UNITED STATES

NUCLEAR WASTE TECHNICAL REVIEW BOARD

WINTER 2002 BOARD MEETING

January 30, 2002

Bob Ruud Community Center
150 North Highway 160
Pahrump, Nevada

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I N D E X

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P R O C E E D I N G S

8:30 a.m.

COHON: Seats, please. There will be another public comment period at approximately noon today at the conclusion of our pre-arranged presentations. This morning begins with a continuation of the session we started yesterday focused on views from external organizations on the work that DOE has done, especially in TSPA. Jeff Wong is the Chair. Jeff?

WONG: Thank you. Again, this is a continuation of yesterday. And this morning the presentation will be by Dr. Tönis Papp, who was, until March of 2001, the Research Director for SKV, the Swedish Nuclear Fuel and Waste Management Company. He is now retired and is a consultant. He recently served as Chairman of the IAEA/NEA International Team reviewing the Yucca Mountain TSPA-SR. So with that, Dr. Papp?

PAPP: Good morning. Okay. I will start with giving you some, a little overview of what the IAEA and NEA are doing when they are doing this sort of reviews, and then I will go through the main findings of the International Review Team. And the reports is not in printing. We made it during July, August, September. It was three months of quite hard work. And most of the formulations were ready

by October or so, and I'm referring to the discussion yesterday when compared with what new results have been coming up and so on. But it is now in the printing and they say, NEA, that these will be available from the print in mid-February.

Okay. The IAEA/NEA, they have for quite a while worked with these sort of reviews. And I assume that most of you are quite familiar when the WIPP facility was evaluated. There has been a couple of other also methodology for scenario and model developments and review of the UK methodology. And there was a review of the Japanese H12 concept for final repository, final geological dig repository.

Our own work in Sweden, SR-97, it was for post-closure total system performance assessment, also it was also reviewed. And there has been recently another made, specific review made, on the biosphere issues and biosphere modeling for Yucca Mountain.

When the IAEA/NEA are doing these reviews, they are selecting special groups. For each review there is one special group created, and the experts are selected with regard to what is the special areas to be reviewed. In this case it was quite a lot of people working with the performance assessments that are within this team. I was heading it as the chairman, and there has always been an

effort to try to get some international balance here for these reviews, so there are people, as you see, from Spain, France, Canada, UK, Australia. And also members from the IAEA and NEA. That's very important of course. After a while you get a certain routine of doing these things and it's not very easy in a short while to make and review over large documents. We have to have a standard procedure by which to address questions in ways you don't forget them.

There is various distributions among the various international countries and there is also distribution between expertise in various areas here.

Okay, let's go from this over directly to the objectives of the assessment, also of the review. And I shall perhaps read it directly. The job we had was to compare methods used by Department of Energy with international current or developing recommendations, standards and practices. We also asked for a statement regarding the adequacy of overall performance approach for supporting the site recommendation decision by the Secretary of Energy. Detailed recommendations were also asked for for improvements to help the performance assessment, to better support the next programmatic decision point in case the site is recommended.

That was all a job, and I'd like to comment that

our task was then to make a review of the methodology, not to review or evaluate the adequacy of the repository design of the site.

We had as a main reference document, or the document that we reviewed, that was the TSPA-SR from the year 2000. We were aware of the fact that there are other work going on, but they were not all reported so this was the focus of our work. We worked with this review, we greatly benefited from many face to face meetings, too, rather groups of meetings with the DOE staff and contractors. And we also benefitted from a comprehensive answers to about 150 written questions. And these formal questions and answers was very important for us because perhaps it made it easier for us to track some of the--I heard yesterday about the problems of tracking the information from one, the original source on to the safety assessment or performance assessment. Perhaps this made it a little easier for us, but we didn't have so much problems with it. When you are doing a review in two or three months, then really you cannot look at everything. You have to go down on some details here and there to see whether it checks. And this we made in a number of areas And for these areas we found that there wasn't a traceability that was acceptable. We found what we wanted.

So my presentation will go directly parallel to these three objectives. First, look at our views on the international perspective, then I will present a statement, then talk about the recommendations. We had a number of recommendations so I will go into some highlights from these recommendations.

So when we go to international perspectives, we observed of course very early that the Yucca Mountain setting is quite unusual from the international point of view. It was in a closed basin system where all the systems otherwise in Europe or the world has been with a release into the, some ocean or some sea. Also, the oxidizing environment was unusual so we had to take this into account when talking about how this compares with international standards.

The rationale was, of course, one of the more important things for us to look at. And--of the TSPA, it was made--the rationale was to make a TSPA to determine whether it's likely that the selective repository concept at Yucca Mountain site will be able to meet licensing requirements. And we also observed that the dose rate requirements for the 10,000-year period given in the regulation was met by designing the engineered barrier so that the available corrosion data, based on these corrosion data there would be no release from the waste

package under normal conditions for this 10,000 years.

This rationale we observed is quite capable of addressing many issues, but we also believe that there are alternative approaches that could have been taken. We believe that the extensive knowledge accumulated in many years, all the characterization and analysis of the site has not been utilized in the fullest extent. It would have been desirable perhaps to have a better place to have placed greater emphasis in the TSPA on the performance of the geological barrier in its own right.

Moreover, we think that the broader safety case could have been developed to support this site recommendation decision.

But again, the methodology used for providing the basis for these decisions, the overall structure of the methodology and the building on a series of performance assessments which they made here, they conformed to best international practice. Moreover, we thought also that the structured obstruction process that has been shown in this TSPA by linking process level models to assessment models is, as we see it internationally, in the forefront of international developments.

We saw, when talking about the methodology, that there was much more probablistic approaches, more

probablistic methodology approaches, and more used, and lists natural analogues than normally in international assessments. But we were also aware of the fact that the regulation which are more prescriptive than is common internationally with this 10,000 years and the stylized intrusion scenario and defined biosphere and so on. These have been the ground for doing many--for having this higher emphasis on the probablistics and the higher focus on the compliance issues.

These discussions lead then up to a statement by the IRT, which I'd like to read out. We said that, "While presenting room for improvements, the TSPA-SR methodology is soundly based and has been implemented in a competent manner." Moreover, we believe that the modelling incorporates many conservatisms, including the extent to which water is able to contact the waste packages, the performance of the engineered barrier and the retardation provided by the geosphere. We say that overall, the IRT considers that the implemented performance assessment approach provides an adequate basis for supporting a statement on likely compliance within the regulatory period of 10,000 years, and accordingly for the site recommendation decision.

We also said in the third section of the statement that, on the basis of a growing international

consensus the IRT stresses that understanding of the repository system and its performance and how it provides for safety should be emphasized more in future iterations, both during and beyond the regulatory period. Also, further work is required to increase confidence in the robustness of the TSPA.

This is leading up to our recommendations for the coming phase then.

So from this we went on then to what sort of recommendations, what sort of changes would we recommend, what sort of additions would we recommend in order to have this PA approach more close to the internationally, those internationally made performance assessments we've seen before. And we looked through all the system, quite in detail of course, and came up with 27 recommendations in various areas. We talked about the overall system methodology quite a lot, and the subsystem methodology, and then we had disruptive events and documentation. But I will address these two issues first because I think that's the more interesting things that we have looked upon there.

When we go to the overall system methodology, we have in many places in our report talked about the need for something that we call a safety case. Perhaps that's not so easily understood what we mean by it if you haven't

been in this discussion, but in general, I would say that the safety case as this internationally is something which is still developing. Every country might have a little different opinion on what it should contain, but I think there are some common ideas about it. And the one is that it should be a higher level document to address the strategies for how you're reaching a repository. That means that we are aware that there are a number of decisions, a sequence of decisions to be taken, and for these decisions there is the basis, the information that has to be developed. And this strategy for how the decisions will be made and how the information for taking the decisions will be built up, should be in such safety case documentation. There might be strategies for safety and strategies for confidence, and there might be a little difference. And strategies for compliance of course also.

And lists that was published in NEA document on this performance--this safety case is talked a lot about this presentation, also of the line of arguments which you have in order to allow yourself to move to the next decision phase. That is to show, to be aware of what is decided, what is defined and why you have the confidence, and also be aware of the lax areas where the confidence is not yet there, but if information will be coming in other evaluations. For instance, by building the repository and

emplacing in the waste, there is a lot of new information coming in. And then it should be in a safety case a definition or discussion about how this information will be used in order to help the confidence for this, say the final closure of the repository or whatever it is.

The robustness and the flexibility has also very often been discussed in the safety case, in connection with the safety case. For instance, if there are unexpected things coming from the results from the investigations, then there should be a discussion, what sort of options do you have with regard to your concept, with regard to your design of the repository in order to meet unexpected events or information coming from the geologic investigations.

The robustness and the flexibility, design options and so on should be there and planned work for the next stage. All these things we think should be in the safety case, a sort of higher level document to address these things.

Sensitivity analysis we looked upon quite a lot. We found that there were a number of very interesting tools used. One on methods to evaluate the importance of various barriers and so on. We were favorably impressed by these things, but we think also that this could have been further developed into much more conclusive

discussion about work of important things and then simplifying the discussion of all the presentation on how the repository is working into finding that say, five or six or seven most important issues because one of the problems we always had also for us quite knowledgeably believe was to be able to grasp the, what is really important in these areas. And by using sensitivity analysis of course this would be helped a lot.

The system's understanding, this is almost the same thing as with regard to things that has to be presented in the safety case. But we think that, yes, we have said that it should have an equal importance to compliance because we think that you cannot always foresee everything that will be coming up. And the understanding is then more important than whether you have shown compliance by using a lot of safety margins or conservative evaluations.

We think that the realistic modelling is the only way to get this understanding, and we think that this should be done much more. I don't mean realistic as opposite to the unrealistic, but opposite to the conservative modelling. This realistic modelling should be done in order to be able to see what data, what information is really crucial and important. But we also are aware that there should be a conservative analysis for

the compliance so this is not instead of the compliance analysis, but rather complimenting the compliance analysis.

Now we come to the final slide then, and this is the subsystem methodology. And here we saw that--we talked about the engineered barrier quite a lot because it's a very important part of the system. And the first observation made by us was of course that it was in line with the international best practice, but we were also aware of the fact that also in the international best practice there is quite a lot of lack for the long term data. These materials are used perhaps 50 years and so on, and the very long-term data is not there. So we had in our report a list of recommended, first to start the long term testing as quickly as possible. And then we had a long list of all sorts of factors which would have to be started. For instance, the gama radiation field, the special Alloy 22, kinetics of pitting and crevice corrosion, salt position and local corrosion, stress corrosion and cracking, especially on wells and Alloy 22 --corrosion and aging and so on.

Well, this type of lists of what we think are good and should be done, we have in the report quite a lot of it. And then we, after the barriers we went on to the transport within the engineered barrier system. Okay, I

will just mention it rather quickly that we regarded it overly conservatively modelled, and very complex, and possibly not credible. We looked quite in detail on this diffusion through the stress corrosion cracks. The model requires that there is a continuous fill of water allowing the diffusion all the way from the waste form to the cracks in the degraded waste package and down to the bottom of the inlet. And these things, there are quite a number of assumptions that are, as we think there should be reviewed a little more. And possibly not credible, but what we recommend is that it should be reviewed more. It should be made a more detailed review on. We still consider that the availability of water for this system and dripping, or whatever it is, the dripping of fluid, water, is one of the crucial points which might be one of the big conservatives in this assessment.

And the final thing, I'm sorry, I'm drawing out in time here, but the final thing here is the saturated zone. And here we also were rather critical. We said that, all right, we are aware that when you're making a sequence of decisions somewhere in the decisions you're allowed to use conservative simplified models, and you might take away the simplifications and go on to more realistic models as they are. Here we think--thought that perhaps you had it too simplified and too conservative

model from the beginning. We didn't forget it is a sate of the art, and I was rather glad when I heard yesterday about quite a few of these many actions that have already been started. We, at these meetings when we discussed this report we heard that the Nye County holes (phonetic) were coming in to the system and so on. So there are a little of good things happening, but when we saw this then we regarded this could have been done better. And we recommended really a significant effort to produce new data and new calibrations and new models for this saturated zone transport model.

Thank you. I think I leave it with this.

WONG: Okay, thank you, Dr. Papp. Questions from the Board? Silence. Is it too early in the morning? No questions from Dr. Bullen? Okay, Dr. Bullen.

BULLEN: Bullen, Board. I know that this is beyond the purview of your organization because you were limited to TSPA-SR, but having seen some of the stuff that's been presented in the SSPA, the supplemental science performance analysis report, and the lower temperature operating modes, were there any comments specific, or maybe just sort of general conversations that were had by the International Peer Review on maybe benefits, detriments of hot versus cold.

PAPP: Yes. In fact, we discussed it a little. We

indicated let's say perhaps in a more general way that there were a number of design changes made from the earlier performance assessments, and that was also something that we didn't understand. It was not written in the documentation why they were made.

Now we had a lot of discussions on the higher and lower temperatures also. And the issue is of course you have more data for the lower temperature situations and so on.

On the other hand, the high temperature is perhaps also one of the more important factors for avoiding getting fluid water into the system. And as we saw it, a lot of the--if you control these things there is a lot of benefit to be gained by this one. So we didn't make any suggestions on how to go with regard to the repository concept, but we observed that there should be perhaps better arguments made for why this or that design changes are made to show what is the benefits and the consequences of it

BULLEN: Bullen, Board. Just a follow up on that. When you looked at the presentation for their TSPA-SR design, did you have difficulty with the way the TSPS handled coupled processed, handled the exclusion of water, or was it the assumptions that underlay maybe the discussion of that, or was that not a topic that made it

to the top of the heap in your evaluation?

PAPP: We have in the report commented on this exclusion of the water issue, and we think that perhaps the simplification of the model was made too far. That's why perhaps it was not credible, because there could have been more discussions on whether these natural waters really existed under these higher temperature situations, and so on. But we didn't make any alternative evaluations of this proof, no.

BULLEN: I realize that was beyond the mandate you had in what you did. Thank you very much.

WONG: Debra?

KNOPMAN: Knopman, Board. Tönis, going to your first chart, first objective of putting Yucca Mountain in the TSPA process in some international perspective, I'm wondering if you could tell us a little bit more about what is going on elsewhere in terms of the emphasis on a site characterization versus a overall evaluation of a repository system, and the way that balance is being struck elsewhere. Is the natural barriers, the natural system by and large, you mentioned that you thought that DOE should have emphasized that more, but is that in fact what the experience is elsewhere, that much more of a focus on natural barriers apart from what might then get engineered into the system?

PAPP: Yes. Bottom line of the answer would most probably be that, yes, most often you'll see more emphasis on the geosphere. On the other hand, I know from my own country, Sweden, that we also in the situation where we was to show--we haven't any site selected yet, but we made this last SR-97 with three possible sites, not selected, but we had data on them. And just in order to show that this repository system would be working in many of these sites. And there, there was of course the effort then to show that the system was so stable so you could use many of these sites, but I would say that perhaps the sites in Sweden are much more similar than the sites, let's say the difference between a unsaturated area here and the granite, since we live--it's a very large difference there. So the sites we looked upon were much more similar to each other than this Yucca Mountain repository.

Then the other hand, on the other hand also, how we approach the site is very much an issue of the legislation and tradition in the country. We were aware of that. But perhaps from the international point of view, even if this is very much dominated by how the legislation and tradition is in the country, there could have been the discussion on what's the reason why we are selecting this approach. Why we're selecting the strong barrier concept for instance, or why we are accepting to

have a rather simple model for the saturated zone in the beginning for this. This reasoning, these arguments which I think could have been in safety case, we didn't find anywhere so we had to guess a little about it. But we don't say that one route is wrong or the other is right, but sooner or later you have to have all of this information at the final licensing stage or final closing stage or whatever.

WONG: Dr. Runnels?

RUNNELS: Runnels, Board. Yes, Dr. Papp, in the reports you mention both in the section on saturated zone and in the section on unsaturated zone, that the possible role of colloids may be overrated in the TSPA. Could you comment on that, the basis for that suggestion?

PAPP: I think the only comment I would give is that in the--and again, I will say that here we see that there is a difference between the non-saturated, so on, compared to most of the other investigated areas in the world where we're talking about saturated areas. In most of these cases the naturally occurring colloids have been shown to be rather low, even if we have, for instance in the Swedish system, bentonites and so on, with a suitable chemical environment and so on, the colloids in the natural system have been shown to be very, very low. So that could be one of the arguments, but we are fully aware

of, these colloid issues are constantly coming up again and what we are saying is that we are not making a conclusive, we are not concluding anything here, but rather observe that this should be further evaluated because it has quite a big importance. So we think that these colloids should be, you should further study and build up a better confidence for why these levels of these amounts are used in the assessments.

WONG: Dr. Parizek, I'm going to give you the last question, but I have to give you warning that the real chairman is giving me the evil eye.

PARIZEK: Parizek, Board. In one of your slides you talked about the methodology conforms to international practice, and then indicated that it was more probablistic and less natural analogues being emphasized. Obviously, in international reviews we see a lot of use of analogues. There are very powerful arguments that they support positions being taken. In your review and then just in discussions amongst your group, did any analogues come to mind that might apply to this oxidizing environment, and that we are somewhat unique and you point that out, but in just the debates and discussions, did anything come to mind that would be useful for the program here to pursue.

PAPP: We talked about the Pena Blanca analogue quite a lot. And among our geochemists, there is also a very

clear idea that this was a very good analogue to use for the Yucca Mountain case. But we also said that any of these natural analogues to be used for the, let's say I think a more realistic picture of what's happening, should be used in parallel with using the Yucca Mountain area as a sort of self-analogue, comparing the situation in Yucca Mountain to the Pena Blanca system, for instance.

The main role we saw for this natural analogues were not really to provide much new data, new hard data in for the modelling, but rather provide a better possibility to create realistic models.

WONG: All right. Thank you Tönis very much. Thank you for making the long trek from Sweden, and I'd like to thank all the speakers for the session that I chaired, and I return control to Dr. Cohon.

COHON: Thank you very much, Jeff. And let me also extend my thanks to Dr. Papp for being here to participate. Thank you.

