?

DR. CLANTON: No. The 120 that we have, we do not have a 120. That belongs to Lang. Lang has two 120's. They built the first 120. We had it under contract, drilling, trying some of the techniques. They saw what it would do. It opened up a totally new market for them that no one else was in, and they built a second one. The same way they built a 300 for us and saw what it could do and they built one then, a smaller skid mounted rig for them.

If we need to accelerate the drilling program, one of the possible ways we could do it would be go back to Lang and contract with them to bring their equipment, their rigs on board and do contract drilling for us. But the plan at the moment--well, we probably have a tough decision to make in '93. Considering the limited resources that we may be dealing with, what makes the most sense? Contract out for drilling, or order the second rig? Or, is there some innovative way where we can order three rigs, but not pay for two of them until the following year.

DR. CORDING: Are you ready for production with the 300, or is there more prototype testing to be done? Where do you stand? What will it take to get it to being--getting the rates you think it should be doing there?

DR. CLANTON: The rig should be on the pad now, the UZ-16 pad now. The total depth of drilling that we have done, either with the 120 or the 300, is about 5,000 feet. About 3,000 feet of that is hammer drilling. And in particular, what I am referring to here is the use of a bit that is normally used in mining to produce cuttings for analysis. Where is the ore? What is the grade. So, this bit just beats a hole into the rock. That is the normal one that is used dry. I use that term loosely. A certain amount of water, mist, mud, foam goes down the hole during that.

The last borehole that we drilled in Utah at Berrick-Mercer was a 2,000 foot borehole. The primary purpose of that borehole was to shake down the LM-300 rig, check out the pipe handling system to see if there was a problem with the equipment. So, about 3,000 feet and maybe a little more of the total 5,000 feet of drilling that we have done, has been the hammer bit, hammer hole.

We probably have roughly 2,000 feet of drilling, where we have used some combination of the reaming bits and coring bits that we have looked at since the early part or the late part of '88. We will probably start site characterization with prototype bits, the 42 bit that I showed the picture of, with a few feet of experience. This is in the test fixtures at Colorado School of Mine.

If I had to pick one today, and that is about where

I am, the bit that we have been running with Alan Flint, we have a total of about 200 feet of drilling with that bit, and that is the bit that in the ODEX system is giving us about a penetration rate of about 75 feet an hour. Those would be the two bits that I would start site characterization with. Please realize that both of those bits are still prototype bits. They are not off the shelf items. If you want one, you go to the appropriate company and say build one. None of the down hole tools, drilling, reaming, coring are off the shelf items.

Did I answer your question?

MR. GERTZ: The bottom line though we intend to start the end of April with that equipment and those bits and we will see how it goes.

DR. CLANTON: I have my fingers crossed.

MR. GERTZ: But, isn't that right Uel, you are going to start in April when we have our last injection well permit.

DR. CLANTON: But with the same token I mentioned earlier when we were talking about the double dimple bit, and I said I was not yet ready to abandon that design. There is a high probability that the coring rod that we use, that we were using right now, will buckle, will flex, because it is running kind of naked in the hole. It is inside the six inch pipe, but it is just sitting there rattling and flopping around. We do not have mud in the hole to dampen that vibration. When we have out say 1,500 or 2,000 feet or maybe even 1,000 feet of that core rod, you may get one or two turns upon on one end before the bottom end knows it is supposed to turn.

The concern that we have, both from the consultants that we have had in from the drilling industry and the bit companies is that bit may wind up. It may buckle. It may jump up and down in the bottom of the hole. And all it is going to take is about one hop in the bottom of the hole and I may not have any PDCs left on the bit. So, at the moment, for insurance, I am continuing to carry the double dimple design kind of on the back burner, because I may have to use that bit. I may have no choice except to use that bit at deeper depths.

Now there is some new technology, the thermally stable diamonds that are on the market. They are a little tougher. But they have a problem. The thermally stable diamonds you take in effect, that man-grown diamond layer there, actually it is a little thicker than that, and you remove the cobalt that is used in the growing process, and so the diamond is not as temperature sensitive. Or the diamond is the same, the matrix in the diamond is then removed and the diamond that is left is not as sensitive to the expansion contraction of the extraneous material included in the bit.

There is some new technology developed by

Christiansen, this is Eastman-Christiansen, the oil field side of the house, that takes these little triangular pieces of diamond and forms them into a larger cutter, somewhat like the PDCs you see there. The smallest ones they normally make are about a half inch in diameter. Based on about 25 or 30 PDC bits that we have already gone through at about three thousand a copy, we will have to go back to those people to use those bits and get them to do, once again, a prototype bit where we can get the little TSD composite built at about a quarter of an inch. We have done enough testing to date that we know that to get the core that we need, the quality of core we need, that the cutters are going to have to be somewhere around quarter of an inch.

Now if you come back to me in two months or six months and I tell you hey, we are at a half inch or something else, please realize that we are on the leading edge of the technology right now. We are running the PDC bits orders of magnitude better than the people building them thought they would ever run and survive. Wet, in an oil-based mud; that is the preferred way to do it. We are running they dry.

DR. DEERE: This D. Uel Deere, with a question for Uel Clanton.

DR. CLANTON: We share the same name.

DR. DEERE: And I have heard of it three times now, the other is my father.

The question I have is perhaps more of a comment. You said that you would have think about the possibility of whether you would want to buy the rig or maybe to lease the rig or actually go out for contract.

I would like to offer a recent experience, a very, very short one. Three contracts were let. One for over 100 kilometers of drain hole drilling up to 200 meters depth. One for driving 25 kilometers of tunnel. The other one for about a $50 million grout curtain. It was international bidding, and the winners of the bids, one was from Italy, one was from France, and the other was a combination of Italy and New Zealand.

The interesting thing was they started working, they worked for about three or four or five months. The new construction manager was very keen on the target estimate type of contract. And since claims were starting to develop and progress was slow in some areas and fast in others, he said, I am going to renegotiate the contracts. He asked the board of consultants for their advice. Their advice was it will be impossible.

But, the bottom line is, they renegotiated every one of those three contracts and turned it into a target estimate. The reason it was easy to do, the contractor now knew what his costs were. He now knew where he was really low on some of his bid items and really high on others. And also the owner knew that by now.

So they were able to get together and roll in all of the claims, all of the low bids into a new price from then on. If they did it cheaper than that target, the contractor got two-thirds of the savings. They were able to negotiate first one and then later they renegotiated the other and then the other. I might add, all three contracts are now being finished well ahead of schedule with only one minor claim.

It worked out extraordinarily well. That was in New Zealand.

DR. CLANTON: The situation that we have is, if we had to drill, if we wanted to bring in another contractor, it would have to be Lang. Because, the equipment to do dry drilling the way we have defined it now, that capability essentially does not exist with any other company.

DR. DEERE: But he also has the capability that he knows what he can do now. He knows what the rigs can do and you might well benefit.

MR. GERTZ: Dr. Deere, let me point out an element of our contracts with REECO that maybe no one is aware of. They are on a cost plus award fee contract. So, if they can reduce cost or we give them certain milestones or we can say we know how long this takes, now if you get done sooner or quicker, or something like that, you will get a certain amount of your award fee pool and I as the project manager get to make that decision. We do have an incentive. So, I don't want to leave the Board with the thought that because it is a cost contract there is not cost incentives to save, because there certainly are for the company to do that. And there certainly is for us as project managers.

DR. NORTH: Okay. Anything further?

MR. MCFARLAND: One question, if I may. Cost reimbursable award fee is different from a cost reimbursable incentive fee. What Don was talking about is a formula before you start, the award fee is after the fact.

MR. GERTZ: I understand, the award fee based upon their performance.

MR. MCFARLAND: One question. In Apache Leap, there was a question with regard to the HQ versus PQ and you mentioned earlier in the presentation that you were tripping on the core at 10 foot intervals, which I believe was with a small 2.4 inch HQ core. You were tripping, I think at 40 feet with a larger 3.3 inch PQ core. Have you tried to analyze the benefits of the larger core versus the smaller core in terms of the drill performance, the drilling time and perhaps the quality of the core you are bringing out?

DR. CLANTON: The testing that we did at Colorado School of Mines used some of the equipment that was used at Apache Leap. So, yes, we have run the 12 1/4 bit with a six inch diameter hole and with a four and a half diameter hole in it, the HQ/PQ core. Those numbers are available.

The thing that perhaps drives the core size is a PI requirement. Primarily, Al Yang has his triaxial press

already built and sitting there. He can squeeze the 2.4 inch diameter core and get the water out of it. And if you remember running the numbers, when you go to 3.3 the squeezing mechanism kind of goes up exponentially.

There could be some possibility to center punch a larger diameter core, get the 2.4. In discussions that we have had to date, he does not prefer to do that. Any processing, reprocessing, recording, he thinks will modify the information that he gets to the point where he begins to wonder what he is measuring.

Now there is one other consideration. When we were at Apache Leap at about 1,600 feet or so, we twisted off a 101 core barrel. And I have been back to the USGS people and said, people, I am between a rock and a hard place. The first borehole when we get down 1,500 to 1,600 feet, if I start twisting off that 3 3/4 inch core rod that I have, if I start having repeated failure on that 101 system, I may not have any other choice.

Now, that is not totally correct, because I have Bill Mitchell out of Colorado School of Mines now, working with us. He is analyzing the tools down hole, the drill string buckling, flexing vibration and will come back to us hopefully in a few months and make some recommendation. I am 99 percent sure right now that what I should do is go out and buy some thick walled, four inch diameter rod from the oil company, bring it in and have the mining style threads cut on it and put that in the hole.

That may not solve all of the problems, but at least it would give me a much stiffer tool that may not buckle as rapidly. If I have a vibration such as the bit does not maintain contact, if it bouncing like this, either from a buckling movement or from vibration in the drill string, I will probably destroy the PDCs.

Now we are working again with Eastman-Christensen in contrast to the mining Christensen, the Boyles-Christensen. They have a new concept that they are pushing where they--the backing. They take another carbide slug and brace it on behind the carbide slug that has the diamond grown surface and they have gotten a tougher design that survives better.

We are turning 60 rpm. They normally like to turn wet 200 to 400 rpm. The thing that may work for us, we core in ten foot intervals. If we can keep the borehole straight coring, then maybe we can core 50 feet before we pull the rod or the 60 feet before we pull the rod. And the time we save then in running the rod in and out of the hole, could be quite significant. We are going to have to learn that on the first borehole.

DR. NORTH: It is time for a coffee break, I think. Let's try to make it about 15 minutes.

(Whereupon, a break was had off the record.)

DR. NORTH: Okay. We are all set. As soon as Carl gets his mike hooked up.

MR. GERTZ: Dr. North, we are ready to go, I guess?

DR. NORTH: Ready when you are.