We will depart from our agenda for just a very short period of time so that Dan Bullen can ask a question and apparently make a speech about an issue that came up yesterday.

BULLEN: Bullen, Board. Actually, there is a benefit to the detriment to live in two time zones away. The detriment is that at 6:30 last night after you've been in

11 hours of meeting you're a little bit brain dead. The benefit is at 4:00 in the morning you're actually pretty wide awake. And so I had the opportunity to take a look at the presentation that was given in the public comment session by Parvis Montazer yesterday. And as I was thinking about it, I also looked at my notes and realized that Russ Dyer mentioned that there was a thermal operating mode white paper that actually I've seen and liked a lot, that has sort of a real good mix there. In fact I liked Parvis' presentation because he's thinking out of the box and he's looking at opportunities that give you both a smaller repository footprint and also the potential to keep the waste packages even cooler than the Board has said. So what I was wondering was, Russ, is that white paper going to soon be available for public consumption, or is it not--since you mentioned it in our meeting that I can put you on the spot, so what's the status of the white paper? Can you tell me?

Don't you love it when you--you can use my mike if you want, but--

DYER: This is Russ Dyer, DOE. We got it in last week. It should be going through the dissemination process right now, so--

BULLEN: So is it publicly available? I mean I know you gave it to us and said don't tell anybody about it.

When is it publicly available, I guess is the question?

DYER: Now. Week or two. Soon as we can get it printed and distributed.

BULLEN: Okay, great, so--

SPEAKER: Printing the copies now.

BULLEN: Super, so--

DYER: We're in the printing process now.

BULLEN: In a couple of weeks then I think it would be great if Parvis could get a copy of that because he could put some numbers to what he has done just to kind of put it in more context that would be better presentation in May. That's why I brought it up now, so if we could get it.

DYER: Okay.

BULLEN: So, Parvis, are you out there somewhere? I'm sorry, I was not paying attention. Did you hear that?

MONTAZER: Yes.

BULLEN: Get the report form Russ, okay? That's all I wanted to say. Thank you very much, both for indulging me with my brain dead nature at 6:30 at night and being awake at 4:00 in the morning.

Mr. Cohon, it's yours.

COHON: Thank you, Dan, and thank you, Russ.

Returning now to the last session of our meeting, which will focus on various regulatory considerations and

developments as they pertain to the Yucca Mountain program, both at this moment and going forward, we're going to have four presentations by five speakers. And let me introduce all five speakers. And as I do so, I encourage Tim McCartin to start making his way up front and getting wired. Here he comes. Tim McCartin is indeed our first speaker. Tim is Senior Advisor for Performance Assessment in the Division of Waste Management of the Office of Nuclear Material Safety and Safeguards of the Nuclear Regulatory Commission.

He'll be followed by Jerry McNeish, who is at Duke Engineering, which is part of the Bechtel-SAIC Team, which is a contractor for DOE.

Jerry will be followed by Joe Boyle and Peter Swift who will be sharing a presentation. Bill is Senior Policy Advisor in the Office of Licensing and Regulatory Compliance of the Yucca Mountain Project. And Peter Swift is Manager of Performance Assessment Strategy in Scope, at Sandia, another part of the Bechtel-SAIC team.

And we will conclude with a presentation by Bill Reamer, who is Chief of the High Level Waste Branch in the Office of Nuclear Material Safety and Safeguards at NRC.

And with that we'll just have each person come up one after another. And I give it to Tim McCartin.

McCARTIN: Thank you. Prior to starting I would like

to at least acknowledge my colleagues at the center in NRC. Neil Jensen, Janet Kotra, Jeff Pohle, and Gordon Wittmeyer and Bill Reamer who all participated in development of the regulation and certainly shared in all the work.

Going right to the next slide, in preparing for this talk, 15 minutes to explain Part 63 is a relatively short period of time, so I focused on four points. The first two points, safety approach and multi-step process, really provide a framework for the Board to understand how the regulations fit into the overall approach at NRC. The final two bullets, performance assessment and reasonable expectation are two, what I consider to be important interests for the Board to consider. And that's how I arrived at those.

We are certainly, myself and Bill Reamer are here from the NRC, as well as a few others. We're willing to take questions on any part of the regulation, but I clearly have distilled things down to four primary points.

Next slide. In terms of the safety approach, there are three aspects to safety within the regulations. Safety analyses are required, both pre-closure and post-closure. Safety plans and procedures are required and there's regulations for continued oversight of safety. And I'll go into detail on those three.

Next slide. Safety analyses. As I indicated, we have requirements to assess safety, both for the operational phase and the post-closure phase. Specifically, you're looking at safety assessment that will--what can happen, what can go wrong. Pre-closure they have somewhat likened to design basis events, more of an operational term. And post-closure we have the FEPs, feature, events and processes. Those are the kinds of things, what needs to be in the assessment. You certainly, from that you then evaluate the radiological consequences and most importantly as information comes, continues to be developed, it's incorporated into these assessments. They are required to be updated with time. I'll get into that a little bit more later. And certainly all these assessments are subject to NRC review. So that's the approach for these safety assessments.

Next, there are safety plans and procedures. This is primarily an operational aspect. We have procedures, Subpart H, to train, test, qualify, the personnel that will be operating the facility. There are emergency plans required in the event there's an accident during the operational phase. There are procedures and plans that have to be put in place by the DOE. That's Subpart I. Waste retrieval really gets more obviously to post-closure but at some time during the operational phase

if it comes to light that indeed this would not be in the best interests of public health and safety, there is the option to retrieve the waste, remove it and take it somewhere else.

Next. And finally, there's continued safety oversight. For the repository there are a number of requirements for land use control, permanent markers, records and archives so that future generations know what's there.

Additionally, there is a requirement for post-permanent closure monitoring. This is to go on indefinitely. Clearly, the NRC is not saying that we can guarantee that NRC will be there, or DOE, for the next 10,000 years. There are requirements to act like that is. We do not rely on these requirements to protect public health and safety, but it is required to plan for continual monitoring of the repository and permit records, etcetera. Okay, that really is the safety approach in the regulations.

Next is how do we anticipate new information and incorporate it into the evaluations of Yucca Mountain. And there's three primary aspects to the licensing or potential licensing of Yucca Mountain. First there would be a construction authorization. That's based on the site characterization information.

Next, over that construction period there's additional information collected. You would get to an amendment to receive and possess waste at the site. That kind of decision at this point is formed by the construction activity and all the performance confirmation data that you've collected up to that point. After that amendment, at the end there is an amendment for permanent closure.

Also, this would be updated by that performance confirmation program. Time period for this progression, we've heard somewhere around the order of 100 years. It's possible DOE could keep the site open longer. Maybe it's 300 years. All that information would be factored in at this end point.

I would like to say sometimes you use words in a regulation that don't necessarily express exactly what you mean. The performance confirmation program, I could spend 15 minutes just on that. What do we mean by that? And I think the NRC, and we will work with the DOE on this, is that this is a program that is a testing program. It is a research program to challenge the safety case. It's not just trying to look at a performance calculation, but you're looking at all the information that has gotten you to the point where you made a decision, let's challenge it. And that 50 or 100 years is used to challenge your

safety case.

The other part of all that is you certainly know it's in the regulation. At times we try not to be too prescriptive. Performance confirmation is one of those areas where we've given a lot of flexibility to the Department of Energy. It is their safety case. It is their performance assessment. They should know where the strengths are. They should know where the weaknesses are. We have given them the flexibility to design this performance confirmation program as they see fit. However, it's certainly subject to NRC review. There may be different opinions NRC can weigh in. At times we can put license conditions. Yes, you're going to test this. We want you to do these other things. And we certainly, we expect that stakeholders will be involved in the performance confirmation program. Nye County, the state, possibly the Board, all might have valuable input to assist in this long-term performance confirmation program. But I guess the main point I'd stress is that in this additional information it will evolve with time, and it is a broad-based program. Testing and research and challenge the safety case. That was the intent.

Okay, next slide. Now I'll switch--that's sort of the overview of the framework behind the regulation. I will now go into two very specific aspects of the

regulation that at least in my opinion I thought the Board would be interested in. And performance assessment is that. This is the post-closure performance assessment. When we talk of performance assessment within our regulation we tend to adopt a, possibly a broader definition for performance assessment than the Board and others might imply. We are looking at, not only the calculation, but all the information you have used to support your confidence in the performance assessment.

It certainly has to account for uncertainties. I think we're appreciative of the Board for stressing upon DOE the need to evaluate the uncertainties, etcetera. That is a very important part of understanding the performance assessment.

You also have a technical basis for what's in and out of the performance assessment. The models used in the performance assessment. Here also I think we're consistent with Board recommendations in terms of multiple lines of evidence. We have tended to group them within the performance assessment, even in natural analogue, if it's supporting your confidence in the performance assessment. We have grouped it within the performance assessment. And so when we look at PA we're looking at a very broad performance assessment. And certainly at the end the identification and description of the barriers,

which can be very important. When we look at performance assessment it is not just, well, is the final dose below 15 millirum. That is, it is far more than that. What are the capability of the barriers? We need to understand why the numbers came out the way they did. And all this information analyses contribute to that.

Just one quick aspect, when you look at the performance assessment, if you just look at the dose, you see iodine, technicium and neptunium, primarily contributing to dose.

One of the things we look at in terms of the barriers, well, there's a host of other nuclides that you never see. What's the reason for that? It's not the waste package. The same waste package that let out iodine lets out plutonium, thorium, americium. Why don't you see it at the critical group? There's aspects of the geologic system that resulted in some of those nuclides never getting there, not only in 10,000 years, 100,000 years, possibly as long as a million years for them to get to the location of the--that's a capability of that barrier. We want to understand that capability as much as we want to understand why the dose from iodine is there. It's also important to understand why isn't there a dose from americium or thorium, etcetera. And so all of that is part of that performance assessment.

Next slide. Reasonable expectation. It's in the regulation as to what tests will NRC use to determine compliance. And this is consistent with the EPA standard. Less than absolute proof. You have to acknowledge there's greater uncertainties in going to a very long-term projection. You want to look at the full range of defensible and reasonable parameter distributions. All of this is quite reasonable. We agree with this. We have adopted it into our standard. You can't expect exact servitude, clearly, in this kind of analysis, and that's what is in the regulation. What does that mean in terms of compliance?

And I guess my final slide--confidence that DOE has or has not demonstrated compliance, that is the essence of NRC's licensing decision. The entire process, the adjudicatory process, presenting evidence, cross-examination, all these different things, the performance confirmation program, performance assessment, understanding uncertainties, etcetera, all of that is taken in. The Commission considers the full record. They use a phrase that I think in my mind says it all. They make a decision based on the preponderance of the evidence. All of that information, the multiple lines of evidence, analogues, etcetera, everything gets taken into account in making that decision. I think we believe that,

irrespective of the term used, whether it's reasonable expectation or reasonable assurance, the Commission will consider the full record. Reasonable expectation certainly provides the commission with the flexibility that they feel they need to do, need to have to weigh all this information and ultimately decide whether public health and safety is protected. That is a decision the Commission makes. It's not whether 10 millirum or 2 millirum, etcetera. You look at all this information. A big part of it certainly is the uncertainties, etcetera, but it's public health and safety. That's the final Commission decision.

And with that, that was a quick run through the regulation at a very high level. I skipped over many, many topics, but I'll try to answer any question you might have with respect to any part of the regulation.

COHON: Thank you. That was very good. Questions? Dan Bullen.

BULLEN: Bullen, Board. Thank you very much for opening the topic up of performance assessment because I have a couple of quick questions about that. Maybe based on the fact that we had a presentation by John Garrick last night where they talked about the AC&W findings and obviously you guys have to respond to what they say. So it's maybe a follow-on question.

When they talk about things like the absence of a simplified model to sort of understand, and I don't want to go all the way back to like back-of-the-envelope kind of calculations, but could you kind of give us an update on what the NRC might be thinking with respect to what an acceptable simplified model might be and kind of how do you hold DOE's feet to the fire so that there's a simple basic understanding of what's going on when you make the safety case. And then the follow-on question is, you know, add margin of safety to that. How would you address sort of safety margins?

McCARTIN: Well, first, yes. I mean as Dr. Garrick indicated he has been talking to us quite a bit about a simplified model, and we have been working to accommodate that. In general, the performance assessment is relatively simple the way it's calculated, just by necessity. There are many things now included, both our model and the DOE's. And it is true, we have struggled with there should be an easier way to explain this. I mean I'll say I've been doing performance assessment in the high level waste area for 20 years. I look at the DOE documentation of their performance assessment, and I think it's quite good. But I will tell you, when I read it there are some pages I will take two to three hours to read. There is a lot of information. You have to really

think hard. There should be a way to distill this in a simpler form. And I think we are trying to do that at NRC. I'd like to think that you could identify, as Dr. Garrick indicated, a handful of the most important parameters, what they are, and/or models, your basis for it, your uncertainty and how it affects the dose, and go through that and be able to explain it that most people would be able to understand it. I think we are working towards that.

I'd like to think, I know the way I've put it in my mind, if the Chairman of the NRC said to come into his office and explain the performance of Yucca Mountain and you have 45 minutes. Would I be the one to tell him, no, sir, we really need two days of your time, and we'll go through this? The answer is no. I need 40--he wants 45 minutes. I think it's doable. But it is difficult. But I'm not convinced--and that's in terms of a presentation that would be explaining the performance assessment. I'm not sure a simplified model one would do. Now, in terms of the margin, that's a difficult one. There's nothing in NRC's regulations that requires margin. Nothing requires an applicant to be conservative.

BULLEN: That's exactly the answer I expected. One more follow-on that kind of might help you with the margin issue is that you talked about performance confirmation

program, and perhaps license conditions of operation that you say, well, we want to see you do this. How willing is the NRC to say the way to go, very aggressive. I mean put waste packages in there and sparge water over the top and make rocks fall on it and see what actually happens. But the reason I say that is because in the 300 years that it's open you're probably not going to see anything happen. And so the performance confirmation, unless you make it an aggressive environment that tries to mimic the derated waste package with lower power output 8000 years from now, you won't learn anything. And so I guess--yeah, what are your thoughts on that?

McCARTIN: I think that's correct that, that in general the repository itself, if current ideas are correct, you won't see much of anything. It will be ventilated. There won't be any drips, etcetera. There are certain things you still can measure. The testing program to challenge the safety case I think would occur somewhere else where you do these kinds of aggressive tests, etcetera. And I think we just started discussions with DOE in terms of performance confirmation, and I think that it will evolve with time. I think every year you'll learn more, etcetera. But one thing I didn't quite finish, although the NRC regulations doesn't require somebody to be conservative and we don't require margin,

I think the key is to understand the uncertainties. And I think both the AC&W and the Board have stressed that. If you look at many of the agreements we have with the Department of Energy, it's getting to try to understand what that uncertainty is. The reason I don't like, in this particular situation, conservatism, sometimes you really don't know. And one man's conservatism is another man's optimism. So--

BULLEN: Thank you.

COHON: We're going to have to move quickly. I have four people who want to ask questions, in this order, Richard Parizek, Dan Metlay, Paul Craig, in the time allowed. Then we're done. Three people. So questions to the point and short answers.

McCARTIN: I'll try.

COHON: And, Richard?

PARIZEK: Parizek, Board. Tim, would a one-off or one-on analysis help you in terms of understanding the role of the individual barriers. You say that's kind of a critical thing to be able to analyze that, and you've heard Debra's point on this a number of times. Would that help in making it simpler, perhaps address the part of the help for it.

McCARTIN: Right. It is certainly additional information and in our regulation we have steered clear of

trying to prescribe what DOE needs to do, or how they would do it. We want to understand the capabilities of the barriers. And it may be--there may be some analyses that are very useful, some are not. They need to try a variety, which they are, and use the ones that are most helpful. But we would agree that generally that has added information to the process, the one-on and one-off.

PARIZEK: A second point on--

COHON: Could you get closer to the mike?

PARIZEK: Yes. --September 11th concern. Is that somehow dealt with in the regs? I mean where does the September 11th experience fit at the repository level?

McCARTIN: Well, sure. As this was going forward to the publication that, it was right in the process there. And the Commission as an agency is looking at its requirements across the board in terms of are there additional things that are needed in response to the events of 9-11. And in that process, right now we're not aware of anything that needs to be changed, but in that process of reexamining the regulations if something needs to be changed it will be done in a public rule-making, etcetera. Part of, certainly during the operational phase we tie ourselves more to what is done at other facilities, and changes in those regulations would convey into 63.

COHON: Dan Metlay?

METLAY: Dan Metlay, Board staff. Tim, I'm wondering if you might explain sort of the evolution of the NRC's thinking from Part 60 to Part 93 with respect to defense in-depth, sorry, 63, and let me just clarify. I'm not talking about multiple barriers which is a statutory requirement. I'm talking about the notion of defense in depth that introduces some notion of redundancy.

McCARTIN: I'm not--in terms of 60 to 63 I'm not aware of any philosophical change between 60 and 63. In 60 there has never been an implication of redundancy between the barriers that the performance could be completely taken up by one engineered barrier, and one natural barrier. And I think it's still consistent. As people have noted, we had subsystem requirements in 60 that had at times depending--I don't think were redundant by any means--had some specific requirements quantitatively. Right now the Commission has opted to evaluate, tell us what the capabilities of the barriers are. It will be a subjective decision as to whether the commission agrees that DOE has demonstrated both natural and engineered.

COHON: Paul Craig.

CRAIG: Paul Craig, Board. A quick one for you. Could you summarize the NRC's current thinking about the post-10,000 year period?

McCARTIN: In terms--well, the regulatory period is 10,000 years.

DR. CRAIG: The regulatory period is 10,000 years?

MR. MCCARTIN: Correct.

DR. CRAIG: You're aware--

MR. MCCARTIN: Sure, yes.

DR. CRAIG: --institutionally aware, and how do you think about that and what role does it play in your decision process?

MR. MCCARTIN: Well, the compliance period is 10,000 years. The Commission would look at the 10,000-year behavior period. The post 10,000 years is provided in the EIS, and so that information is available and out there. But compliance would be based on the 10,000-year period.