MR. GERTZ: Certainly, I can make sure all my employees are here because they work for me. That's easy. And most of the contractors can be here because they are all on award fee, so I can arbitrarily grade them. So, I am always sure of getting most people here.

I do want to point out Russ brought up an element, when we call it contract and award fee, it is a perspective approach, because we set up a plan and goals for the next six months or so for each contractor and we grade them on how they met those plans and goals. So, it is not just grading performance in the past. It is setting up a plan for the future. We have Raytheon on that. We have REECO and also the M&O contractor will be starting after the first year on award fee.

DR. LANGMUIR: What do bad grades give result in?

MR. GERTZ: No fee.

DR. LANGMUIR: No fee?

MR. GERTZ: No fee or very low fee. One or the other. So, it is an incentive that the department has used very successfully I think in achieving performance from cost contractors.

DR. NORTH: What is the range of fees? I mean, what do A pluses get?

MR. GERTZ: About 90 percent of their pool. The pool depends upon whether you are a construction contractor or an architect contractor or a research and development contractor. The contracting officer has different ranges from two percent of the expenditures to 10 or 12 percent of the expenditures depending upon what kind of work you are involved in. You have about now exhausted my knowledge of procurement practices.

I will tell you that the scientists and engineers have to spend some of their time setting up the plans for the contractors and then grading them on those plans. You know that involves Russ and Uel and the people who work for them. So, they are involved in setting the goals for the people that are doing the work for them and evaluating them.

DR. NORTH: Are they written evaluations?

MR. GERTZ: Yes, sir. Written evaluation and they are open to the public, so if the public asks we can give them a written evaluation of how we graded our contractors.

Okay. We are ready to go I think. What I am going to talk about is the status of permit applications, because, despite what you heard about the good work we are getting ready at UZ-16 and the drill rigs being ready and everything else, we have to have a certain suite of permits to do work.

What I am going to talk about today is give you a quick example of what a process is like, what we go through with the state agencies to obtain certain permits. Talk about our general needs. Talk about what we are going to need for the ESF. Just point out some recommendations that we are all trying to adhere to so this process goes smooth, so the science and engineering get done. Talk about the status of legislation because we have some legislation that is front of Congress now that addresses this issue. And I'll have as back up for you some additional permitting status.

Wendy Dixon works for me and manages this process for me. I am giving the presentation in lieu of her. She is really trying to get permits for us right now.

But, let's talk about the process in general. The scope of work that Uel, Russ, Bill Simecka do is develop from the site and engineering categories. They compile information and provide it to the people who are going to go to the state with the permit application. Examples of the information involve the purpose of whether it is a drillhole or a road or a pad, the location, design, the acreage, schedule, water requirements, what kinds of tracers, whether it is gaseous or liquid tracers including the material specification data sheets that go with it.   Once we get all that data, we then start what we call our informal consultation with the regulatory agency; whether it is a state water engineer, whether it Department of Natural Resources, whatever that state agency is, we go up and talk to them about it.

We prepare and submit then the permit application based on our informal interactions with them. The agency then reviews that application and gives us some comments. They say, gee, we told you about this beforehand and you didn't put in the application, or something like that. We respond to those comments, we being the applicant. The agency then says, yes, we now think your application is complete and they will issue a notice for public comment. In other words the permit goes out for public comment if applicable, depending upon the state regulations.

DR. PRICE: Carl, excuse me. Just a quick one. On the MSDS sheet, was that material safety data sheets that you are talking about?

MR. GERTZ: Yeah. Did I say specification? It's what you have for those different tracers. I don't know whether it is safety or specification.

DR. PRICE: Safety.

MR. GERTZ: Safety. Excuse me.

The agency depending upon the particular permit may or may hold public hearings. It may depend upon the amount of comments it gets on our application. The agency then makes a final decision. That final decision is to grant us a permit or reject us the permit. If they grant us the permit it specifies the conditions for compliance and they can put in a time limit. A time limit for starting, any operational limits, monitoring conditions, reporting conditions; whatever is required. So that is kind of the process that we have gone through on many, many permits or permit modifications.

Let's just talk about general needs. Activities that require these kind of permits can proceed right now at Yucca Mountain. Land disturbance can proceed. We received that in 6/91. We have our water appropriation from J-13, 3/92. We have a BLM--

DR. ALLEN: Excuse me. This is Clarence Allen.

When you say land disturbance you mean for specific projects, specific disturbances, not a general one.

MR. GERTZ: No. We have a general one right now that includes those so many acres and includes our plot plans as we knew them when we put them in.

This particular one is a clean air act permit and it is for disturbance. If you are less than five acres, you didn't need a state permit. The state determined that because of the accumulative effect that we were doing a while ago, we were well over five acres, so we needed a permit for our entire program. So we have laid out our entire program, as we knew it that time, and received a permit for disturbing some amount of acres. It might even be 400 acres. I don't know what it is in different areas.

Now, much like all these permits as our designs change, we are going to go back in and modify it like a mine does or any industrial agency does. We are going to be continually modifying these permits. But, it wasn't hole by hole or place by place. It was a general permit with the specifics inside of it.

Water is the same thing. We anticipated our amount of water and went through a water appropriation hearing. We had tracers, part of underground injections. Our first permit was only for the C-Well complex and for a suite of tracers that those scientists thought they were going to do in C-Well. As part of the underground injection permit, we wanted to add some gaseous tracers and do it in all other holes. The negotiations went on with the state where initially they said maybe for each hole we are going to want to see a tracer and give you a permit. They more recently have said, no just 50 holes at a time. So we have a permit under consideration for UZ-16, our first hole that is part of the first 50 holes. So it is a negotiated process with the state agency.   And for the LM-300 for diesel engines we needed a permit for a point source of emission for the diesel engines. So that's things we have in place right now.

And therefore, these kind of activities could proceed: geophysical surveys, trenches, test pits, Alan Flint's holes of course, are proceeding because he is not using a gaseous tracer in the shallow boreholes. We can do roads and pads. We just completed UZ-16. Pavement studies can be done, meaning the geologic pavement studies and the C-Well hydrologic tests could be done with the permits we have in hand.

As an example, we were talking about this is the pad for UZ-16, the drill rig as Uel said I think is out there today. We will be drilling off that pad near the end of the month. The only reason we are not drilling a lot sooner than that is we are waiting for the final underground injection permit because we decided to use gaseous tracers in the first part of this hole different from the underground tracers we had approved before.

DR. LANGMUIR: Carl, Langmuir. You had an overhead a couple back which had to do with conditions and compliance. Do you define those or do you have to negotiate them in terms of the amount of time that you are allowed for a test, for example or when you can start it and when you must finish it?

Is this something--

MR. GERTZ: Well, we put in our request and the state may say, gee, that's too long or we don't want to give it or you have to renew after eight months or after five years or whatever.

DR. LANGMUIR: Has that been a stumbling block for you? Has that been an issue?

MR. GERTZ: We hope not. Up to this point in time, once the lawsuits were over about whether it was legal within the state laws to proceed with site characterization as the Supreme Court said it was and that national law preempted state law in this case, the state has been acting in a responsible manner, the governor has. And, the state agencies have been exceptionally professional in their processing of these activities. So, I would say they have been reasonable at this time. Certainly we do live in a fish bowl with the Yucca projects, so they are very careful that all the "I's" are dotted and all the "T's" are crossed. But state agencies dealing with these things have been exceptionally professional. I think the governor has certainly been responsible since the court cases have been decided.

But you are right, they could put in some restrictions on that that would make it difficult for us. They haven't at this time.

I'll just go back. Initially they did and I'll get into one or two of those. Such as, our gentlemen that were handling Desert Tortoise. Initially they said if he was working on the Yucca Mountain project, he couldn't handle Desert Tortoise. His permit was lifted, his handling permit. But he could do it if he were working on the test program, the nuclear test program. But that was all part of the initial law whether we were legal to be there or not. And that I think has gone by the side.

Anyway, that drill rig will be on that pad I showed you shortly. That involved a suite of permits just to put it in perspective drilling into the water table requires a waiver from the state engineer on water wells, because if we are going into the water table, we have to tell them what we are going, and we are going to have to say, we are not pumping water out of that, but provide us a waiver. And he did. It involves an underground injection control permit for the tracer and a discharge approval if you are going to go into the water well and put some water out, you have to get a discharge permit. These kind of holes are going into the water table and that is what we'll need.

Drilling not into the water table, such as Dr. Flint has been doing and we have completed eight or nine of his holes right now, we needed a permit for tracer. That is not right, because we didn't use a permit for tracer there.

But neutron boreholes, NRG, SRG, we are okay. Actually this here gaseous tracer should have been up there.

DR. LANGMUIR: Carl, Langmuir again.

A few years ago a geochemist would have loved to have used radioactive traces. They don't have to interfere with the site and they would be very, very useful, but weren't not allowed to. Is that still an extant regulation now, no radioactive traces can be used?

MR. GERTZ: We have not applied for the use of radioactive tracers. Russ, do you know, have we made a policy call on that?

DR. DYER: I don't think there is a policy call. The stipulations as I recall is that you need to have 100 percent recovery. That is not our requirement.

MR. GERTZ: When you talk about permits for the exploratory studies facility, here is the kind of suite we require in November when we start our earth work activity.

We have to have our air quality disturbance permit and of course we have that.

We have to have our water appropriation to keep the dust down. We have that.

We have to be able to use gravel. We have some gravel from some soil pits but we would like to use better soil pits and we have to get those permits.

We have to make a flood plain assessment and we are well above the flood plain.

We have to get our underground injection control permits for the tracers we use, gaseous or liquid. We have to make sure that we have a storm water discharge permit, because we will be having a pad. It rains on the pad and the water flows into the environment and we have to make sure that we are complying with the discharge requirements.

DR. ALLEN: Carl, Clarence Allen again.

MR. GERTZ: Yes.

DR. ALLEN: Over at the test site, do they have to do the same sort of thing?

MR. GERTZ: The test site does now have to do the same sort of things. In fact, they got 72 permits in the time we got none and were asking for one or two or three. So the test site has to get the same suite of permits. The state has a little different ground rules with their activity than ours.

Air quality point source, when we start a concrete plant or gravel plant, we have to get those type of permits, landfill permits, drinking water, sewage treatment, effluent discharge, ponds, all the kind of things that a normal construction project has to work with that. And that is the kind of dates we are needing them for the ESF.

Now the state, as I said, has been responsive. They have provided us our three major permits, a suite of minor permits at this point in time, and we assume that process is going to continue, so as a result we are trying to work with the scientists and engineers within the project to now even expedite the project from our point of view. Make sure that we know what we are going to do in the future and make sure that the detail criteria is available so the permitting people can go to the permitting agencies with the right data and line up a suite of site characterization activities that can be done with our existing permits, so in case there is some delay in the process for either inadequate information or a lengthy public hearing that we can have an ability to do work out there.