DR. COHON: Thank you very much.

Next is Jerry McNeish.

MR. MCNEISH: The title for my presentation is "Total System Performance Assessment, TSPA, Analyses Evaluating the Final Environmental Protection Agency, or EPA, and Nuclear Regulatory Commission Rules". An alternative title is "How I Got My Gray Hair". There's a patch here for SR, there's one here for the VA, I think there's another one back here (indicating) for these current federal reports.

I want to give credit to several people who helped

in the development of these letter reports that I'm going to be talking about today, in particular George Saulnier, Pat Lee, Dave Sevougian and Don Kalinich, as well as the many reviewers that we had that helped with the quality of the document.

As an overview of my presentation, I'm going to first talk a little bit about the TSPA-SR documentation suite. There seems to be a little bit of misunderstanding about what is actually being used in the upper level documents, so I'll try to clarify that. And then talk about the contents of two letter reports that were finalized last fall, one on the final EPA rule and one on the final NRC rule, and these were both put on the web in November, and I believe they're still there. And then I'll summarize.

Next slide, please.

The TSPA-SR documentation suite consists of several documents and include lots of analyses, which are then rolled into the upper level documents, such as the Site Suitability Evaluation document and the FEIS, which will be released sometime soon. We believe--I believe these are the crown jewels of the TSPA-SR documentation, and of course beauty is in the eye of the beholder. There may be some disagreement there, but these documents provide a lot of information that has then been folded into the upper level documents.

Starting with the TSPA-SR document in September of

2000, so almost a year and a half ago, which documented the base case. That was then updated in December of 2000 to incorporate a couple additional features, the long-term climate model and secondary phase effects. And then last summer we completed the Supplemental Science and Performance Analysis document, which yesterday was referred to as the STSPA. We call it the SSPA, but the performance assessment analyses are in Volume 2 of that document set, and Volume 1 is the technical basis for that update. And it's main focus was to incorporate unquantified uncertainties and to update some of the scientific information as well as analyze the difference in the high- and low-temperature operating modes.

The next two boxes on the figure are the documents that I'm going to talk more specifically about today. The first one deals with the final EPA rule and the changes that were brought in for that analysis. And then the second letter report is the one that deals with the final NRC rule and the additional modifications that were made or analyses that were done to address that particular rule.

So moving to the first letter report for the final EPA rule, this was conducted--the analyses in this letter report were conducted with an updated SSPA model. So the model that was developed in the summer of last year was updated to do these analyses. And the analyses considered various waste inventories. This is specifically for the

FEIS, looking at the high temperature operating mode and the low temperature operating mode for the 70,000 metric ton case and then also looking at expanded inventories, so-called Module 1 and Module 2, which I'll describe in a later slide.

We also conducted analyses for igneous activity scenarios, and the igneous activity includes two components, the intrusive condition where it just disrupts the packages and does not erupt and then also the eruptive condition.

And then final analyses in this document are for the human intrusion scenarios, and there are two scenarios there, one scenario where the human intrusion occurs at 30,000 years and one where it occurs at 100 years. And our expected case is the 30,000-year case, and I'll talk a little bit more about that as well.

Next slide, please. The details of the changes in the SSPA TSPA model to produce this model that was used for the EPA analyses. The first thing was making the changes that were specific to the new rule. So incorporating reasonably maximally exposed individual biosphere dose conversion factors instead of the dose conversion factors that were used in the previous analyses, which were for the--somebody help me out--it's a critical member of the group. And then the location of the RMEI was changed from 20 kilometers to 18 kilometers, both for the groundwater release and for the ash deposition, and then also the water demand

was changed from what we had used previously to a 3,000 acre-feet/year average for the individual protection analyses.

Other changes that were brought into this model include things like the waste inventory calculations where we represented the U.S. Navy fuel as commercial spent fuel instead of as high-level waste, which it had been in the TSPA-SR model. Also, the waste package corrosion calculations were assumed to be independent of temperature, which was different than the SSPA. And you'll see that that provides the major difference in the long-term performance.

Additional changes include correcting some errata that were identified. One was in the LTOM, or the low temperature operating mode, case where we had to include radiation connections that were omitted in the original analyses. This didn't have a material significance in the results. And in the human intrusion scenario we incorporated colloidal transport down the borehole, where previously we just had soggy transport. And then a new version of the waste package degradation model was incorporated, which included some additional processes, microbially influenced corrosion and the aging multipliers for inside-out corrosion, corrosion from inside of the package going out.

The bottom line is that the changes were most significant in the waste package area where we eliminate that dependency on the thermal case.

The next slide, which based on what's been said earlier in this meeting and previously, is probably the lightning rod slide for this talk. This is the comparison, high temperature operating mode compared to the low temperature operating mode for the normal case. And what I'm trying to show here is the differences between when you go from the TSPA-SR results--these are mean annual doses, and the TSPA-SR is the black curve--to the SSPA high temperature case, which is the red curve. Obviously performance is much better at later times than it was for the TSPA-SR, but you have an early release because we had early waste package failures.

But then looking at the two additional curves, the blue and the green curves, which are the model that was used for this final evaluation of the final EPA rule, and the difference there between the HTOM and LTOM is insignificant, and so some of the cases that were done in this letter report were just run with the HTOM rather than doing both the cases. The long waste package lifetime diminishes the effect of this early thermal period.

The next slide, as I mentioned, is specific for the FEIS and deals with looking at some additional inventories. The black curve shows the base case 70,000 metric ton inventory, and then we ran an additional case called "Module 1" which incorporated additional commercial spent fuel, so

going from what was in the original inventory up to 105,000 metric tons of commercial spent fuel. The DOE spent fuel was kept the same at 2,500 metric tons, but the high-level waste also was increased from 4,500 to 11,500 metric tons.

And the case of so-called "Module 2" we ran just by itself, so that was some additional waste greater than Class C and Special Performance Assessment Required waste. And that waste has a higher C-14 inventory in the GTCC, and that's what gives you that early rise that's above the Module 1 releases.

The next slide deals with the igneous activity scenario results, comparing the TSPA-SR case with this new model that was developed for the final EPA rule. It's been updated for the 40 CFR 197. You know, the two main things according to the rule were the change in the location and the BDCF's were updated, and then the other features that talked about previously.

The early dose is greater in this case than the TSPA-SR, but it decreases at later time. And the increase at early time, as the figure notes, it's primarily the eruptive dose at early time, and there are several things that changed in the eruption scenario: the BDCF's increased by a factor of 2.5; the wind speed went up by a factor of 2; the vent probability also went up by a factor of 2; and the number of eruptive conduits also increased by a factor of 2. So that's

what gives you the rise above the TSPA-SR nominal case. And at late times the dose is primarily from the intrusive part of the igneous scenario. And those humps in the new model are due to the fact that we've incorporated that long-term climate model.

The next slide talks about the analyses of the human intrusion scenario, and as I mentioned, we did it for two different time periods. This considers a release through a borehole that is drilled through the waste package all the way down to the saturated zone, and it's done at a time in the first case where the waste package is not recognized by the driller. So there's a big enough hole in the waste package due to degradation of the waste package that the driller does not recognize it, and that's our expected case. And then the bottom plot shows the results for case where the human intrusion occurs at 100 years, which was what was in the proposed NRC rule. That has since been changed, but the doses are similar. They're a little bit higher in the 100-year human intrusion case simply because of some of the radionuclides have not decayed yet. This obviously is a stylized scenario pretty highly specified in the rule.

The next portion of the talk is dealing with the second letter report, which is reporting on the final NRC rule and the impacts of that on our analyses. It has three major components.

The first one is the groundwater protection standard evaluation utilizing an unlikely igneous intrusion scenario, so what's the effect on groundwater protection when you have an igneous intrusion and the analyses are done for both HTOM and LTOM and calculating total radium concentration, gross alpha concentration and the dose to the critical organs.

The second component is dealing with the individual protection standard for a human intrusion event considering an unlikely igneous intrusion. And this case is brought on partly because of the lack of a definition of "unlikely" in the rule, so we--I don't want to say "concocted," but we developed a scenario that said, okay, here's an igneous intrusion and right after that you can have a human intrusion because the igneous intrusion has disrupted the packages enough so that the driller doesn't recognize it.

And then the third component is just looking at what the effect of using the 3,000 acre-feet per year water demand for the individual protection standard impact is versus what we were using in the TSPA-SR.

The next slide is just to set the stage a little bit for the unlikely events evaluation. As I mentioned, unlikely FEPs were not defined in 10 CFR Part 63. We, however, believe that a definition of "unlikely" was expected to be between 10^{-8} and 10^{-4} per year at the time of the

analyses last fall. And so that's the red zone in there on the figure. Just for reference, the mean annual probability of the igneous intrusion at the potential repository is unlikely at $1.6x10^{-8}$ per year. Human intrusion also is considered to be very unlikely. Thus, you know, one of the reasons for having this stylized human intrusion scenario.

The next slide presents the results for the groundwater protection standard evaluation, which incorporates the igneous intrusion. This disrupts some waste packages early in the simulations, leading to release to the unsaturated zone and out to the groundwater. The results for the calculated total radium concentrations are orders of magnitude lower than the background value. The background value is 1.04 pCi/l, and that's shown in the red curve. And the delay in release is just due to the transport of the radionuclides through the natural system, the retardation of those elements. The calculated gross alpha concentrations are approximately 10 percent of backgrounds, and the background is .4 pCi/l for the first 10,000 years.

The next slide was something that was asked about, asked that we talk specifically about, and this is about the human intrusion after an igneous event, what's the logic for that. And as I said previously, our base case, the expected human intrusion case, is that the human intrusion won't occur until 30,000 years after closure, because that's when the

waste package would be degraded enough that the driller wouldn't recognize it. But for the particular analysis for this letter report, we assumed and igneous event occurs that compromises the waste packages and then the driller would not recognize the waste package as he was going through it. And the consequences for this chain of events is determined by multiplying the conditional dose, the probability of the initiating igneous intrusion, and the probability of the driller not detecting the waste package, and in this case we assumed that the driller would not detect the waste package.

So the next slide shows the calculation. Basically, we assumed that the igneous intrusion probability occurs sometime prior to 30,000 years, and that probability is 4.8×10^{-4}. The human intrusion at 100 years post-closure is assumed to occur then, and the maximum mean dose for that particular case is 4.8×10^{-3} mrem/year. So the approximate maximum mean dose for this case is 2.3×10^{-5} mrem/year. And this is significantly lower than the maximum mean dose due to the igneous intrusion alone simply because you're linking up unlikely events and the probabilities are reducing that consequence.

The next slide just goes through the analysis that was done to say what's the effect of using 3,000 acre-feet per year water demand on individual protection as opposed to what we used in the SSPA and the TSPA-SR models. Previously

we used approximately 2,000 acre-feet per year with a range of 887 to 3,367 acre-feet per year, and this is based on 15 to 25 farms' water usage. The final rule did specify, though, that we should use 3,000, so the result was simply to scale the dose to the RMEI by approximately 2/3, leading to peak mean annual dose reduction from 1.7×10^{-8} mrem/year to 1.1×10^{-5} mrem/year.

So in summary, we conducted additional analyses to evaluate the effect of the final EPA and NRC rules. These analyses are documented in two letter reports, and the letter reports were released last fall and then they were included in the Supplemental Public Hearings that were held statewide in December. And the analyses supplement the other TSPA analyses that were conducted for the SR, so they have to be viewed as part of the package of SR analyses if you remember the TSPA-SR documentation suite figure that I showed at the beginning.

Another point to make is I recognize that the results that I've presented have been in means and I know there's a big issue about uncertainties, and I have figures which show the ranges for some of these, but for comparison purposes on the plots, in order to get several individual cases, I've just shown the one curve rather than showing the whole spread of the analyses.

So that concludes my presentation. I'm willing to

answer any questions that I can.

DR. COHON: Thank you.

DR. KNOPMAN: Knopman, Board. Is this on?

DR. COHON: No.

UNIDENTIFIED SPEAKER: There's a switch on the top of the microphone.

DR. KNOPMAN: No. Knopman, Board. No?

UNIDENTIFIED SPEAKER: Okay, no questions.

DR. COHON: Let me start while they're bringing you a microphone. Could we go to Slide 8? I know we're going to drive you crazy. These were the scenarios where you looked at additional fuel loads to the repository.

MR. MCNEISH: Yes.

DR. COHON: Where did you put them physically in the repository? Did you expand the repository footprint?

MR. MCNEISH: Yes, yes. The report has the layout that shows the expanded footprint.

DR. COHON: Is it possible to characterize that verbally without showing us a map as to what they'll look like? Did it go north into the high hydraulic radian area?

MR. MCNEISH: I believe all of the extension was to the south, yes. Let me see.

DR. COHON: Is the database available for that part of the data available before this expanded repository comparable to the data available for the provisional footprint, the

smaller footprint?

MR. MCNEISH: No. And we had to make some adjustments in terms of how we hooked it into the UZ and into the SZ because of that. But we believe that the effect on the overall performance was not significant, you know, by that sort of abstraction that we did to move the releases through the UZ and the SZ.

DR. COHON: Are you live?

DR. KNOPMAN: I'm live.

DR. COHON: Debra.

DR. KNOPMAN: I'm alive. Okay, Slide 13, I just want to make sure I understand what you've done here with this scenario. Would you just restate what has happened to all the waste packages, what percentage of waste packages have been degraded and what constitutes degradation of--disruption of waste packages for these results here?

MR. MCNEISH: This is for the igneous intrusion, so the intrusive event came into the repository and disrupted a small number of packages.

DR. KNOPMAN: How small? How many?

MR. MCNEISH: I believe it's on the order of 10. Is that right, Peter? No. Peter Swift can give you the actual numbers.

MR. SWIFT: Peter Swift, Bechtel SAID and Sandia National Labs. Fort his calculation the assumption was made

that an igneous dike intruded the repository and crossed several drifts. This is a mean, so it's a mean of many different intrusions and many different numbers of drifts crossed. The answer is about 200 packages were assumed to be sufficiently damaged they provided no further protection to the waste, i.e. they were essentially removed and we had bare waste exposed to water flow.

DR. COHON: While the mike is shifting, is the vertical axis probability weighted?

MR. MCNEISH: Yes. Yes.

DR. COHON: Why doesn't it say "probability weighted"?

MR. MCNEISH: I don't know.

DR. COHON: It absolutely should. I mean for the record, I just think that is inexcusable. If it really is probability weighted and it didn't say it, it is at best misleading.

Debra, continue.

DR. KNOPMAN: Yes, okay. Let me just keep going on this. I hadn't even realized that it was probability weighted. But whether it is or not, then it represents the natural system, it represents a dose, then, that's coming from this failure scenario of roughly 200 waste packages; is that correct?

MR. MCNEISH: Yes, for these particular radionuclides.

DR. KNOPMAN: Okay. So it's something of a surrogate

for just the natural barriers, right, for that? Which is something we haven't quite seen in this form before, at least I don't recall it with that many waste packages out. Let me try to understand a little bit more now. When the waste packages have failed, what about the invert, has that failed?

MR. MCNEISH: No.

DR. KNOPMAN: So you still have your same assumptions about diffusion through the invert? Okay.

MR. MCNEISH: Right.

DR. KNOPMAN: All right.

MR. MCNEISH: And through the UZ and--

DR. KNOPMAN: And through the--okay.

DR. COHON: Dan Bullen.

DR. BULLEN: Bullen, Board. Could we go to Slide 5? A couple quick questions on this one, Jerry. The second bullet, which says the wastes inventory calculations removed the navy fuel from the Defense spent nuclear fuel inventory and represented it as civilian spent nuclear fuel, when you did that, did you have the same release rate from the waste form or did you incorporate the release rate that you used for the Navy fuel in that?

MR. MCNEISH: We kept the same release rate that we use for commercial. We did not create a separate Navy fuel category.

DR. BULLEN: So you just bumped the inventory a bit?

MR. MCNEISH: Right.

DR. BULLEN: But assumed that the same release rates occurred?

MR. MCNEISH: That's right.

DR. BULLEN: Which is actually conservative because the release rates would be significantly less. Okay.

MR. MCNEISH: Right.

DR. BULLEN: The next bullet says, "The waste package corrosion calculations assumed general corrosion independent of temperature," but what we saw yesterday from Mark Peters was that it's not. So why did you do that?

MR. MCNEISH: We did that because at the time we did it the defensibility of the temperature dependent case had been called into question, and so we backed off of that and got the case back more like the TSPA-SR case as opposed to the SSPA case, which incorporated the temperature dependency.

DR. BULLEN: Okay, but I guess the question that follows there is that basically what we saw from Mark Peters yesterday the low-temperature operating mode would actually have a better performance if the waste package degradation module reflected the data that were shown. Are you updating the model, is it being incorporated? I guess how are you addressing the temperature dependence of the waste package corrosion?

MR. MCNEISH: Well, for this--

DR. BULLEN: For this one you didn't do it because--

MR. MCNEISH: --suite of documents we didn't.

DR. BULLEN: Right.

MR. MCNEISH: Obviously going forward, you know, there's a whole phase of analyses that will be done for investigating the LTOM. I mean it's a separate work package that's going on right now. And, you know, when those analyses are finished, then we will update our TSPA model accordingly.

DR. BULLEN: Okay, could we go to Figure 7?

MR. MCNEISH: And I believe that will provide more defensibility for that temperature dependency than we were able to claim from the SSPA.

DR. BULLEN: That actually leads into this question because if you had HTOM corrosion rates and the data that Mark Peters showed yesterday said that the HTOM corrosion rates were actually higher, higher temperature corrosion rates are higher than the lower temperature corrosion rates, is the HTOM then overly conservative? I mean you would expect based on the assumptions that you had previously that the waste packages would last longer at higher temperatures, and they may indeed not. So is that--I mean it's an overly aggressive, I guess, assumption as opposed to a conservative assumption?

MR. MCNEISH: Right.

DR. BULLEN: Okay. Well, I was just very interested in

seeing the incorporation of the temperature dependencies in future TSPA's. Thank you, Jerry.

MR. MCNEISH: Yes, I mean it's obviously a lot of interest in--you know, the model has several features which are dependent on temperature. You know, the waste package is not the only thing, but at the present time in these analyses, you know, we took that out, yes.