I'll update you on litigation. I had litigation involved around these permits. One of the first lawsuits went all the way to Supreme Court, and that I believe, is now closed for all intents and purposes. A second law suite we have asked for dismissal, which said please state follow your own laws and issue the permits and that there is no longer a reason not to issue them. There original reason not to issue them was their state law prohibiting a repository.

In the last year, the state did issue the three major permits. The governor has indicated they will be handled with their merits. He is going to make a good faith effort to do that. As I said, the state agencies have been professional in the activity all along. The one that we have received, the major ones were the air quality permit, the underground injection control, the water appropriations. Other incidental permits, LM-300 diesel engines, actually the overweight permit that you saw, we had to get an overweight permit to bring it on site, which isn't even on this list. Permit waiver for holes JF-3 and UZ-16 and additional permits and permit modifications, including modifications to all these will be requested as we get more data. That is what we see the normal process.

However, there still is Congressional legislation. In fact one law that in effect preempts the state permitting, one proposed law that in effect preempts the state authority passed by one committee 42 to 1 in the House as part of the National Energy Strategy. It was originally included in the President's proposed National Energy Strategy. As I said, the House and Senate have various options that they have passed. And it is up to the House and the Senate leadership as to what will be determined the next steps.

Certainly, I am asked and asked by the governor at times, well, we are acting cooperatively, why don't you withdraw your support for this legislation? We don't know preemptions anymore. The state is going to be responsive. Well, certainly the governor has been professional and the agencies have been professional. But, who knows what a new administration in the state would do.

I'll just point out to one recent election in North Dakota where three county commissioners that asked for an MRS grant of $100,000 to help study the economic benefits of an MRS in their facility, they all lost in a recall election by 2 to 1 just less than a month ago. So, under a scenario that a new attorney general or a new governor may say, I can stop the program with a new legal theory, I think it is incumbent on me as project manager and on the department to assure science can go on uninterrupted for ten years. So, therefore, we still support this kind of legislation and it has no reflection at all upon the current state's position. We think it is the appropriate thing to do for future activities.

As we talked about, we are going to demonstrate resolve to move on with studying Yucca Mountain. And that is really what the '87 Amendments Act and the '82 Act says, see if Yucca Mountain is safe; see if it is suitable. We don't want to go through continued litigation. We would prefer some legislation to assure that these permits can be obtained. But, permits without appropriate funding doesn't do us much good either, so I do want to remind you without all three and permits one of them, this program could become stalled. We won't be addressing the existing environmental problem, the National Energy Strategy of keeping nuclear option open may not be that part of the energy strategy may not be viable.

I won't go through all these, but I have some sections in the back and one of them is called the Federal Permits. And the Federal Permits that we deal with, and I will just point out a couple are the Federal Land Policy and Management Act, which included our land withdrawal and our right of way for characterization. The Endangered Species Act and Clean Water Act, and there is some nationwide permits and there are some other things on there.

There are some other state permits that are required by flowdown. That is some of the ones we have been dealing with including the Clean Air Permit, which talked about disturbance of land activities. Just Air Quality Registration Operating Permit for things like Batch Plant, Portal Vents or LM-300s.

There are other state permits that are required by Nevada law and exclusively Nevada law. And that is things like Groundwater Appropriation, Water Pollution Control, Sanitary Sewage Disposal, etc.

The other ones are in there for your information. I would just like to point out the last page which are what we call Ancillary permits that we have been working with the state agencies all along, whether it is the animal handling one that I talked to you about for an archeological collection permit, or well drilling or chauffeur's licenses. There are lots of things that we do with the state all the time. Right now we see no problem working with Nevada and we are pleased to be out in the field working and drilling and building pads. We just hope we can continue that operation in the future.

I'll take any questions you might have. There are many more details that are in there.

DR. NORTH: It's good to hear that all those problems that we heard so much about in the early years of the Board have been put to rest.

MR. GERTZ: We think so. I am not trying to be cynical, but certainly the governor has acted responsibly as I said, but did he act responsibly because he believes Yucca Mountain should be studied, or did he act responsibly because there is a legislation pending that may strip the state of all its rights and there is litigation that said, please issue the permits. Right now, his point has been I am making a good faith effort and I'll take it on faith. But, I want to sit that aside from the professionals we work with in the state. The state engineer and the Department of Natural Resources have acted very professionally each step of the way.

DR. NORTH: Any questions or comments from the Board?

MR. GERTZ: Senator Hickey has a comment.

DR. NORTH: Okay, Senator, we would welcome your thoughts.

SENATOR HICKEY: Thank you for allowing me a few more minutes.

I would kind of be remiss as a legislator who is involved in the Sage Brush Rebellion in dealing with state rights and those issues. Just to point out to you, I was the swing vote in the Senate and it was done by one vote that dealt with objecting to the location of Yucca Mountain. That tells you how flexible our legislature is. We have been very protective of our rights, particularly with water, EPA and those standards as set by the state rather than on a national level.

I know I did not agree with the tactics that our state took, but so be it. It was settled by court. And as you realize and as was testified here by Carl, that the state acted in a responsible manner and I was pleased to see that. Carl, I am pleased with your comments.

I think you have a position maybe that DOE, and I have always questioned whether they weren't too political, but I would address the Board, and I don't think this is an issue that the Board should take up, because it is a political issue. And I think your issues are in other areas. I wish I could convince DOE that they shouldn't be in these political issues.

That is my only comment.

DR. NORTH: Thank you. I think the Board is eager to stay away from the political issues and concentrate on the technical ones.

SENATOR HICKEY: I don't have my gun.

DR. PRICE: If you would permit us, we would like to stay out of political things. We need a permit.

DR. NORTH: Are there any other questions or comments on this section of the agenda?

We now have a section entitled discussion. I know we have at least one person that wanted to make some comments based on the two day meeting.

Charlotte Abrams.

MS. ABRAMS: Well, I want to take us back to performance assessment. I know everybody is interested in permits and drilling, but I want to take us back to performance assessment for a minute and comment on the first talk this morning. I think maybe I am being a little over sensitive, but I want to point out a couple of things about the NRC's performance assessment.

I guess I am disturbed that it was used in a comparative way with the other performance assessments. And I want to point out that the NRC's performance assessment was really a limited effort by a limited number of people. And it is simply an effort for the NRC to gain the capabilities, and by that I mean the skills and the tools to conduct their own performance assessment. We don't want to be in the position of getting out ahead of DOE on this. It is not our intention in any way to put a performance assessment on the table. We would be doing DOE's job for them. We just want to develop the capability to be able to do an intelligent review of DOE's performance assessment.

That is really all I had to say.

DR. NORTH: Thank you for that comment.

That was clear to me, having attended a number of meetings on the NRC performance assessment, but I think it is very good to get it in the record and make sure that the Board collectively knows that NRC's exercise was really intended, shall we say for demonstration and educational purposes as opposed to anything beyond that.

Nonetheless, I think there are a number of interesting issues raised by the comparison and I am glad that was presented. I hope those issues will be continued. In particular I think questions having to do with the infiltration rate and the definition of drilling scenarios for human intrusion are clearly deserving of being on the agenda for further study. So, I hope as time goes on there will be a good deal of additional comparisons between the various performance assessment efforts. I think it will be appropriate for the Board to have additional meetings on this subject in the near future as these efforts, shall we say become better documented.

To go in further depth to compare the expert judgment aspects in particular and the relation between the expert judgment inputs and selection of modeling assumptions to the results of the various performance assessments, because, I think you can only really compare these outputs if you compare the inputs and try to understand the reasons for all the differences.

I am very pleased with the progress this meeting represents. I am looking forward to additional stages where we hopefully will make even more progress.

Are there any other comments that people in the audience would like to raise with respect to the contents of the last few days?

Are there any comments that the Board or Staff would like offer as we conclude your discussions.

Leon Reiter?

DR. REITER: I have a question for Jean Younker.

Jean, you have been around this program a long time in a positive matter and you have played a key role in the site characterization and chaired the group on early site suitability. Based on our personal, not the Department view, but what do you think the likelihood of the site being found suitable?

DR. NORTH: I could offer to get out a probability wheel.

MS. YOUNKER: Yeah. This is Jean Younker.

I guess I would have to separate my thinking on answering that. This is going to be totally a personal opinion, of course, into kind of a political answer, or at least an answer with a political blinder on and then a technical answer. If I look at the technical side, which I am certainly much more qualified to do, I guess that it is really my perception that, if you are going to go forward with the geologic repository in this country, you probably won't find much better site than Yucca Mountain.

Everything I know about it I can't imagine but what we once get the waste there and get it in the ground in the way I think it needs to be encapsulated, proper engineered barrier system, I think the rock units there and everything we know about the processes that operate conditions present, probabilities of disruption over 10,000 year period, I think it looks like a pretty good site to me.

Whether this country will move forward with a geological repository, and now I am in the realm that I am not a very good judge of that, but certainly having watched the program for as long as I have, Leon, it appears to me that it will be, at least we will still have an big uphill battle. I think the public acceptance of this kind of facility in this country is not at all clear.

The National Research Council's report that has been brought up several times is obviously the DOE and the people who work with the DOE are having to put on some kind of a different thought process to look at the whole program from that standpoint of the National Research Council's idea that you maybe should not have some kind of fixed goals out there but there should be some kind of work your way towards some level of adequacy or some level of acceptability.

So on the political side or the acceptability side, it is certainly still an uphill battle. I don't have a probability for Warner, but I could certainly dredge one out.

DR. REITER: Let me just ask a question. Again Leon Reiter.

If there is a problem, where do you think it might lie from a scientific point of view?

DR. NORTH: If the site were found to be disqualified for technical reasons, what would be the most likely candidate in your judgment? I remember we used to ask questions like this back in the Reactor Safety Study. If there were a reactor accident, what caused it. It is interesting at the time that we asked that in the pilot study for what became Wash-1400, which was done by some colleagues of mine, the answer was, human malevolence. This was Norm Rasmussen's answer to that hypothetical question. If there were a problem, it would be human problem, either deliberate or unintentional. And this of course was well before Three Mile Island or Chernobyl.

DR. ALLEN: But neither of those was malevolent.

DR. NORTH: Well, it was sabotage or incompetence.

DR. ALLEN: There is a big difference.

DR. NORTH: Well, I don't know whether what you want to call Chernobyl. I think there are possible elements of malevolence there.

MS. YOUNKER: It's Jean Younker again. I guess I look at the whole, everything we know about site conditions and the probabilities for disruptive events, I guess to me, if the site hydrologic system is as we in general think it is, if the unsaturated zone behaves about like we think it does, and if the climate will be pretty much like it is today for the next 10,000 years, then I can't perceive of a disruptive event that is really a problem, except a direct volcanic hit, which the probability on that seems to be well in the range that is acceptable in this country or in this world for the kinds of things we deal with all the time.