DR. COHON: Alberto Sagüés.

DR. SAGÜÉS: Yes, this is in this same slide. Two issues. Even if you don't enter the temperature dependence of the uniform corrosion rate, which by the way it may not make such a big difference because that acts on a small period of time at the beginning, when the temperatures are very different, and if you integrate a very little rate as shown in the previous calculations when they have the temperature dependence but still that didn't show a tremendous difference. My concern is the following: forget about the variation of the uniform rate, how about the greater risk of, say, localized corrosion that could exist when you go to higher temperatures. Your models don't acknowledge that one way or the other. You could have high temperature, you could have low temperature, but since your models don't include any temperature effects on imposition of localized corrosion, then the result is transparent to that. But there is a risk. Any corrosion engineer will tell you

that some thing when you boil something for 1,000 years that wouldn't happen otherwise. And right now you're not--you're just simply not quantitatively introducing that because you don't have enough knowledge to put that quantitatively. But that common sense engineering issue is there and that could send your blue curve way, way up during the first 10,000 years. But that cannot happen in the way TSPA is wired.

MR. MCNEISH: That's correct. I don't know if there's anybody here from Waste Package that wants to comment on that. But you're right. I mean for the current model, it's not included.

DR. SAGÜÉS: One final issue. The other thing is the spike for the blue and the green curve that happens at 50,000 years, approximately, that comes from the knowledge of the assumptions about what the uniform corrosion rates are. You have the 2 centimeters a corrosion rate of about a quarter of a micrometer per year. That takes you about 80,000 years or so before you start cutting through the 2 centimeters along 22 in the package. But again, any corrosion engineer who has done any testing on curves will tell you variations of a factor of 2 are very, very common. You have two side by side curves, one of them corrodes twice as fast as the other, and this lasts a few years, or maybe a decade or so. How can we possibly say or have any confidence that over, say, 80,000 years those corrosion rates have--are not going to sink by a

factor of 10, maybe in the high direction? And that will move that spike dangerously close to the 10,000 years, maybe into the 10,000 years. I mean that is the concern that we have had over and over and over, and I just cannot get it resolved.

MR. MCNEISH: Yes, well, again, these are mean annual doses, so there is a spread in that. I don't know that it comes back into the 10,000-year time period, but there's definitely a spread in those--you know, that initiation time.

DR. SAGÜÉS: Sure, there's the spread over the short-term corrosion tests, you know, you have those variations in corrosional rates, you get an S curve with that kind of stuff. But now the problem is that now we are trying to extrapolate that into huge, huge amount of time. And that is not recognized there, I'm sorry, about the time.

DR. COHON: No. But Alberto, he's saying that what he's showing you are only the mean curves for what you've seen before, the horsetail diagrams. Whether the range of the horsetail diagrams is as broad as you think it should be, that's another question. But his point is he's just showing the mean and he emphasized that when he was making his presentation.

But you didn't see the last set of questions from me about uncertainty. Can we go to Slide 9? In what sense are these mean annual doses? I understand the probability

weighted part of this, but are the mean annual dose in the same sense the other ones were for Alberto's question?

MR. MCNEISH: Right there's--

DR. COHON: Okay.

MR. MCNEISH: They're spread around these curves.

DR. COHON: The quantification uncertainty, as you know and everybody associated with the program knows, is something that this Board has been very adamant about. For me and for the Board as well, the communication of uncertainty is also very important. It is to your credit that you now say "probability-weighted". That's good. But if you're trying to communicate to someone other than the Board or a few relatively small other number of people, it is totally obscure as to what that means. I think at the very least, if you present a slide like this, you need to put a big note on the bottom that says, "Those doses are the result of multiplying nominal dose by," whatever the number is, "$1.6x10^{-8}$," or whatever the appropriate number is, so that at the very least the knowledgeable reader can back out from that what I'll call the conditional dose that is the dose unweighted if the intrusion happen. Otherwise--

MR. MCNEISH: That's a good comment.

DR. COHON: --what makes me so annoyed is it's a comment that's been made over and over again and it's completely ignored time and time again. I've decided the next time we

see a presentation like this I will interrupt and make this point again. And I'm going to be even ruder than I'm being now.

MR. MCNEISH: Well, I--

DR. COHON: Can we go to Slide 10?

MR. MCNEISH: --I have the slides, if you'd like to look at the spreads, for--

DR. COHON: No, I don't want to see the spreads. This is about your communication.

MR. MCNEISH: Well, I also have--

DR. COHON: This is about your communication that you're supposed to be communicating to--communication to people that supposedly you care about communicating with. That does not show an attempt to communicate in a meaningful way. That shows an attempt to obscure information.

Can we go to Slide 10? Why does this say "Annual Dose"? What does that mean? Why doesn't it say "Mean Annual Dose," or something else? In this case it's because we're showing all of the horsetail?

MR. MCNEISH: Right.

DR. COHON: Now, what about probability weighting in this case? Were these probability weighted?

MR. MCNEISH: No.

DR. COHON: Okay. Thank you very much. That ends our session. We'll now take a break for 13 minutes. We will

reconvene at 10:25.

(Whereupon, a recess was taken.)

DR. COHON: We continue now with Bill Boyle and Peter Swift, and I promise that I won't yell again, at least not at you. Maybe.

MR. BOYLE: Well, I'll wait while they straighten out the image there, but I was asked by some people to come back to this last discussion. Not the labeling of the Y axis, that will come up again in my talk as well, but the one about the temperature dependency. And I'm comfortable discussing it because Kevin and I as part of the unquantified uncertainties tasks that preceded the SSPA and eventually became part of the SSPA, we asked people to incorporate as many temperature dependencies as they could. And with respect to that corrosion rate, the waste package people created one. And then when it was propagated through and the results, as Jerry showed, some people raised an issue of, well, what was the technical basis, how firm is it, is it real, look how much it moved. So as an alternative analysis, we took it out, and it's actually a more conservative calculation and that's the one used in the FEIS calculation. And it's more conservative in my layman's terms in that although the corrosion rate is higher at the hotter temperatures, it's also lower at the cooler temperatures where we spend 99 point whatever percent of the time. So I

just wanted to get that across that as we now have the calculation it has a more conservative representation.

DR. BULLEN: Bullen, Board. Just to follow under that, Bill, the assumption that it's higher at higher temperature and lower at cooler temperatures later is predicated on the fact that it's also dry?

MR. BOYLE: I'd have to ask the waste package people.

DR. BULLEN: Because if it's wet, all bets are off.

MR. BOYLE: Yeah.

DR. BULLEN: If it's hot and wet, I disagree. That's why I don't think it's conservative. And we don't need to do this in public meeting, I'll argue it later on a side bet.

MR. BOYLE: Okay.

DR. BULLEN: But it just strikes me that that may not be conservative.

MR. BOYLE: Okay. Good enough. Now we'll switch to this talk. Good morning, thank you. Peter and I are here to discuss uncertainties. I'm going to focus, as you see, on an existing report. The report is, you know, part of an ongoing effort. I mentioned the unquantified uncertainties effort that was discussed at the meeting a year ago and that was followed by the SSPA. I believe this report is available on our web site. I think you might have to go to the "What's New" portion of our www.ymp.gov, but it is there. It represents the work of many people, and as usual I like to

acknowledge and thank them.

For those that haven't seen it, I brought a hard copy here. It is a Bechtel SAIC report, their logo up here (indicating), on the front page. If you go to the third page in, you'll see the two people's names who had to sign off on the report, Jerry McNeish as the responsible manager within the BSC, and the report would have never been published without the efforts of Jerry, but also Jerry also signed for Kevin Coppersmith because Kevin wasn't in Las Vegas the day it was printed, and the report represents great effort on the part of Kevin. But there were also others involved in the report, specifically in Section 2, Jerry had a significant role as an author and synthesizing and integrating input from various process model leads on the current state of uncertainties.

Chapter 3 represents the efforts largely of Kevin with some input in a specific section by Robert Youngs of Geomatrix. But also Section 3 was the subject of quite thorough review within the project and benefitted from many intense discussions and the comments by Peter Swift and Bob Andrews.

And Section 4, the section on communications, was written by Karen Jenny and Tim Neiman of Geomatrix. Karen can't be here today, she has a longstanding commitment to another client, but Tim Neiman's here, and if there's any

questions on the communication part, Tim can help with the answers.

I would like to thank the Board for in their letter of last week acknowledging that the SSPA and the uncertainties report, in part prepared by the same people as part of the same effort, is a step in the right direction, and we appreciate those reports. And at the ACNW we're still here, and I would thank Dr. Garrick for a similar mention of a step in the right direction.

This "Overview" slide, I'm going to deal with the first bullet, Peter will deal with the second bullet, and that second bullet should be the title of his presentation.

Next slide. What I intend to do in this presentation is just go through the content of the report. Section 1 is the introduction, that's the title of it in the report. And on page 2 of that section, down at the bottom of the page are three enumerated goals of the report, and they're distilled as those three dashes right there.

Section 2 of the report summarizes and discusses what has been done to evaluate, clarify and improve the representation of uncertainty in the Total System Performance Assessment. Section 3 discusses the strategy for how to handle uncertainties and propose some improvements for the future. And Section 4 discusses issues related to communication of uncertainties and proposes some improvements

for the future.

Next slide.

That's the title of Section 2 in the report, "Evaluation of Uncertainty Treatment in TSPA-SR and the Significance of Uncertainties". I won't go in great detail in every item, every entry on pages 4 to 9, we don't have enough time for that. But what I want to get across is this table, at least the left most 4/5 of it, the left most four columns, is simply Table 2-2 of the report. It's on pages 30 and 31 in Section 2.3. And this is the part of the report where the process modelers were essentially asked, "Given the stage where we're at in this national decision point, how can you sleep at night with the uncertainties that remain with respect to your model?" And process modelers responded to Jerry and Jerry had to synthesize that and get it all into a coherent form in the report. And in the report it's the left most four columns, which deal with, you know, what component of the analysis is it, what are the uncertainties related to that component, what's the perceived significance of the risk, and what's the possible treatment in analysis. You know, setting aside that we could also address the uncertainty through design, through further testing. The column just deal with, well, how could we do it through analysis.

Now what's represented as the fifth column now,

that came as a request from people back at headquarters to capture, you know, the impacts of the remaining uncertainties. It is captured in the report, but it's captured as text, but there was a request to get it all in one table. So in the report you only see the first four columns, but there is text that describes what is captured here as the fifth column, but here I decided not to show the table from the report but the expanded one with the fifth column.

In my words--and it was captured in the transmittal letter that went to the Board that transmitted the uncertainty analysis report--we got two common answers from the principal investigators of why they could sleep at night with respect to the remaining uncertainties. One common answer is, "Well, the uncertainty really doesn't matter," that they're fully aware of the uncertainty, but when they incorporate it in their models, it doesn't change the answer that month. The second common answer is, "Yes, we're fully aware of the uncertainty, but for now we've decided to bound it conservatively. I know that the performance is probably better than I'm actually showing, and therefore I can sleep at night."

So with that, can you go to--question?

DR. NELSON: Nelson, Board. Can you tell me what exactly Column 3 refers to? Significance of risk regarding

what?

MR. BOYLE: How much it might change the Total System Performance results, you know, given that we don't have the complete answer here.

DR. NELSON: So it's totally focused on TSPA results in the regulatory period?

MR. BOYLE: Probably, yes.

DR. COHON: But just to nail this down, presuming its mean dose? Suppose something were contributed to the--

MR. BOYLE: Right, the spread.

DR. COHON: --spread but no impact at all on the mean--

MR. BOYLE: Right. Right, right.

DR. COHON: --how would that be--it wouldn't be captured by that, would it?

MR. BOYLE: Well, given that the spread would eventually effect the mean, particularly on our log logged plots, it would start to drag the mean out. But odds are people most commonly probably think of the mean result. So that would--I don't know the exact instruction given to the investigators, but it probably is with respect to the mean.

Slide 10. I'm jumping up to Section 3 right now, and that's the title of Section 3, "Strategy for Future Treatment of Uncertainties". Only has two sections in Section 3. Section 3.1 is a compilation of the comments various groups have made about the treatment of uncertainty

starting with the two regulatory agencies, the EPA and the NRC, and what they said in their rulemakings. And there's a long discussion of "reasonable expectation". But that section also compiled and synthesized the core comments from the Board, from the Advisory Committee on Nuclear Waste, from the Review Panel, the NEAI Review Panel, and other panels.

And based upon a synthesis of those comments, in Section 3.2 a possible strategy was put forth on how to treat uncertainties in the future. And these eight bullets on the next two pages, 10 and 11, are the bolded subtitle headings in Section 3.2 for the eight steps or elements of a possible strategy.

The first one is, is "Develop a general framework for uncertainty framework. That is, develop a TSPA that meets the intent of 'reasonable expectation,'" which is in both regulations, word for word the same.

Secondly, "Quantify uncertainties in the inputs."

Thirdly, "Identify processes that encourage the quantification of uncertainties and gain concurrence on whatever approaches were used with the Nuclear Regulatory Commission."

Fourth, "Provide the technical basis for all uncertainty treatment."

Next page.

Fifth, "Address conceptual model uncertainty."

Six, "Develop a consistent set of definitions and methods for 'bounds' and 'conservative' estimates."

Seventh, "Develop and communicate information that can be used by decision-makers." And I'll deal with that a little bit more in this talk.

And lastly, "Develop detailed guidance and provide for its implementation." And that's what Peter will talk about.

Now, there is that Y axis again, and it should be labeled as "Probability Weighted Dose". And there's no reason why we couldn't do that on this chart, and John could have done it in real time, but it wouldn't have changed the handouts. But with respect to getting across to people the true nature of the plot, the subtitle that goes with this figure and the others is about a paragraph long, and it already exists, but it wasn't put with this figure because it takes up so much space. But it does go into all that detail that was requested in terms of explaining that it's a probability weighted dose. It's just that in trying to get a bigger graphic on the page it was deleted. And not only does that explanation exist as the subtitle, it exists as text separately.

Now, for those of you that have read this report, you'll say, "Well, where did that figure come from?" because it's not in the report. And what I'm trying to get across in

these next three slides of this presentation is that Section 4 contains some recommendations on how to communicate uncertainties to different groups. And what I'm trying to do here is show some examples based upon the recommendations in that report.

Remember, back in September Dr. Knopman commented on the Preliminary Site Suitability Evaluation and the paucity of discussion of uncertainty. So based upon that comment, the request came that, well, if we were to modify the PSSE based upon that comment and the recommendations in Section 4 of the report, what might we produce. So a number of figures have been produced and additional text has been generated, you know, for inclusion in future documents or modification as documents, such as the PSSE. And I'm showing some examples here.

But I've got to give some cautions. If you remember the PSSE, Preliminary Site Suitability Evaluation, a lot of the discussion focused in on the first 10,000 years. You know, that's the regulatory period. And so in keeping with that constraint, these figures similarly focus, and the discussion focuses in on the same 10,000 years, notwithstanding that this one goes out to 100,000 years. But I'm violating with this figure one of my own general rules, I don't like to start with the igneous results. And, you know, it represents a very low probability event. I'd much rather

show the nominal results, something that is much more likely to occur. And I'll get back to the specifics of this occurrence in a second.

But with respect to communicating about uncertainties in the first 10,000 years, there's not as much to say with respect to the nominal case other than the doses are small. In the TSPA-SR they're all 0, and it's awful hard to generate a cumulative distribution function, you know, where all the values are just 0. So this figure in contrast does lend itself well to, you know, particularly graphical representations.

But as Dr. Cohon brought up, Chairman Cohon, you know, that this should be labeled as probability-weighted, which is an issue in and of itself how you do that. But the other thing I want to bring up to people, if you really go into the details of this calculation, this igneous calculation, it's a remarkably persistent volcano. It occurs every realization, all 5,000 of them, every time step. And we do it that way in order to gain insight into, well, what if volcanism does occur, but it doesn't represent any sort of geologic sense. You know, there is no volcano that's going to be that persistent. You know, it's just a mathematical tool that we're using to gain insight and it's a calculation we have to do. I would have preferred to show the nominal results, but they don't show much in the first 10,000 years.

And there is a discussion, you know, I mentioned that we were asked to provide figures and words for if we were to make additions to the PSSE, and frequently for the nominal case the discussion of uncertainty is in words rather than figures.

DR. COHON: Bill?

MR. BOYLE: Yes?

DR. COHON: I'm sorry to interrupt, but I think it's valuable since we're here--

MR. BOYLE: Okay.

DR. COHON: --at this moment. A phrase that was used yesterday with Dr. Garrick was the notion of risk-informed decision-making. And being risk-informed in a situation like this, I believe, means that decision-makers should understand that there is a very low probability event with a very high consequence. Do your best to explain just what a probability of 10^{-8} means so they can embody that. But ultimately it's up to decision-makers, not you, not Jerry McNeish, not anybody else in the program, to decide whether or not that low probability, high-consequence event has a low enough probability to proceed or not. However you qualify it, presenting it this way does not inform decision-makers about the risk.

MR. BOYLE: Okay.

DR. COHON: It obscures the risk.

MR. BOYLE: Okay, and I understand the point and I've already--I don't like this figure, either, but I will bring up an alternative way--well, first of all, I'll back up even more. We do show the doses in the SSPA unweighted. You know, they are available if anybody wants to look at them, although they're not shown here. That's one thing.

The other thing is, is there is an alternative way to do this calculation. Instead of assuming that the volcanism occurs every realization, every time step, we could make it part of the Monte Carlo simulation. The problem is it happens so infrequently when it finally does happen, whichever realization, whichever time step, it's happening with another--with a vector of parameters that are unique for that calculation. And that's why I still think this figure is helpful but perhaps it shouldn't be the only figure. And as with respect to the other figures, they are in the SSPA.

Now, one point that came up in Section 4 is there are different groups with different levels of ability and understanding uncertainty, and so you should perhaps present it in different ways. This is the most complicated full presentation. And what I mean by that is it shows all the horsetails, the main, the median, 95th and 5th percentile.