I guess from the standpoint and obviously I am couching my answer with a couple of conditional probabilities, but, I am pretty confident that our overall perception on the way the hydrologic system behaves is not fundamentally wrong. I am not saying we are not go to learn something by characterizing the site. But if we are not fundamentally wrong about that and if our whole handle on the increasing of the Basin & Range province, an the climatic changes that are within range of expectation for 10,000 years, then I really believe there isn't a credible scenario for the site to be an unsafe site.

DR. DOMENICO: I know that you are on the spot and I don't think there is any possibility that the climate is not going to change over 10,000 years. I don't think you do either. I mean, there is going to be change. It may be for the better or for the worse. I don't think you are going to find the unsaturated zone that behaves like you think it does today. It may behave better or it may behave worse. But, once you get underground, as our chairman says, things are going to change on us, don't you think, for better or for worse.

MS. YOUNKER: Clearly there will be changes. What I was talking about was the range of expectation on those changes. Whether those changes, let's say in the climate are such that the consequences would be disruptive to waste isolation, to performance of the site, I find it hard to believe that the kinds of increases and flux that we would have to see in order for some of the predictions that we have right now, to lead us to not be able to meet the 10,000 accumulative releases, you know, those kinds of changes are pretty low probability given everything we know right now.

It's the same thing with conditions in the unsaturated zone. Of course we are going to learn and we are going to find it is not exactly like we think it is. But, how far off could we be given the number of hydrologists in this country who have looked at the information, and looked at what we know about the site. Yet, could we be fundamentally wrong about the way the unsaturated zone behaves. You know, 180 degrees off. It doesn't seem too likely to me. But, obviously, there is some probability.

DR. NORTH: Any further questions of Jean along these lines?

I find this interaction not only a nice fun way to wind up the meeting, but also very much in the spirit of the kind of discussion that is going to have to go on as we get further in this process. The people responsible for performance assessment are going to have to stand up just the way Jean did and answer these kinds of questions in Congressional hearings, on national television, all over the State of Nevada, etc. And, they are going to have to have very good stories. They are going to have to be very persuasive at the level that we have really studied it. The scientists really understand it and we think the probabilities of these adverse conditions are acceptably small, whatever that means.

So, we all might as well start practicing. I think there is no reason to run away from these kinds of issues. We ought to use friendly audiences so that we learn how to do it this very articulately and precisely and then perhaps we will be better at dealing audiences which are less disposed to be friendly and perhaps more in need of developing the technical background to understand some of these very complicated issues.

So, I think the theme for the whole performance assessment area ought to be, how can we package it so it is more readily understandable by potential skeptics. And as the program proceeds, I would like to see a lot of effort put on that, as well as refining some of the technical aspects.

DR. ALLEN: Not only understandable by professional skeptics, but by professional supporters. Because, after all we depend upon people on both sides getting together.

DR. NORTH: Yeah. I think what we want to do is enlighten the debate. The debate is surely going to go on. I think the function of the analysis ought to be to educate people on both sides as to what the technical issues really are. And in this way hopefully the debate will be much more effective in dealing with the issues that are important as proposed to issues where people can make an argument.

I think a couple of years ago, we heard a lot of assertion that the vulcanism issue was a potential disqualifying condition. You could stand on the top of Yucca Mountain and you can see four volcanoes and should you have a nuclear waste repository located in this kind of an area? Now I think now we have seen a lot of evidence and analysis pointing to vulcanism should not be a disqualifying condition.

DR. LANGMUIR: Langmuir for Carl Gertz. Carl, I am sure you have had to deal with these questions on a daily basis and your people that go to the Yucca Mountain site with the public and discuss these issues are doing it all the time.

MR. GERTZ: I am glad you asked. I was just going to talk about that. Can I get my closing remarks in now? Is that appropriate?

DR. NORTH: Sure.

MR. GERTZ: Because I was just going to discuss some of those things and I will just start with that one.

Many of our scientists do deal with those questions in an adversarial type approach dealing with the public. Mike Voegele has taken people out on tours, Jerry Boak, and they go almost monthly out on tours. Let me just show you the results of some of that.

DR. NORTH: That was a planted question right?

MR. GERTZ: It was perfect. It is perfect.

You know we take a lot of people on tours, over 5,000 last year and we have asked, and when the public calls up, not a technical tour or ANS tour, but when the public calls up, we try to give them a little survey and ask them what they think. This represents about 2,400 people mostly citizens of Nevada that have gone on tours. After they have taken the tour 90 percent of those people believe DOE should study Yucca Mountain.

Now, the question is, what do they believe before the tour? Many were undecided, over a 1,000 of those people were in the blue or the green. They took the tour, the talked to Dr. Boak or Dr. Voegele or Dr. Crowe, because we have our scientists out there, not our public relations people. That is the same thing we do with our meetings we have every six months. And many people, 80 percent change their opinion positively.

So we are gaining some experience talking, I would say to the laymen. We certainly gain a lot of experience talking to the technical boards and the NRC. So, we hope many of those people will be around in ten years when the licensing time comes around, too. But there is a lot of this going on and we found when we surveyed these people, they say, we want to talk to the scientists one on one. I want to look Jerry Boak in the eye and see what he thinks. Or I want to look somebody in the eye and see what they think about it.

DR. NORTH: Your sample size keeps growing. I notice that is the end of this last month.

MR. GERTZ: Yes.

DR. NORTH: Have you seen any drop off in the interest of going out and touring the site? Are you still getting lots of people requesting this, or are the requests going up?

MR. GERTZ: Let me ask Ms. Riley who runs this program for us.