The next slide shows essentially the same results but remove the horsetails and they cloud the issue and it shades between the 5th and 95th percentile of this

calculation, which is a conditional calculation. Again, it's for that very persistent volcano. But to get across that, well, if we were to have volcanism, the answer might lie somewhere in that gray band. Again, probability weighted.

Now, this last slide with respect to the graphics, this has to do with the specific recommendation in Chapter 4. For those people that are comfortable with cumulative distribution functions as shown on the top or histograms or probability density functions, show them, show them same scale, one on top of the other. And that's been done here for the Slide 12. What was done is at the time of the peak mean dose, which I think is at 312 1/2 years, we looked at what was the value of each of the 5,000 realizations in the horsetail and we created a CDF at the top, PDF, or histogram, at the bottom. And that's why the curve is so smooth, it's based upon 5,000 data points. It's not a fitted plot, it's just that you don't plot them all.

And I personally am comfortable with these plots and I think they're quite informative. The bottom histogram, because of it's logarithmic scale and the hint of bell-shaped curve might lead you to believe that perhaps it's log uniform or something like that. The CDF, just its very shape communicates a lot of information to people. My background in geology and civil engineering, whenever I see a cumulative distribution function I think of grain-sized distributions

for soils. Just looking at that, while we're not dealing with a clay or a well-sorted beach sand, it's more like a glacial till with grain sizes from car-sized boulders all the way down to clay because of the large spread on the X axis.

So, next slide. At this point I came across this quote by Charles Darwin. And I don't know, I've never read his "Life and Letters", got this out of a book of quotes, but I found it appropriate and relevant to TSPA. First of all, because it is by Darwin and, you know, we associate evolution with him, and our TSPA has evolved through the years, you know, VA, TSPA-SR, SSPA. Hopefully not by random mutation and natural selection, although perhaps by--it does represent survival of the fittest, one would hope that the more fit models are propagated, but I think it represents more not random mutation but genetic engineering by Peter and Bob and Jerry with quite specific changes made.

Also, I think it's relevant in that it speaks about a future, and TSPA does calculate for the future. But it also mentions conflicting vague probabilities and having to make judgments in the face of them, which that's a situation we're faced with. And Peter will talk about how to implement a method to perhaps make these less conflicting and vague.

Now, two weeks ago I would have stopped my talk right here, but two weeks ago tomorrow I attended a meeting that I think is relevant to this issue. I attended a meeting

of the National Academy of Sciences Committee on Geological and Geotechnical Engineering. It was their inaugural meeting and a discussion ensued that was quite similar to the exchange that Dr. Bullen had with Dr. Garrick about Dr. Garrick's conversation with Chairman Meserve, and it has to do with conservatisms and bounding versus realistic and risk-informed.

At this meeting of the National Academy of Science Committee, a discussion ensued that really wasn't about Yucca Mountain, and it had to do with there were apparently--engineers can be put in one of two groups, decision-makers and owners. One group likes things conservative, bounded, simplified, and the other group likes risk-informed, probablistic, realistic. And the discussion was, although at times it's perhaps amusing, it's generally frustrating when the two different groups have to deal with each other. And that is true within the project as well, Yucca Mountain Project. And people have asked me, is the division in the project, you know, split along the lines of government versus contractor, and the answer is no. Dr. Bullen is shaking his head no, and I agree. It's a much more fundamental split, which is what was evident at the meeting two weeks ago. So it's not an issue that's just parochial to Yucca Mountain.

And for those of you that don't follow this, well, I'll try--you know, the two fundamental approaches are, you

know, there's a group that believes let's just bound it conservatively, it's faster, cheaper, and in my words the exchange between Chairman Meserve and Dr. Garrick is--and they complied--what's the problem, you know, well how could people object to it? On the other hand, there's the well-documented comments by the NEAIEA, the Board, the ACNW as to the alternative approach, which gets at "Well, are you sure about your calculation? Well, how well do you understand it and what confidence do you have in your calculation?"

Now this issue isn't going away for the project. In the last few months, as recently as last week, I hear that as we approach licensing those people that prefer the conservative approach believe that it's all the more appropriate for licensing. On the other hand, I believe we heard Dr. Garrick say last night that as an agency the NRC five or six years ago switched to risk-informed performance base. So we need a path forward between these two approaches.

Now in the extreme, the bounding approach can be viewed as some unyielding lock. It doesn't yield information, it doesn't yield insight, it just is. On the other hand, in the extreme, the risk-informed approach can be viewed as this giant whirlpool that just sucks in time and money and you never come to resolution. So with this image of charting the course between a rock and a whirlpool, it

brings Scilla and Charybdis to mind, and Odysseus, having to chart a course safely between these to obstacles. And for today Peter Swift will be our Odysseus and he will explain that course.

What I want to bring across is Odysseus did get through, and he did so by shying away from Charybdis, the whirlpool, and going more toward Scylla, the rock. And in doing so, although he made it through safely, some of his crew members were snatched right off the boat. So I have now displayed my bias, which camp I'm in, you know, it's I'm from the probablistic, realistic side.

But with that, I'll turn it over to Peter.

UNIDENTIFIED SPEAKER: Jerry, can we ask questions now?

DR. COHON: No, if we do that, I guarantee you we'll never get to Peter's presentation, because we have a lot to say about this, I'm sure. So let's continue on, and I'll be as liberal as I can in giving the rest of you time.

MR. SWIFT: Bill, first of all, thank you for the Odysseus introduction there. I've got to remind you all that the real moral of the Odysseus story was that he was on the road too long. So thank you.

Can I skip on to the next slide here? The first point I want to start with here is just a reminder that trying to deal with this question of how to deal with uncertainties actually comes straight up against conservatism

v. realism, where Bill was. A little summary there that people have come and gone, including this Board, and--you know, I'm going to have to move a little bit so I can see my own slides here, sorry about that.

This bottom bullet here--the top one just lists the people who have offered the comment they'd like to see more realism in the TSPA--my comment down below, these are my words, reviewers in general do not distinguish between the TSPA and the process models that underlie it. This is appropriate. The TSPA is a window that people should use to look through our analyses into the underlying science. And I heard Lake Barrett yesterday describe what I just call the window, described it as a black box. We have a problem here, then. We have a window on one side and a black box on the other. But it is entirely appropriate to, as the Board just did when Jerry was up here, to look at TSPA results and, in this case, the temperature dependent corrosion model wasn't there. It wasn't there because TSPA was tastefully reproducing in that case the process model underlying it and a level of confidence in that process model. But that's a good example of how TSPA worked as a window. You saw something you didn't like, you commented on it.

Go on to the next slide, please. The NRC requirements here. This is interesting, this might be one of the few things that have been shown twice to the Board, and I

won't spend too much time on it. Tim McCartin showed the same slide earlier with two more bullets in it. The point I'm getting at here is that the NRC staff and the rule itself give us pretty clear guidance on this question of realism versus conservatism. I think it's--I come from a performance assessment background and a regulatory background--I'm a geologist, actually--but I do look to the rule first. And what do I see here? I see these two bullets that I've pulled out and quoted down there: "Does not exclude important parameters from assessments simply because they are difficult to precisely quantify." All right, so the answer, if you didn't know, is not an excuse for not having it in the analysis. The other point: "Focuses performance assessments on the full range of defensible and reasonable parameters rather than only on extreme physical situations or parameter values." Two things here. The first word is "focus". It is not "limit exclusively," it's "focus". And the debate that Bill referred to there has to do with how fuzzy or sharp that focus might be. The word "only upon physical extreme parameters," I think the staff meant something when they put that in there. We could ask Tim later. But those two bullets, anyway, are something that I think the project must address. It's a regulatory requirement besides being good science.

Next slide, please.

So the key points that I come up with out of this are that our performance assessment "should be some version of a realistic analysis, rather than a bounding one." There we're headed towards that whirlpool, and off to the rock here, "Pragmatically, some conservatisms will remain, but the project must be clear about where they are, what the basis is for them, and what their impacts are." Further documentation, in other words, explain where and why we were conservative.

"Focus on realistic treatment of uncertainty, which is not the same as a full understanding of realistic performance." They really are different. Those who are looking for a full deterministic proof of a future behavior of the system are going to be frustrated forever. The Board acknowledges this in the letter. But what does it mean pragmatically to me? I believe that simplified models are okay in the TSPA, and in fact you can have a realistic treatment of uncertainty in a relatively simple model with a broad treatment of uncertainty. It's okay as long as you've justified and explained it. The question then is, does that broad uncertainty affect your decision? "Your" not "my". "Your" as in the regulator or the Board, others who are reviewing the project and making decisions.

So how do we do it? Well, "Project scientists and the performance assessment, PA, analysts work together to

incorporate uncertainty in the models and parameter distributions," and "Focus on a clear explanation of what we did." Mathematical models, conceptual model descriptions, and the traceability that has been so hard to maintain.

Next slide, please.

How are we going to implement it? Well, first of all we've got a guidance documentation that is in preparation right now. It's still actually in author review, but it will be at DOE within a few weeks here. There are three points, these next three bullets, the NRC picked up on very firmly in their KTI issue--sorry, key technical issue agreements from the meeting last August on TSPA. They're looking for, everyone is, a consistent treatment of abstractions in TSPA, a consistent treatment of alternative conceptual model uncertainty, and a consistent treatment of parameter uncertainty. And so our plan is to issue guidance in how to address these things and then to implement that through the Analysis Model Reports, the AMR's, to provide the technical basis for the process models and then in turn for the TSPA. And as these are updated for the LA, we'll work these through.

Next slide, please.

Abstractions. The goal is to capture the aspects of process models that are important to system interactions, with the appropriate representations of uncertainty. And

what more can I say here? They have to be developed by subject matter experts. We don't want, for example, the abstraction model for waste package performance developed by a performance assessment analyst, we want it developed by someone who's familiar with waste package performance, an expert in the field, and that is what we've done.

These abstractions have been developed and documented in AMR's in the past, and we observed that various forms of abstractions, there's no unique solution--simplified numerical models, simple functions, response surfaces. At its simplest a simple parameter distribution might capture an entire process model. At its most complex, put the whole process model right into the PA.

A step that we have not done well enough in the past is to have the abstractions reviewed by the PA analysts before documentation is complete in the process area AMR's, make sure the transition is going to work better.

The implementation of the abstraction in the TSPA is done by PA analysts. It's got to be done by people who are familiar with the TSPA model, Jerry McNeish, people who work for him. And here we need to turn around and make sure that is properly reviewed by the process model team. We haven't done a good job of that, either. So that we can have the important situation where someone, a TSPA person, will stand up and present results and the scientists who developed

the underlying data isn't actually sure what they mean because they aren't sure how their results were used. That's not okay. We need to get that linkage fixed. So, basically, proper documentation of abstraction is a matter of review and joint ownership between PA and the process models.

Can I have the next slide, please?

Alternative conceptual models. And here, the process here I think we haven't gone through with any very great--systematicness (sic)? That's not a word. But for each process of interest the subject matter expert working on it should identify alternative conceptual models, if any, that are consistently available information. And "if any" is important there, and so is "consistently available information". I'm not defining alternative conceptual models here to include ones that can be shown not to be consistent. If the data shows this alternative does not fit the information, then it should be screened out at this point, documented, carefully explained, but not carried forward. There's no reason to carry forward models that don't fit the data. And that's quite independent of whether they're conservative or optimistic. The right thing to do is to work with the ones that fit the data.

Then, at the subsystem level, evaluate the impacts of the alternatives that survive that first step. And this, again, is a subject matter expert's job. If the ACM's,

alternative conceptual models, result in the same subsystem performance, then I think we can conclude that that uncertainty is not that important. If, for example, you have two different approaches to seepage and they both deliver the same flux to the drift at the same time, as a PA person, I'm not that worried as to which one we use. I would like to have it documented that both were considered and they gave essentially the same result. If two or more of them do show different subsystem performance, then develop abstractions for both and deliver them to TSPA.

Here's a point where you come to conservatism. Let's say one of them is very difficult to formulate and one of them is straightforward. If you know that and you can pick out a conservative one and save yourself a lot of work at that point, I believe it's an acceptable thing to do. Document it, explain why, go forward.

If you do deliver multiple ACM's to TSPA, TSPA can then evaluate the system-level impact. You know, we've already shown there is some substance to the impact, and that's documented and displayed so that people can evaluate it externally, but what is the system-level impact? And if the impacts are significant, there are two options here. One is to carry multiple alternative conceptual models all the way through to the system-level calculations that are used for the NRC for decision-making on their part. That would

require weighting them. You could assign a 50-50 weight to them, for example, or you could have technical basis for them, you could assign other weights. It's a trick to actually come up with justifiable weights, and people can be rightly criticized for that.

So at that point again an option I believe is to use the conservative one at that point for the system-level information provided to the NRC. But going through this, hopefully at that point you have a good display along the way of what the subsystem impacts were.

Could I have the next slide, please?

Parameter uncertainty. This one is the easiest of them all to address because it's what models are best at. Build a big numerical model, you've got variable parameters. It's very straightforward to track the sensitivity of overall results to uncertainty in input parameters.

But first of all you have to actually catalog. Go through these steps. Identify and categorize what your input parameters are--and I've written this for the TSPA level because that's where I work--but what are the input parameters to TSPA. For the uncertain ones, go back to the NRC guidance. That's our goal, we should do it. And how do you establish uncertainty distributions, that full and reasonable range of distributions? Start with the available data, but you've also got to consider how the parameter is

used in the model. And it is not appropriate simply to take a physical effect or data set and plug it into a model. You don't get good results that way.

Scaling issues, variability, and what's the equation the model's actually using it for. Scaling and variability, take a property like porosity. At a local scale in a rock, porosity varies tremendously one cubic centimeter to the next, or one cubic meter to the next, or whatever. But your model is probably using it at 10's, 100's of cubic meters, or even quite a bit more than that. And your model's probably actually interested in an effective bulk porosity rather than some local variability. So your distribution for TSPA calculation on porosity might actually correctly be smaller, narrower, than the full set of fill data you've got, because they're collected at a very small scale.

So how do you do this? You develop the distribution jointly. The subject matter expert knows the data and the process model, the PA analyst knows how it's going to be used, you can get a statistician in the process to introduce distributions to lead the other two to a distribution that's not introduced various information. Don't go assuming you can fit limited data with a normal or whatever distribution you imagine. Those distributions are probably fairly rare in nature and you're probably better off not fitting limited data with a distribution that you somehow

assume must be right. Instead, linear distributions, connecting the dots. It's crude, but at least it doesn't introduce new information. This step should get documented in the AMR's that document the input parameters to TSPA, and it should document the participation of both subject matter expert and the PA analyst.

And then this is just this last point, implement the parameters in TSPA through a controlled database. This is an internal issue, probably not of great concern to the Board here but is a concern to the NRC. We need to have better control on documenting what actually was used in the TSPA.

Next slide, please. Sorry, I'm running over.

Some summary points here, and these are in part-- well, they're largely my own observations. I use this slide internally in presentations. Some of the wording of it is aimed at an internal audience as much as an external one.

First of all, I don't think that either the regulator, NRC, or reviewers like this Board are asking for the impossible when they ask for something closer to a realistic analysis.

My interpretation, what I believe they, you, the ACNW, others are asking for is a commitment to shift our aim from conservatism to a realistic treatment of uncertainty. At least that's the goal I think we an achieve. I hope

people aren't asking for the full deterministic exact truth of the future of the Mountain, because that is going to be unachievable. But I think we can realistically show you what the uncertainties are, the understanding of it, and how they affect our estimates of performance.

We need to shift our thinking and rhetoric as well as our actual methodology. We have defaulted to conservatism as a justification for an assumption so many times. We ought to actually be documenting for you--for anybody, including ourselves--what the conservatism--why it really was conservative, how constant we were, and what the impacts of it were. So literally a shift in our own thinking, to think instead of "How can I be conservative?" instead "How can I capture my uncertainty in a simple model or simple parameter distribution and have some confidence I really have captured it?"

Our ability to explain the approach is the key. There's no unique solution. Our credibility just comes from our ability to explain and convince, so we've got to do it.

And last point here, the process issues--quality assurance, configuration management, documentation of data/parameter transformations--those are going to be critical because confidence in a regulatory world comes from careful attention to the process as well as the science.

And I'll stop there and I still--

DR. COHON: Thank you very much.

MR. SWIFT: --field questions.

DR. COHON: Okay, I see your--I'm going to go first, though, at least part of my questioning. But I've got Paul, Priscilla, Debra, and I'm sure there'll be more.

First, let me say, as Bill noted in his presentation, the Board commended DOE on the uncertainties report as a move in the right direction. Speaking personally, on behalf of myself, I was delighted by it. I think it was very well done, is one of the best things DOE has produced that I've seen, and it was very significant because it showed the ability of the program to shift in a very significant way and take on really a very different approach to this problem. So personally I congratulate you and you and everybody else involved in this, I think you did a great job. And it's good to see this good hard thinking about now how to implement that.

On that I have a suggestion, or an observation that leads to a suggestion. I like very much, Bill, the way you laid out the choices. I'll let others comment on the classical metaphor. But to me, the key driver, really, is why you're doing it. And if you know why you're doing it, then I think it all falls into place. If your goal is to show compliance, absolutely, use the easiest conservative bounding approach. Why bother with all this other stuff?

If, on the other hand, your goal is to understand the system as well as possible, then the more realistic representation approach that you're advocating and that we've advocated and others have follows directly.

I think it's very important to keep that in mind, the why part of this in mind. Because there will always be a tendency to lapse in the TSPA mode. Well, you know, it didn't show much impact. There are all sorts of ways it can I think skew too much back towards the show compliance approach, which I refer to as the TSPA mode. For example, you've got two models, all right, just weight them. That's not a bad way to proceed, I guess, if you've got to produce a result right now. I would hope that would lead to a determined research program to try to determine, to figure out which model, in fact, is more realistic.

So there are modeling compromises to be made, but it also has to be driven by--and one has to be reminded constantly that you're doing it to create better understanding of the system.