MS. RILEY: We put in the paper in January of this year and we have already filled up the March tour, was full. The April tours are already full and we are taking people for the May tour now. That is one ad that we ran back in January. So there is--

DR. ALLEN: These aren't the same people coming back again, are they?

MS. RILEY: No. We do have a few people.

MR. GERTZ: Few people like to go there every month.

DR. LANGMUIR: Based upon that, how long will it take you to get the whole State of Nevada?

MS. RILEY: We are trying to figure that out.

MR. GERTZ: That's a long time to get the whole State of Nevada. I would like to do that if at all possible. But, that is why we appear whenever we can on any talk shows in the state. We never turn down anything. As I said, we have our public update meetings where the last one had 500 people that came to a meeting in Las Vegas. They talked to the scientists. It was a fairly positive meeting. Some of the meetings haven't been that positive. Now we have a format where they talk to the scientists first around the room and then we bring them back in a group to ask any group questions. It seems to work very well.

MS. RILEY: Carl, one more thing. We feel that if we really did do some good advertising for the tours and really promoted them, we could fill, we could only take about 300 people per tour and get them up to the top of the mountain and get them back down. But, we think we could run two or three tours a month if we had the staff to really support that without a problem.

DR. NORTH: What does it cost to put on these tours, just in terms of what would it take to do two or three a month as opposed to one a month.

MS. RILEY: Well it is about 60 volunteers.

DR. NORTH: The limit is the volunteer time?

MR. GERTZ: The limit is the volunteers. I would make the money available, but you know, we want to get our good scientists out there and we are trying to develop most of the people in the program to go out there. But things are busy. I know it sometimes gets hard for Mike Voegele or Jerry Boak, or Bruce Crowe to volunteer more than two or three times a month.

MS. RILEY: And usually it is the Saturday tours that the scientists volunteer for. We would have a hard time getting them to take a Wednesday off. We run one weekday tour every couple of months and it is harder to get staff to do those tours. Most of them will volunteer their Saturday to come out. But it is mostly cost to volunteers and buses and that is about it.

MR. GERTZ: It is not really expensive. I think Winn was telling me $20,000 a tour or something like that.

I think you for that question, Don, and the opportunity to bring that up.

I guess my other closing comments are, I hope you've been able to see that we are moving from planning and preparation into in effect implementation or production, if you want to keep it all "P's". We are moving forward.

Steve Frishman indicated he saw some momentum. Well, I am glad he saw some momentum as a project manager. We do have momentum. I believe the momentum is to study the mountain and ask the questions. It is not to make Yucca Mountain the repository if the momentum is there to study it.

I can't go away without telling you one officiating story, so I will tell you sport's officiating story that goes on that line.

I had the opportunity to do one of the state basketball playoffs this year, lower level basketball playoffs. But, I was at a small town and if you remember the Duke game where they played Kentucky where Laettner got the last second shot with two seconds. Well, in this game I was doing, the visiting team had the ball out of bounds with 2.7 seconds to go and they were down one point. Visiting team. So, they do almost what Kentucky did, except they threw a quick in-bound pass and then they threw it to their center who was standing near the top of the key and I happened to be under the basket. As the center is going to get the pass, he gets pushed by the defensive man. I blow the whistle for the foul. I look up at the clock and there is .3 of a second left on the clock.

Now, I am at a home team gym and I am going to give the visitors a chance to tie or win the game with two free throws. And obviously, it could have been ignored, and it all goes back to integrity or whatever. As it was, the kid made one of the free shots, they went to overtime and the visitors won the game and I was not nominated to be mayor of the town. Although, I will tell you the losing coach was very classy. He said afterwards, that was a gutsy call, but it was the right call and my kid never should have pushed. Not too many coaches will say that. So, I appreciate that.

But that goes back to the integrity of the scientists here. The people out there with four years, if it is not going to be a safe site, I have no doubt they are going to speak up. Besides that, there is all the oversight including the Board like you all, and the NRC and the state's people. And when Steve points out about the early site suitability, you know when we look at the independent reviewers we had two people from the University of Nevada system as part of those reviewers.

So we are making an effort to do the best we can and to explain to the public what we are doing and to try to get an impartial evaluation. Because, as project manager my success is just answer the question yes or no. I am successful either way. So, my goal is much like Don's now, to get below ground with some of the things.

So, I think that is my closing remarks. Just a couple of incidental things. Don, you brought up the QA\QC thing and I want you to know that I think the scientists have really accepted both the project management controls we have and the QA/Q/QC.

We have guys like Dr. Flint and Dr. Stuckless who are champions of the QA program now who are saying hey, we like this structured approach. We understand what it is. We can do business in this way and it allows us to plan. I have heard some people say it has even improved our science a little. I won't quote which people have said that, but they have said that.

So I think that is beyond us. Whether there was over kill before or not or whether there was appropriate participation by the scientists is another question. But, now I think that is behind us and we are moving forward both in the QA/QC and in the project control way of doing business.

I am pleased with where we stand and that is my closing remarks and I'll answer any other questions you might have and thanks for the opportunity. We thought it was a nice interaction on both the performance assessment and ESSE and we appreciated the interaction with you all.

DR. NORTH: Thank you.

I would like to thank all the speakers. I think we have had a very interesting and successful two day meeting.

Any further questions or comments on behalf of the Board or staff?

(No audible response.)

DR. NORTH: Don Deere is not here, so, it is my pleasure to make my thanks to everybody's concluding remark and we will look forward to seeing many of you at our future meetings.

(Whereupon, the proceeding was concluded.)