The good news, in my view, and I complimented NRC on this, is that 10 CFR 63 doesn't really give you a choice. I was really pleased to see what their criteria will be. And you've got to come up with realistic representations of uncertainty. And so this is all coming together very nicely, and I commend you, but my key point is, keep in mind and

communicate as clearly and as forcefully as possible to the PI's why they're doing this, not just to satisfy some hoop but because it will result in better understanding.

Paul Craig.

DR. CRAIG: Okay, is this now working? Yes, it seems to be working. Okay, yeah, I think this is one of your more impressive efforts, this approach, and it really is going in the right direction. And what I'd like to encourage you to do is focus in on some of the issues which are actually believed to be particularly important by people who are out there making comments. A generic framework to be useful has to be applied. And let me suggest two areas where it would be particularly useful to focus in.

In the alternative conceptual model area, which is the toughest one by far, one of these has to do with the C-22 and the corrosion characteristics of the C-22. Thus far, as far as I know, you've only used linear extrapolation, how there's some temperature dependence which is coming in, but still it's linear extrapolation of corrosion rates, and there have been other models suggested. Workshops have suggested a number of other possible ways in which the C-22 might corrode. The probability is unknown as to whether these other mechanisms are important. So your challenge from the point of view of your test is really tough.

Nevertheless, these models, these corrosion

mechanisms have been proposed and it is not acceptable to ignore them. One would like to know what would be the consequences for the repository if some of those corrosion mechanisms do in fact play a role.

Another example in talking to Bo Bodvarsson, he believes that the UZ analysis is enormously conservative, and he has a long list of reasons, some of which he laid out here, as to why the UZ analyses are really conservative. And if he's right, then the Mountain might perform superbly well even without an engineered canister. And that, too, is another area where the alternative conceptual mechanisms really impact the way in which one thinks about the Mountain. And it seems to me that the kind of analysis that you're doing should at least recognize in words the implications of this kind of thinking, but it would be better if one could go beyond that and recognize these concerns in some kind of a formal framework so that you can discuss this. And I believe if you did this it would contribute immensely to the credibility of the overall activity.

DR. COHON: Let's see if unlike Paul and me Priscilla Nelson has a question.

DR. NELSON: Well, maybe I do. Nelson, Board. The essence of my comment was at least at the start very much like Jerry's, and it focused on what kind of a tool do you want TSPA to be. Because if it is compliance-focused, the

regulatory period focus you're going to make one set of selections, one set of abstractions, which one of the slides said was the process model aspects important to system interaction. Well, importance gets decided there on some basis, and the systemness (sic) of the system gets decided and what you modeled for interactions gets decided. So there's all sorts of embeddedness throughout this, and if you're making TSPA, which is really focused towards regulatory compliance, you're going to make one set of decisions. And maybe what you're talking about is from the standpoint of reasonable expectation, which to me I could define it as something other than the NRC's satisfaction that compliance will be achieved. There's another way to do this.

But the idea of creating a tool that actually informs the project of changing importances, of ways of incorporating new data that indicate alternative outcomes, alternative ways of doing things, that may be a different kind of a tool than the TSPA that's focused towards regulatory compliance. Have you thought about that at all, the idea of maybe even juggling two frameworks for TSPA?

MR. BOYLE: Yeah, I'll take a crack at that. First in the general sense with respect to your comment and Dr. Cohon's is, you know, in terms of the project deciding which approach it wants to take, I just want to reiterate that, you know, there are these two different views within the project,

and I think the issue here is, which approach are we going to take? Because there are some people that just believe in compliance is perhaps paramount. In others--I'll put myself in the others camp--would question, you know, you're using this number to check compliance, but what confidence do you have in the number?

Now, to your specific question, is can TSPA be used to look at something more than compliance, if you will. There's an ongoing effort. I believe it was referred to yesterday multiple times about looking at the work that we're going to do, this re-plan effort. And some of the criteria that are being used are: well, how does it affect compliance in and of itself? But other criteria are: well, how does it affect our confidence in our models? So both are being used with TSPA as the tool that's to gain insight into, well, how does it affect compliance, how much confidence do we have in that particular model and the TSPA.

DR. NELSON: Nelson, Board. A sense of importance. That's why I asked about risk here in the natural system, in the dominating effect of the waste package. Things don't get examined with the same priority when that waste package is masking everything as it does in a compliance driven TSPA operation. And I think, you know, this gets into Bo's comment, or assertion, about the UZ. Well, that's all fine and dandy, but where is it? I mean why isn't it there? And

you started hitting these extreme events like the volcanism or human intrusion, and there you start short circuiting out the waste package and you start seeing very short travel times that seem extremely surprising and maybe unrealistic but not documented to be or not presented as. So there's a breakdown there in the drive towards compliance as opposed to really I think understanding the full natural system.

MR. BOYLE: And I believe the project is aware of this masking effect, and that's why in the repository safety strategy there were these calculations done to remove various barriers. But I'm glad you mentioned the igneous events because I showed those results, which they, themselves, can be interpreted--this is something I've said myself, that "Well, it's igneous, stupid," you know, that it's the thing that drives seemingly, it's the thing that gives us our biggest dose. And yet it's an extremely rare event, it masks the true performance. I confessed earlier, I prefer to show the nominal results, which is our expected--you know, what we might expect to happen. So we are aware of this mask both by the waste package and seemingly by the igneous event as well.

DR. NELSON: Maybe in the analogy you build two ships and sail one past Scylla and the other past Charybdis.

DR. COHON: We're going to need to move on, and we have quite a few members who still want to ask questions. I'm going to try to fit them all in.

Debra Knopman?

DR. KNOPMAN: Try to make this fast. In, Peter, your presentation, particularly Slides 7 and 8, you outline something of a decision process that you wend your way through. What's missing to me, and there's obviously a lot more one could add in here, but I think it's worth highlighting, this is contingent on your data as it exists right now. You didn't indicate in your presentation feedback loops; that is, somewhere along the line following along here and saying--stopping and saying, "You know, we really don't know based on--we can't discriminate among models based on the data and we ought to be designing an experiment." Now, this happens, it has happened within the project. I don't mean to suggest that it hasn't. But in terms of laying out a systematic approach to how you're going to proceed with the conservativism versus the real probablistic more realistic case, the data gathering, the research, this is all critical, it seems to me, to your resolving of key technical issues. Otherwise, you're going to run yourself into a corner of the conservativism because you will not have exploited the advantages of your model. Is there a reason why you didn't talk about that here?

MR. SWIFT: In the context--yes, there is, but your comment is well taken and correct--in the context of what I wrote here, I'm looking to write guidance for people writing

or updating an AMR on a fixed cycle. Let's say they're going to update and provide a new feed to TSPA. And in that sense what you're looking for would be, at this bullet here, if two or more ACM's show different subsystem performance, i.e. with the limited data you have you can't rule out some alternative, and yes, they do make a difference in whatever is the important output that matters to the system. You're looking for a switch that says, "If it matters, go back and study it further, collect data, resolve the issue, pick one or the other." And that is absolutely a valid fork in the road at that point.

It is also, however, appropriate, I believe at that point, to pass the uncertainties resulting from that forward in the analysis. It doesn't answer your question, could we reduce the uncertainty by studying it further, but it does allow decision-makers to make a decision based on the present knowledge as to whether or not the uncertainty related to the inability to resolve those two alternatives. Does that uncertainty--first we must inform decision-makers of that uncertainty, and second, it's their decision as to whether or not they need to go back and collect more information.

DR. KNOPMAN: All right. And then just one--I'll accept that, and I know we have to move on. I just want to take issue with your second slide where you say that reviewers do not in general distinguish between TSPA and process models.

And I have inferred that you must be referring to the people who work on "etc.," because we distinguish--

MR. SWIFT: Good.

DR. KNOPMAN: --among those all the time, and I'm not aware of anyone who hasn't in that list. So you may want to reconsider that particular assertion.

MR. SWIFT: How about this: I would like it if you didn't. I think it's a fair question for this group to ask, as you did to Jerry McNeish earlier, why a certain process was or was not in the TSPA. I would like the TSPA to be a window through to the rest of the system, because I think as long as we continue to show TSPA results, people are going to ask those questions, and that's appropriate.

DR. COHON: Dave Diodato.

DR. DIODATO: Diodato, Staff. The question observations relate to alternative conceptual models and data, and then the issue of realism versus conservatism. In the case of the drift scale test, the numerical model that you used to represent that does not include the active fracture model concept in the numerical limitation. And the reason the analyst gave is because then that produces saturations in the fractures that are too low, so the fractures get too dry. On the other hand, in the Mountain scale model for flow and transport you use the active fracture model is used and is retained, and that has implications for radionuclide

transport.

So that's a case where there is data for the thermal modeling which suggests they should not use the active fracture model. But in the case of the Mountain scale model, where we don't have maybe the same kind of data or processes, it's not retained.

Now, the implications of that are: for saturation, if there's a higher saturation, the maybe that's conservative in terms of advection of radionuclides through the geosphere, which is really the bottom line in terms of the impact for humans potentially from the Yucca Mountain repository. On the other hand, it's non-conservative if you have a higher saturation because you might have enhanced diffusion in that case.

So there's a case where choice of parameters and models can have a difference, but you can't say one is conservative or not. Well, you can, but really, a realistic case, in addition to being required by the regulations, seems to me about the only way to go. You have to find some defensible thing where nature bears out what your choices are. And so that requires you develop more of a database. Do you have that in your mechanisms, in your framework, or do you see that--I mean it doesn't seem to me that there's an opportunity for conservatism. This is a statement not a question I realize, but--

DR. COHON: Yeah, and we have to move on.

DR. DIODATO: All right.

MR. SWIFT: Do you want me to comment or not?

DR. COHON: Very briefly, if you want to.

MR. SWIFT: The comment is well taken. We have to be very cautious calling something conservative at a local scale without realizing what its implications are at the larger system.

DR. COHON: Dan Bullen.

DR. BULLEN: Bullen, Board. Bill, I can't let you off the hook by zipping by that figure with all that fine print on it, so can we go back to Figure 4 in Bill's talk just for a second here? Only because as you read through this and you look at the issue that Dr. Nelson raised with respect to perceived significance of risk, that perception is based on the TSPA.

MR. BOYLE: Sure.

DR. BULLEN: And so as you read that little summary off to the side which is the fine print in any contract and you say, "Okay, well, this is a low perceived perception of risk for seepage because, you know, we put all these different seepages in there and darn, it didn't make any difference." Well, if you put it into TSPA and the waste package lasts 10,000 years and you want to look at compliance, it isn't going to make any difference.

And so as you go through this, can you come up with maybe a better justification for why things were perceived as low? I mean the one that looked at waste form dissolution says, "Well, the colloids didn't seem to make any difference, either, but we don't understand anything about the colloids and don't have much data." But just because they don't show up in TSPA doesn't mean they're not going to be important. So can you kind of comment on how you avoid the masting issue?

MR. BOYLE: Well, I think it relates to this general topic of the nature of the calculation. It's true for all derivatives, if you will. They're derivatives with respect to a certain equation, you know, or a certain model. And if our model does not have something in it, we can't very well take a derivative with respect to it. So our answers are predicated upon the TSPA, and therefore that puts a premium on having a good TSPA with realistic risk and form models. But this is a snapshot. I remember they were asked, "Why are you able to sleep now?" and it's--

DR. BULLEN: I just want to caution you that masking is always going to be a problem with TSPA no matter what you do. But I've got to get back to Peter for one other issue that he raised, and this is the old, you know, you didn't want to carry on any models that didn't match the data, and I completely understand that. But that again is predicated on

the fact that the data are good. If the data are no good and you toss out a model with crappy data, maybe you threw out the good model, and so you always have to be cautioned that, you know, I've been consistently taking the wrong measurement and getting the wrong data for two decades and I threw the model out, but it may have been right. And so I guess how do you guard against that?

MR. SWIFT: You don't throw the model out, you merely don't carry it forward into the system TSPA. It remains, being analyzed by the subject matter expert most familiar with it. It's back there at the AMR level. We'll take hydrothermal water rise. The right people are studying that.

However, if and when they tell us in TSPA that, "Yes, we believe there is a sound basis for carrying this forward," at that point we will. But as long as their conclusion is, "No, this model is not consistent with the data," that's it.

DR. COHON: Alberto Sagüés.

DR. SAGÜÉS: Okay, Alberto. Real quick, we are talking about communicating uncertainties, and this is for William Boyle and it has to do with Number 12 on your presentation. So I want to have this communicated, and I'm a student of uncertainty school, and what I wanted to learn is a little bit more about what is the meaning of that graph. I just wanted to make sure that we're all right on this. And for

example, in the 300 years of the repository, the effects up there to be the most notable there. Do I understand correctly this is going this way, right? I'm at year 300. The volcano doesn't happen that year. And depending on where that volcano hits the repository and how it hits it and the like, there's going to be a number of doses that will happen to the recipient and there will be either huge or less huge, but still they're going to be very, very large. So then I calculate this division of those doses. And then we're going to move the cross-section way, way up into the graph. And then I move the graph as though by the chance the volcano happens, which brings them down to where they're over there (indicating). Which is the multiplier, 10^{-8} or something like that?

MR. BOYLE: I think it's the 1.6×10^{-8}, but that's on an annual probability, so what you've got to factor in is what was the time duration of the time step in which that took place. So I believe that's the probability by which they might divide it. But ultimately it's--

DR. SAGÜÉS: That's annual, isn't it? So what I'm saying is suppose it's 10^{-8}, then, the multiplier, 10^{-8}. So then the median is 10^{-1}, 1/10 of a mrem, and then 10^{-4} of that is about 1 mrem, right? Is that correct?

MR. BOYLE: Yes, the results are in the SSPA.

DR. SAGÜÉS: Yes, I know, I know, but I want to see the

numbers right now because we want to communicate this. So it's 1 gram, right?

MR. BOYLE: Right.

DR. SAGÜÉS: And then 10^4 again is--10^4 rem or something like that?

MR. BOYLE: I don't recall it being that large.

MR. SWIFT: No.

DR. SAGÜÉS: No?

MR. BOYLE: No.

DR. SAGÜÉS: But can you look at it? I want for you to communicate that to me.

MR. SWIFT: I feel a little badly for Jerry there because this is actually in large part my work. And we don't have time now, but we actually do have the material here if we wanted to go through how we built the probability weighted mean out of conditional doses. It is not so simple as to simply take any point in this curve and multiply by 10^8 to get an unprobability-weighted dose, because this takes into account the dose that a person living in the future might get from a volcano that happened hundreds or thousands of years before they were born. So if the volcano happens at Year 100, a person living 1,000 years from now still gets a dose from that volcano. If the volcano happened in the Year 1,000, the person gets a dose from that also. And they all get rolled together into this probability-weighted sum.

The conditional dose clearly is worst if the volcano happens now, because that's when the radionuclide inventory is greatest, times 0.

DR. COHON: Excuse me, I'm sorry, Peter and Alberto, but the key point has been made at least twice now about probability weighted. We don't have time now to unravel the whole thing. But the key point has been made, okay?

DR. SAGÜÉS: Well, the key point I wanted to make was the numbers, I just wanted to see what the number comes to, because I understand also there's a dilution. But what I was trying to ask within my questions to bring up was the magnitude of the dilution factor and what it's taking us to. And that, I don't see that number. Yes, it might be somewhere on the TSPA, but I just--

MR. BOYLE: No, you're right, it's not there, yes.

DR. SAGÜÉS: So we're not--the communication doesn't seem to be communicating very well at this moment.

MR. BOYLE: I understand.

DR. COHON: That's clearly established. Very last question. Having praised you to the rafters for the wonderful report and we hope for the implementation, in my view, the regrettable thing is it's all coming post SR, likely. So it leaves me the question, what did the Secretary know about uncertainty before he announced his intention to recommend the site?

MR. BOYLE: And I only know from my own personal experience, and there's two elements of that. One, I was asked to look at various documents that may or may not have gone to the Secretary and, you know, comment on them, on what it said. And the other is, is when he visited Yucca Mountain, I talked to him at the drift scale tests, and certainly uncertainties came up there. But I was not in any meetings with the Secretary and I'd have to defer to somebody else in terms of answering what materials were supplied. Lake Barrett has been in the room, I don't know if he is anymore. He might know better than anyone else. The question is, is what materials and what discussion of uncertainty did the Secretary of Energy have, and I wasn't there, certainly.

MR. BARRETT: Lake Barrett, DOE. I wasn't there all the time, either. I was there for some of them. He received briefings on the TSPA-SR, the SSPA. He was presented all the uncertainties, we went over the volcanism, so he understood that, he asked questions about he understood it was probability weighted, as the issue earlier, it was presented to him the probabilities in the 10^{-7}-10^{-8} range, the peak doses were discussed, and it was .1. It's never .1 at 0 or a number higher than that. So those kinds of things were discussed with him. There were various issue papers he asked for that were presented to him. And, you know, so that much

I know, and there was more that I don't know. So I would say it was a very extensive review. I think he has a very good policy-maker's understanding of these issues. As the Board has said, he has read your letters and he has asked what we are doing about that, understood what the SSPA was, he was briefed on your reports. There was then the response to your report; he saw that response. I would say he is very much involved and he's responsible, he's the Secretary, he's a decision-maker.

DR. COHON: Thank you, Lake, and thank you, Bill, and thank you, Peter. And Dr. Sagüés has requested the Secretary to come and explain this slide.

Let me call on Bill Reamer with a double apology. First of all, for delaying your presentation by this much, we had a lot to cover in the previous ones, as you heard. And second of all, for in introducing him at the outset of this session for conveying the wrong title. In fact, I gave his old title. He's been promoted to Deputy Director of the Division of Waste Management at the NRC. Welcome. Thank you for being here.

MR. REAMER: Am I coming through?

DR. COHON: No. Try it again.

MR. REAMER: Coming through now. Good. All right. I'll be talking about the NRC's preliminary comments on sufficiency of DOE information. I have a hard copy in the

back of the room. A copy of the Commission comments are attached to that, and I guess the one point I'd make is the comments do speak for themselves, but I'm happy for the opportunity to give the Board an overview.

Next slide.

I want to start with the legal requirement for the preliminary comments. I think that will help to clarify for those in the room the scope of the comments. I'll then summarize the comments and the background to them. I want to also try to clarify the link between the preliminary comments and the NRC staff's issue resolution process. I'll give an example of using igneous activity, how it fits into the preliminary comments and into the NRC staff issue resolution process.

Next slide.

The Nuclear Waste Policy Act requires that any site recommendation of the Department of Energy is to be accompanied by commissioned preliminary comments. The comments are to address, and I'll quote here, "the extent to which the at-depth site characterization analysis and the waste form proposal seem to be sufficient for inclusion in any application to be submitted by the Secretary for the licensing of the site." So in other words, the statute says at-depth site characterization and waste form proposal is the focus, and the measure is the extent to which there is

sufficient DOE information for a potential license application.

Next slide.

So with that scope, the Commission submitted comments to the Department of Energy in November of last year. The overall comment was that the NRC believes that sufficient at-depth site characterization analysis and waste form proposal information, although not available now, will be available at the time of a potential license application, such that development of an acceptable license application is achievable.

Now, there were three specific points that the Commission made in the letter connected to that overall statement: 1) that the Department of Energy either has or has agreed to obtain sufficient information; 2) that although significant work does remain to be done, the agreements provide a basis for the Commission to conclude the development of an acceptable license application is achievable; and 3) that additional information needs could arise based on the Department's consideration of the flexible design.

Next slide.

Now, there were two important constraints that were also in the Commission's comments: 1) that the NRC is not making any conclusion concerning the actual site suitability

of Yucca Mountain but rather is commenting on whether sufficient information will exist to begin a licensing review at some point in the future if there is a license application; the second constraint was that any NRC licensing decisions with regard to a potential repository at Yucca Mountain will not occur until DOE submits a high-quality application, until the staff completes its independent review and documents its conclusions in a safety evaluation report, until the NRC offers an opportunity for a public hearing, and until that process and hearing is complete and the NRC makes a final determination whether the application meets the regulations. And then any such decision would be based on all the information that's available then.

So the gist is that ultimately the Commission may be required to make a licensing decision with respect to Yucca Mountain, and therefore it's premature for the Commission to be taking a position now in advance of a potential application.

Next slide.

Now I'd like to try to link the comments, the preliminary comments, to the staff's pre-licensing interactions with the Department of Energy. The letter includes a background document which describes this, and I'll try to highlight it in quick fashion. But the Nuclear Waste Policy Act requires that the Commission interact with the

Department during site characterization.

As part of that process, which began a number of years ago, in 1996, the staff identified nine key technical issues that it believed were important to performance, and those key technical issues came to be emphasized in the pre-licensing interactions the staff held with DOE. Also, the staff adopted an issue resolution process to deal with the nine key technical issues. And the focus of the issue of resolution process became those issues after 1996, the key technical issues.

The NRC published status reports along the way of where things stood, documenting its own independent work, showing the status of issue resolution with the Department at the staff level, and identifying its information needs. In other words, needs the staff believed, information the staff believed would be needed for an acceptable license application. Throughout the issue resolution process, after the key technical issues, the staff emphasized that an important element of an acceptable license application would be the extent to which DOE addressed the key technical issues.

The pre-licensing interaction process also included interactions with the representatives of the State of Nevada as well as representatives of the affected units of local government and consideration by the staff of the technical

information collected by those oversight bodies.

Next slide.

Focusing now on the issue resolution process, and again, trying to clarify and make more visible the link between the preliminary comments of the Commission and the staff's issue resolution process. As I said, the process focused on the key technical issues. The essential elements of the process were review DOE documents, interact with the DOE in public technical meetings, and identify the information, in the staff's view, that the DOE would need to provide in the potential license application. The interactions took place in a public forum. Interested and concerned representatives and opinion leaders were invited to attend and observe, pose questions, make statements, have access to the results.

Issue resolution in those meetings and elsewhere has always been emphasized by the staff not to be a legally binding process. Licensing decisions are only going to be made after that licensing process that was described in the Commission's letter, the second constraint that I made reference to.

Next slide.

What is "resolution" in the issue resolution process? And the staff defined that as an issue being resolved when the staff no longer had further questions on an

issue. The bases for the issue resolution process, the bases for the definition of "resolution", lay in acceptance criteria that the staff had developed and published in their status reports. These are criteria that the staff used to judge the acceptability of the Department's information for possible license application.

Importantly, when we're talking about resolution, it does not mean and does not signify any licensing determination has been reached. And it's also subject to the understanding that any new information could lead to new questions on the staff's part.

Next slide.

Now, most recently in the last two years, the issue resolution process and pre-licensing interactions have intensified somewhat. The staff's held on the order of 16 multi-day technical meetings with DOE focused on the key technical issues, documenting the results in letters to the Department. In those 16 technical meetings, in connection with the staff's information needs that it had identified, agreements were reached with the Department documenting the additional work that DOE would need to complete. The Commission's preliminary comments summarize that in a table, Table 1, in the background document.

Now, from the NRC staff's perspective, those agreements represent the following: in areas covered by the

agreements, it's the staff's belief that the DOE plans and schedules represent a reasonable approach to get the information. And also, based on the agreements, it's the staff's view that there's reasonable confidence that DOE could assemble the needed information for license application. But there's no prejudgment on the staff's part of its review of the information that comes from the agreements when it's ultimately provided by the Department. And I think it's also important to note in the Commission's preliminary comments that the Commission was saying that reliance on these agreements forms the basis for many of the conclusions in the Commission's preliminary comments.

Next issue, next slide.

So just briefly taking igneous--and this is, you know, at a high level, what the Commission is saying with respect to igneous activity and what the staff is saying in the issue resolution process with respect to igneous activity I think can be summarized as follows: The staff is saying, in the context of issue resolution, that igneous is an issue that the Department needs to address, both with respect to probability and consequences. And the staff is also saying that there's not enough information now, that additional information is needed for consideration in connection with the PA. And the agreement topics and the reasons for the agreements, as I've said, are summarized in Table 1 of the

Commission's letter, and there's additional information on this in our letters to the Department. The staff's also saying that in the areas covered by the igneous agreements that basically it believes that the DOE plans and schedules on igneous probability and consequences represents a reasonable approach, and that based on those agreements the staff has a reasonable confidence that DOE could assemble the information needed for license application. But the staff is not saying that it is in any way prejudging its review of that information when it's provided by DOE.

And for the Commission's part in the preliminary comments, what's being said on igneous activity is that the DOE agreements form a part of the basis for the Commission's preliminary comments; that sufficient information on igneous activity will be available such that an acceptable license application is achievable. And also the Commission is saying that NRC has not reached any conclusions with respect to Yucca Mountain and igneous activity and is not prejudging in any way the outcome of any licensing review of that issue.

Okay, so last slide. Hopefully I've advanced your understanding somewhat on what the preliminary comments that the Commission is making or saying and what they're not saying. They're saying that sufficient information, although not available now, will be available at some point in the future, before license application, such that development of

an acceptable license application is achievable. And also the Commission is saying that it's not making any conclusions with regard to suitability and that licensing decisions proceed in the future, and that the basis, the background for these comments, is a lengthy period of interactions between the staff and DOE during pre-licensing. And also saying that the agreements between the Department and the NRC staff provide a basis for concluding the development of an acceptable application is achievable, and it's noting that the flexible design could add to additional information needs.

So I'd be happy to respond to your questions.

DR. COHON: Thank you very much. Questions from Board members? Dan Bullen?

DR. BULLEN: Bullen, Board. Could we go to Slide 4? Because you just raised an issue. It's true that a lower temperature design would require more information, but that's only if they decide to keep the high-temperature design. If they decided to shift to low-temperature design and you reevaluated the KTI's, is there a possibility that you'd need in general less information? Would things go away, I guess?

MR. REAMER: There's a possibility, yes. I think the comments are not making an overall aggregate statement that there would be even more information needed. I think it's saying that with respect to that change there could be

additional information.

DR. COHON: Priscilla Nelson?

DR. NELSON: Two short questions. One, you still use "close pending". There's a continuing discussion about the difference between close pending and open pending, and is that discussion at all in terms of perception held inside the NRC and its staff or is it not a subject of discussion?

MR. REAMER: Well, "close pending" every time I come to Nevada is potentially a subject of discussion. "Close pending" is a term the staff used to basically categorize or keep track of where issues are. It's more a bookkeeping term. Actually, there's a backup slide, I think it's Slide 12.

DR. NELSON: Right, I saw that. But the perception is the question.

MR. REAMER: Yes, and each time I comment on "close pending" or any of the terms, including in a presentation like this, I emphasize the points I think that the Commission emphasized on this about a year ago when it responded to a letter from Judy Treichel, that it really is a matter of bookkeeping, that all issues are subject to further consideration during the licensing process, that it's a valid concern that's been raised by the public, that these terms may imply greater progress in closing open issues than has actually been achieved, and to emphasize, the staff to

emphasize, that these are bookkeeping terms and they don't carry an implication that reviews of information in any way have been completed.

DR. NELSON: But they are being used with that implication as if problems are going away because they've been designated close pending. That's the perception. So the terminology is being used differently from the way you wanted it to I think when it was born.

Just very quickly, if the project comes forward with some issues still close pending, would that mean they could not make a license application?

MR. REAMER: That's surely a possibility. The issue resolution relates to the key technical issues. What the staff is saying is that the nine key technical issues need to be acceptably addressed in a license application. "Close pending" reflects only an agreement on the part of the Department to address it. And so there still is the basic information gap that the staff has identified. And if there were carried through to a license application, then the issue that would be presented by the staff is does it make sense to go ahead and commence a license application review or not, and that really would depend upon the nature of the missing information.

DR. NELSON: So the basic sense is that it would be possible to come forward with some close pending things

outstanding, but the NRC and staff would have to consider that in the context presented. I mean--

MR. REAMER: Well, the Department--

DR. NELSON: --it's not a stop, you can't even come through the door if you've got still close pending.

MR. REAMER: Initially there is what's called "an acceptance review" that the staff conducts, and it conducts that review when an application comes in with the decision being "Should we even commence a review of this or should we return it?" And that's what I'm talking about. If there's an information gap that's key, the staff has the option of returning the license application without doing any substantive safety review.

DR. COHON: Don Runnells?

DR. RUNNELLS: Runnells, Board. My question has to do with time, time frame, and goals in terms of license application. The project has a goal, we heard early yesterday, of being ready for license application perhaps by 2004. When I look at this list of topics in your table, close pending, whatever, it's pretty imposing. I'm wondering if you could tell us how many issues have in fact been resolved over the last couple of years. You said you had 16 meetings to identify key technical issues, and I'm wondering in that period of two years how many issues that are key technical issues have in fact been resolved?

MR. REAMER: Sure. Okay. There are nine key technical issues. None of those issues has been resolved in the sense of being closed. Those nine key technical issues have been refined into roughly 40--39, 40--sub-issues. On the order of 6, a small fraction, of those sub-issues, have been closed. The 16 technical exchanges that I referred to produced on the order of 290 agreements on the DOE's part to provide additional information. At this point, roughly 10 percent of those agreements have been completed.

DR. RUNNELLS: Thank you.

DR. COHON: Paul Craig?

DR. CRAIG: Paul Craig, Board. This question has to do with the QA process and how it interacts with what you folks are doing on the licensing. We've heard any number of times about the complexities of QA and difficulties with QA and how it slows down processes. It clearly is important. What I'd like to ask you about is how is the QA process used by NRC? What kind of problems might emerge if they go to a low-temperature design where they might need some new data which is not QA'd or it may take a long time to do the QA? And what are the implications of the QA process for doing the kind of exploratory research which is closer to pure science, the sort of thing that you would do if you were exploring alternative conceptual models which are believed not to be high probability, but if they turned out to be important,

they could be really important?

MR. REAMER: Okay. QA in the abstract is a requirement in the regulation. It's a requirement that the Department have a program and that it implement that program. With respect to the information and the license application, the Department has told us that all of that information will be QA'd, will be that any potential indeterminate labels will be resolved. With respect to your third area, it really depends upon how DOE intends to use the information. It would seem to me it's really the ball is in their court to factor in QA at the right place in the process.

DR. CRAIG: But the conclusion is that all the information which is provided to you must be QA'd?

MR. REAMER: Correct, and I think the Department agrees with that.

DR. COHON: I see no other questions. Thank you very much.

MR. REAMER: You're quite welcome.

DR. COHON: Before we turn to public comment, Russ Dyer has a brief update.

MR. DYER: Hi, this is Russ Dyer, DOE. In response to Dan Bullen's question yesterday about when the AMR's and PMR's would be available on the Internet, now. We just ran a test. Go to the home page, "Technical Information," "Technical Documents," the "Search" button at the bottom

gives you the list, and we were able to get in using just basic Internet connection about ten minutes ago.

DR. BULLEN: Bullen, Board. Thanks, Russ. Claudia told me that last week. I just wanted to get you guys to get it up for everybody. But thank you.

MR. DYER: Sorry, Claudia.

DR. COHON: Actually, Russ, you showed remarkable confidence and faith in technology, which you could actually say it was available ten minutes ago.

Seven people have signed up for public comment. I'm going to read your names to confirm that indeed you want to speak: Sally Devlin, Grant Hudlow, Jacob Haas, Bob Williams, Gary Cerefice--and I apologize if I mangled that--Judy Treichel and Kalynda Tilges. I'm going to assume I got it right.

Let me suggest, we'll follow ground rules similar to what we did last night. That is, at five minutes I'll raise my hand; at two minutes more, that is after seven, I'll raise it again; nine minutes; and then 10 minutes and then every minute after that. I'm not going to cut you off, but I know you'll be respectful of everybody's time.

Sally Devlin?

MS. DEVLIN: Good morning again, everybody. Can you hear me?

UNIDENTIFIED SPEAKER: Yes.

MS. DEVLIN: And I want to thank you so much for coming to Pahrump, I hope you enjoyed our beautiful scenery and you realize how beautiful our town is. And lots of changes would occur here if we had Yucca Mountain.

But I want to bring something up right away, and that is when I talked yesterday about not believing the government, I really meant it, and here it is right in your documentation here of Peter's presentation. And it says, "Waste inventory calculation removed from U.S. Navy spent nuclear fuel from DSNF inventory represented Naval fuel as CSNF." Now that stuff is hot, and that naval fuel powered Antarctica for 14 years before the oil companies came in. And I really think this does not particularly give confidence to the public what the DOD is doing, because that's DOD stuff from Idaho, and it is in my report. Then I notice, of course, I didn't know what Peter was going to say. But this is terrifying and I want it on the record that it is terrifying and does not supply the public with confidence.

The other thing I brought, and of course nobody can see it, but it's a little map on transportation of the United States. And these are the arteries that the waste would travel. And I'm just telling you that because I just am now a doctor of transportation, and I'm going to crown myself because everybody here is a PhD, and you know, I just got my AA in fine arts. But I'm just saying, I think that I want to

be known as the expert in transportation. We've really been studying this, and the horror of all of this and that all of this stuff has to be transported.

And I have a couple of other comments, but mainly this DOD stuff, there it is documented and presented right at this meeting.

The other thing I want to go into very, very briefly is the terminology, which is terrifying to the public. "Scientific uncertainties." And that word "uncertainty" is the word that really scares everybody. And when I give them the reports--and I take them to many people who are unable to attend these conferences--it makes me realize how backward our meetings are, because what we should have is prior to the meeting all of this information so that we can e-mail in, so we can teleconference or we can all this kind of stuff and not be such an exclusive club. I know how our government functions, and since it is 200 million people that will be affected by this transportation, they're totally ignorant of what goes on at these wonderfully run meetings because it isn't communicated throughout the nation.

I call my girlfriend every Sunday in Indianapolis and they have absolutely no information on any of these meetings, and she retired from the test site and did many of the shots. And as a matter of fact, she's the one on the poem I gave you was there at that shot. So that's just one

thing.

The other thing, again, I can't praise John Garrick. I just fell in love with him, and that is because he talked business. I've always been a business woman, and I think business is money. And of course I view our civil servants, or whatever the terminology is, and when I was a kid going to the Institute of Design in Chicago, I worked for Adlai Stevenson. And of course he didn't get elected, but he was termed an "egghead". And I look at you all and we all are similar to eggs, are we not? And now that I have my PhD in transportation, I can be one of you. But what is so interesting is the isolation, and there is no public here. And why? Because they wouldn't understand the language. You know, I had to go to school to understand it. Dr. Coopersmith told me I was an idiot, and the last time I was with him I was turning his pages because he did explain things to me. And I had mentors. And this is why our whole educational system is falling apart, nobody has mentors anymore.

We've got to, and I just got a job for Lake Barrett and I said we're going to take the 100 million--and I hope my secret boyfriend back there is listening--for the hospitals and we're going to put virtual hospitals throughout not only Nevada but the rest of the nation like they have in Iowa, Massachusetts--and I could go through so many states. But we

are totally behind in Nevada, and it is because of the dichotomy of getting money for the government for the test site, for Yucca Mountain, and so on.

So you got my point, and you may address me as Dr. Sally. So, anyway, here's my funny report on transportation:

"Nine billion dollars has been spent planning, modeling and other money consuming adventures for the proposed repository to house high-level waste at Yucca Mountain. How does DOE plan to fill it and how will they get the waste transported? Will the untested canisters holding waste last for 10,000 years? Will 43 states be poisoned before the waste gets to Nevada? Thank goodness Nevada is the bottom of the barrel!" I hope that proves my point.

"If there were a terrorist or sabotage attack, where would they haul the hundreds of miles of dead bodies? There are no railroads in Nevada to carry the waste to Yucca Mountain. Where there are roads and there are hundreds of miles between drinks." And I hope everybody understands that terminology. "Our First Nations Peoples' lands are being destroyed." And remember this, "If the Donner Party"--and remember, they goofed up at the test site--"the Donner Party had listened to the Indians, they wouldn't have had to eat one another. Are we willing to let the DOE make the same stupid mistake?

"20 to 30 miles an hour is as fast as these huge

overweight trucks can travel on the 75-mile-per-hour freeways. Will exposure to radionuclides that have never been properly measured affect the health of our future generations?" I just see anything over 4.8 and I want to go hide under a rock. "If the American diet consisted of the three B's"--and of course that's what we have here in Pahrump--"beans, booze and boob tube, plus tobacco smoking and alcohol combined with radiation causing huge cancer epidemics, are they the reason that we're experiencing them? Before exposure to radiation we had no problem eating the good old American diet."

And I will just go down to the bottom here. "One hundred and fifty million mothers can unite and stop this dangerous, unscientific model as well as potential cancer killing repository." And I gave down the report from the NTS. And they have found krypton gas up there--and unfortunately Lauren Millay (phonetic) couldn't be here, so I'm giving her little bitty presentation--and they say that the krypton gas breaks down and that's where the kids get the leukemias. This is one of many theories. So it is now documented that stuff is there, and of course I hope you'll listen carefully to Jacob because he will talk about the particulars and measurement and so on. And this is all new science.

So I expect all of you to take every word of this

back to your constituents and your students and what have you and really, really ponder on it. And I will end here except for one thing, before Jerry yells at me some more and gives me the wrong finger. And that is that I want you to know my feeling about this whole thing. My bugs will eat every canister prior to getting anywhere, and I hope that you understand what we're talking about. They're just like the fungi that we have at our courthouse and in our schools. Every day they find a new one. And my bugs just love the drift shields and will corrode them. They love titanium, they love nickel, so they'll love Alloy-22. So just keep on trucking, guys, and keep on modeling for the next 20 years and we'll all retire together and go fishing in Lake Mead.

Thank you.

DR. COHON: Thank you, Sally.

Grant Hudlow? Feel free to speak at the podium or this mike here (indicating). Okay, we'll skip Grant Hudlow. Jacob Haas?

(Pause.)

DR. COHON: Jacob Haas?

(Pause.)

DR. COHON: Bob Williams?

MR. WILLIAMS: Thank you, Jerry.

I wanted to underline a few points from my talk yesterday evening. Five-thirty in the afternoon is my low

ebb biologywise, I might be a little more awake right now. I hope I can be slightly more lucid. I have four key points.

First is that my suggestions are motivated by the fact that we are at an undeclared war. I have the sense that we should try in some way to redouble our efforts to figure out a way to move ahead more rapidly. I don't know whether some of you may have seen on the cable network "The History of World War I," where the American forces broke through the Argonne Forest. Today we're dealing in Greek mythology, so I'm looking for somebody who will cut the Gordian knot. Now, some of you who are classics experts may tell me what happened to the guy who cut the Gordian knot, I don't know.

Let me slightly apologize. I had forgotten the constraints on the Board, particularly the brouhaha that occurred over the spent fuel report in 1996. But like everything in life, it seems to me there is a possibility for lessons learned. In some ways it's like taking your seven-year-old son and ripping him for showing some undue amount of curiosity or lighting matches when he shouldn't have. You have to chastise him with some realism or you may squelch his curiosity.

Now, there's always the old saw, "Ask permission before you do it." And I've seen NEI and the utility industry go to favorite senators and congressmen through their staff and get the questions that they want to answer be

asked so that they have the charter to pursue that. I certainly don't have the clout to do that, but maybe some of you do. Then there's always the old saw, "If you think the answer is going to be no, do it because it's easier to beg forgiveness than to ask permission." But I won't push you to do that. What I am trying to do is raise the question, "Who will champion out-of-the-box thinking?"

Now, the thing that I want to underline as perhaps most important is I happen to think right now that a negotiation between the State of Nevada and the Department of Energy, including the other stakeholders, the public and the utilities, could result in a simplified project with a much more--with a much shorter licensing schedule.

Some of you may remember my old broken saw, "There is no way to get a death certificate for a technical issue." I was reminded of that by looking at the last presentation, where very little sign of any unresolved technical issues. So I am afraid I have to stand by my assessment of yesterday that we face a long and very protracted licensing process that almost surely will run out of control because it's not possible to keep everything up to date over such a long time period.

So I'm not sure I have the total answer, but I would like to suggest one more time, who will champion out-of-the-box thinking? There is I think the opportunity--I

commend Lake Barrett, Russ Dyer for what they've done. If there is a sense of tiredness, I think it's because every year there has been a budget crisis or a report crisis. Nobody wants to lead the charge through the Argonne Forest. But I think because of the change of administration, because of the other things that we face right now, I would like to commend all of you to take a look at how you can simplify, how you can accelerate the process.

Thank you.

DR. COHON: Thank you, Bob.

Gary Cerifice? And when you get to a mike, please start by stating your name again for the record, because I'm sure I didn't get it right.

MR. CERIFICE: This one's on, I'll just stay back here. My name is Gary Cerifice, I'm with University of Nevada-Las Vegas, and actually I just have a very--I wouldn't say a simple question, or at least a short question, a short request from the Board.

As you know, we all live in the real world, and the real world has budget limitations. And perhaps you do this in reports that just aren't distributed to the public or to the scientific community, but as the group that probably has the best access of an independent group to a large number of documents related to Yucca Mountain, perhaps you could come forth with a prioritization of, one, what work needs to be

done. Sitting here I hear a lot of both explicit and implicit requests on the DOE program of what you'd like to see done, whether it's changes in document structures or additional research. What is the most important thing that needs to be done, what is the least important given a budget hierarchy?

Also, just on the research side, as a researcher, I'd like to know what is the key technical issue that if you only had $100,000, where would it go? If you had a million dollars, what other issues would you add in? That from an independent board would be very helpful, at least for those of us in the research community trying to participate in the process or assist the process. And that is kind of what we're missing, especially now with the shift towards LA and the activities of getting a compliance document and the debate between a compliance document and a real world snapshot. A lot of that is going to take the limited pot and put it all into one side, into documentation, hiring the lawyers and people who are going to go talk to Congress and go to court over the lawsuits. What I see that doing is basically taking money away from that small pot that's research-oriented and there needs to be someone--or at least something to say what or where that focus could be. And I think given your access to the material and the fact that you're an independent group, you have the best chance of

providing an--I wouldn't say unbiased, but a second opinion as to how that research should be prioritized.

That's it, just a simple request.

DR. COHON: Thank you. Well, in fact, let me respond to that, at least in part. The Board has been quite specific and explicit about its view of the highest priorities facing the program. It has been so for, oh, a year and a half of more. We identified four--in our view--four overarching priorities: uncertainty, quantification of uncertainty, going after this issue of the behavior of the metals in the waste package, the hot versus cold repository issue, and then making sure that to the extent possible incorporating multiple lines, or other sources to support DOE's safety case other than TSPA, or in addition to TSPA.

Now, these also suggest research priorities, and in particular the corrosion issue. I know I speak for the Board here, this is a stated position, that research on fundamental corrosion processes so that the knowledge base is created on which one can more confidentially predict long-term performance. This has been a very high priority for research.

In addition, the letter that we issued--and there may still be copies back there--includes a long attachment that takes each of 11 repository components and talks about what we view are the strengths and weaknesses in terms of the

current DOE technical bases for that. That also may suggest priorities for research.

In the long run, or in the end, it is DOE that must set these priorities. We provide input, we provide our advice, we react to their suggestions, but in the end it's really their decision as to what happens. So, we are engaged in this, though, in the ways I just mentioned.

Thank you.

Judge Treichel?

MS. TREICHEL: Judy Treichel, Nevada Nuclear Waste Task Force. I wanted to just leave on the record some comments about honesty and straightforwardness and dealing with all of us--the public, the people of Nevada, you, and everybody. The way the Department of Energy is doing that I think is extremely important, and especially at this time. Because I've had side conversations with many of you here, I just wanted to put it on the record. But this honesty issue is very, very large and there is so much suspicion, and unfortunately a lot of it is warranted, with the Department of Energy and the work that they're doing at Yucca Mountain. And one of the things is misuse of statements or data or whatever. There's been accusations made the Department of Energy goes out and they gather data, and when they find something they like, that becomes the answer. And then when other pieces of data or other information don't quite fit

that, it just becomes a part of a big uncertainty thing. So there's uncertainty and then there's the good part.

And that's what I see happening with the letter that you wrote and that's why I got so angry, because I feel like I've been the victim of a word game. And Bill Reamer went into that and my letter and the long time that it took. But what you did was you wrote a letter that had, as we said, I guess 11 very important points. And all you saw in the paper was the one sentence. And you heard Lake up here at the microphone saying, "You know, I'm so happy that the Board said," and then he quoted and it's right here in his statement. And if it were DOE, I would say when you make that statement, "No individual technical or scientific factor has been identified," I would ask you to write me in a letter what--give me a good list of what it is could be identified. If you haven't found any, what is it you're looking for? I want to know what it is that we're up against. What do we have to find? Because it appears the only way Nevadans are going to win is by proving beyond a reasonable--not even reasonable, beyond any doubt that the site won't work. So what should we all be looking for here?

And the close pending thing, it's over, I got my letter. I mean, you know, and the site recommendation was made, the sufficiency letter was written, and that's actually the basis of one of those marvelous information sheets that's

on the headquarter's web page. And you should take a look at that because they have an interesting interpretation for what "close pending" means and that these are issues that just very briefly would not significantly affect the conclusion on whether the site could meet the radiation standard. And I think in that list of some 200 issues there are some things that could affect the radiation standard.

I also wanted to bring out that nothing was ever said when Bill Boyle was doing his presentation, on one of his charts, under the "Strategy for Future Treatment of Uncertainties," one of the bullet items was to develop and communicate information that can be used by decision-makers. What those decision-makers are generally going to get are like the one-liner from your letter, they're going to get a piece of this, a piece of that, a sort of glossed over thing. And when they do get data--I think it was interesting when you asked what the Secretary had seen. Here you've got a table here with all of you who have incredible credentials, you've worked hands on with this for so long, and you couldn't figure out what the actual dose would be on that graph and neither could two of the guys by just glancing at it tell you what the dose would be if you had a situation somewhere on the graph. So it seems to me that a high-ranking guy in Congress who happens to be chairman over some key committee is not going to know what the story is, and

particularly not when it's being hand fed to him by someone from DOE or whatever. Those things do not tell people, the public, decision-makers, anybody, what the story is, and it was very clear here today.

And then I just want to finish up, because I thought yesterday, when it got way too late, that boy made an incredible speech that he had put together himself. I believe his teacher when she said he wasn't coached because I've seen other kids that age, and I have a granddaughter like that who's made statements like that. And I am unwilling to think or to in any way believe that those kids are just being incorporated into a game and they're asked to get up here and told that, you know, the right thing to do is if you believe this, you know what's right in your mind, you get up there and you say so. And then to have so many people telling them, "Hey, this is inevitable. They want to do it, they're going to do it," and then find out that they were just part of a game, that they can't change the way this goes, is absolutely wrong. And something needs to happen about that because either there is a way somehow that Nevadans or any one of over 200 groups that signed on to a letter that's going to Congress today throughout the country that do not approve of this site being recommended, if there's not a way in the process for them to do anything, to have any effect, then you've got to start doing calculations

on how many hurt or jailed people it takes to change the thing. Because I don't know where it goes from there. I mean I'm really stuck with an either/or, and I think it's a horrible situation and I think it needs somehow to be resolved.

So, thank you.

DR. COHON: Thank you. Kalynda Tilges.

MS. TILGES: First Technical Review Board meeting I ever came to was in this room, and I want to thank all of the Board members, because since that time I've tried to go to as many of these meetings as I can. And I want to let you all know that I have the deepest respect and admiration for all of you and I appreciate the work that you have done and the work that you are doing now. I feel a lot more confident about our ability to deal with this situation in a realistic manner that you all are on the job.

There's a couple of things. First of all, I'd like to say that you can add my "ditto" onto everything that Judy said, and because of the things that she said, luckily for you, my comments will be much shorter.

A couple of things before I go kind of into the meat of it is that, first of all, in regards to Bill Reamer's presentation, I really find--and in regards to Slide No. 4, the comments in brief, that although not available now, sufficient information will be available at time of the

license application such that development of acceptable application is achievable. I find that assumption to be totally absurd and conclusionary on the part of the NRC. To my knowledge, no other independent agency agrees with this statement. I could be wrong, but there's no other agency that I'm aware of. And I'm in fear for the American Public because the NRC is supposed to be an independent non-biased agency, and they have shown repeatedly over and over again that this is not so, and it frightens me for license application.

On to Bill Boyle's presentation. His diversion of the issue, while amusing, I think was extremely inappropriate. I'd like the Department of Energy to please stick to just making the science sound truthful and transparent. You've got plenty of work to be done in that area without philosophizing.

I'd like the Board to be aware that just in early to mid-December I was at the National Academy of Sciences International Committee Meeting on staged repositories. And I know the title is much longer than that, but you all can fill in the blank, that's as much as I can remember of the title. And the presentations that they got on some of these same issues were really different than what you get. There were quotes from DOE people to this Panel talking about the-- well, let's just name off a few that stick in my head all the

time that I lay awake at night with.

One, the fact that they have no idea how thick the volcanic crust is under Yucca Mountain. That disturbs me. The fact that they have absolutely no idea if there's any magma underneath Yucca Mountain disturbs me, and the fact that--and I can actually remember this quote, I wish I could remember the scientist's name when they were talking about dealing with the groundwater, was that astronomy was a more perfected science than natural science--than earth sciences are and that the scientific community, as you will, has a better idea of where the stars in the heaven will be at any given than where the groundwater will go.

Now, Alan Flint, who worked with USGS on Yucca Mountain and still works for the DOE and was a peer reviewer in the latest underground testing area, the latest peer review. Also made a comment that I connect with those, and he said that, "If you don't know where the groundwater goes, you're wasting your time." It's one of the few times I find myself with agreeing with a DOE employee.

I'd also like to let you know that a lot of our groups had a reading--a recent meeting, excuse me, with Under Secretary Card, and we were quite frightened and it was very interesting to find out when they were asked specifically by Judy Treichel at this point, since the guidelines have changed, what is their definition of a "show-stopper"? They

no longer have one. That was what Robert Card told us.

Lastly, I'd like to just state to the Board that Citizen Alert finds that the public cares less about compliance, because they don't necessarily trust the people who made those regulations in the first place. They care less about compliance but they care deeply about sound science and an honest and thorough understanding of the site, the entire program, especially transportation, and the risks. And we won't even go over the probability weighting.

I would like--I was a little disturbed about some of the things that not necessarily were said in the letter but maybe the way they were presented so that they could possibly be taken out of context. But I won't go into it. I had a long one-on-one conversation with a member of the Board today and I feel much better knowing that that's not the only thing that they're going to see, that you will actually get an opportunity to talk to the people on the Hill and explain what was in between the lines and what didn't get said and what may have been taken out of context and misunderstood. But I really want to make sure that the Board makes sure that Congress knows what the consequences of different levels of uncertainty in this project are. If the consequences are found to be acceptable, then they must be found to be acceptable by the people who will bear the burden of those consequences and not by the policy makers or their advisors.

Those people have no risk in this, they have no stake in this.

This is our lives. It may be their jobs, but this is our lives, this is the future of our children, of our state, and, with the transportation included, of our nation.

Thank you very much.

MR. HUDLOW: I understand you called my name already. I was--

DR. COHON: That's all right. You're more than welcome to speak now if you like. You can speak here or at that mike, whichever you're more comfortable at. Go right ahead. And would you start by identifying yourself?

MR. HUDLOW: Sure.

DR. COHON: Thanks. Stay close to the mike.

MR. HUDLOW: Okay. I'm Grant Hudlow, I'm a chemical engineer, I have nuclear engineering training and experience, and basically the letter that the NWTRB wrote saying that they had some problems with some of the science, kind of surprised me that they were that open until I realized that DOE absolutely ignored that. So that incident was phrased in the bureaucratese properly so the DOE doesn't have to pay any attention to it.

And for a group of scientists to do something like that is appalling to me. We've come in this country to understand that people like the DOE have no conscious, no

cares except for getting a paycheck, and we've accepted that. The studies show and surveys show that the reason people accept that is because they're busy. We're building a nation, we're trying to do things in the world. I'm trying to clean up the world. I don't have time to go out and do DOE's job for them. And--although I'm probably one of the few people capable of doing it. And I'm appalled that DOE doesn't have anybody that is capable. I'm appalled that scientists would not hold their feet to the fire and force them to do it, or get rid of them. That's what I assume your job is. My job was the project manager of Boulder Dam, so I'm well aware of the level of integrity and confidence required to be a government employee. And I haven't seen anybody in the DOE--and I can state that flatly--that qualifies. Working for my dad, he would have bounced all of them. Working for me and my company, I have even a higher standard that wouldn't even be considered in the first place.

Again, I'm appalled that a group of scientists will let a group of DOE officials run a "sandy" on us to the tune of hundreds of variables that are not properly considered. What this does is it undermines not only our government, which the DOE has done that already, it undermines the scientific community, and we could lose our civilization by doing these kinds of things.

I am always reminded of Patten's comment during

World War II, "Hey, you guys, you need to pay attention, we can still lose this war.

DR. COHON: Thank you. And my thanks to all who have participated in this meeting. It's been a very interesting one, I think, and a very good one. As I said at the outset of the meeting, this is an important time in the history of this program with the Secretary having indicated his intention to recommend the site to the president.

There will be many things happening over the next several months. We hope that you'll stay engaged with and interested in what the Board is doing during all of this. Our next meeting is May 7th and 8th in Washington, and for those who find themselves there or care to travel out there, you're more than welcome to attend that meeting.

I want to thank Dave Diodato of our staff, who was the lead staff member in organizing the content of the meeting, and to Linda Coultry and Linda Hiatt for doing everything, including feeding us this morning and yesterday morning. And again, thank you all for your participation. We are adjourned.

(Whereupon, the meeting was adjourned at 12:45 p.m.)

REPORTER'S CERTIFICATE

MEETING NAME: NUCLEAR WASTE TECHNICAL REVIEW BOARD
WINTER 2002 BOARD MEETING
LOCATION: PAHRUMP, NEVADA
DATE: JANUARY 30, 2002

This is to certify that the above transcript is a true and accurate record of the aforementioned meeting which was electronically recorded and transcribed under my direct supervision.

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Scott Ford
Federal Reporting Service , Inc.
17454 E. Asbury Place
Aurora, CO 80013
303-751-2777ssss