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NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON NUCLEAR WASTE (ACNW)

143rd MEETING

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TUESDAY,

JUNE 24, 2003

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ROCKVILLE, MARYLAND

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The Advisory Committee met at the Nuclear Regulatory Commission, Two White Flint North, Room T2B3, 11545 Rockville Pike, at 10:30 a.m., George M. Hornberger, Chairman, presiding.

COMMITTEE MEMBERS PRESENT:

GEORGE M. HORNBERGER, Chairman

B. JOHN GARRICK, Vice Chairman

MILTON N. LEVENSON, Member

MICHAEL T. RYAN, Member

ACNW STAFF PRESENT:

SHER BAHADUR, Associate Director, ACRS/ACNW

NEIL M. COLEMAN, ACNW Staff

HOWARD J. LARSON, Special Assistant, ACRS/ACNW

MICHAEL LEE, ACRS Staff

RICHARD K. MAJOR, ACRS/ACNW Staff

ALSO PRESENT:

ROBERT ANDREWS, Bechtel SAIC Company, LLC

JIM DANNA, NRC

DAVID W. ESH, NRC

APRIL V. GIL, Department of Energy

TIMOTHY GUNTER, Department of Energy

TIM McCARTIN, NRC

I-N-D-E-X

P-R-O-C-E-E-D-I-N-G-S

10:31 a.m.

CHAIRMAN HORNBERGER: The meeting will come to order. This is the first day of the 143rd meeting of the Advisory Committee on Nuclear Waste. My name is George Hornberger, Chairman of the ACNW. The other Members of the Committee present are John Garrick, Vice Chairman; Milton Levenson and Michael Ryan.

During today's meeting the Committee will (1) discuss the process of Yucca Mountain key technical issues, agreement, resolution and risk ranking with representatives of the Department of Energy and the NRC staff; and (2) discuss potential ACNW letters, including the status of KTI agreement resolution.

Howard Larson is the Designated Federal Official for today's initial session.

This meeting is being conducted in accordance with the provisions of the Federal Advisory Committee Act. We have received no requests for time to make oral statements from members of the public regarding today's sessions. Should anyone wish to address the Committee, please make your wishes known to one of the Committee staff.

It is requested that speakers use one of the microphones, identify themselves and speak with sufficient clarity and volume so that they can be readily heard.

Before proceeding, I would like to cover some brief items of interest. One, Ms. Tanya Winfrey, who is the ACRW/ACNW Administrative Assistant received the NRC Meritorious Service Award from the Commissioners on June 12th during an agency-wide ceremony on the green. Congratulations to Tanya.

Ms. Tina Ghosh, Ph.D. candidate from MIT joined the Technical Staff on June 9th. She is working with the ACNW Staff on PRAs and so forth and is keeping interested in risk and uncertainty issues at Yucca Mountain.

Third, in a June 3rd press release, the world edition of BBC News discussed Neil Coleman's paper titled "Aqueous Flows Carved the Outflow Channels on Mars" which was published in the Journal of Geophysical Research, Volume 108 and was actually accepted on January 3, 2003. Congratulations to Neil, too.

So we're going to move into our regular session and John Garrick is the lead member on risk and KTI, so I'll turn it over to John.

VICE CHAIRMAN GARRICK: Thank you, George. I think that we're coming to the point in time where we're really going to begin to test the issue and the ability to risk-informed technical issues associated with Yucca Mountain and to deal with the differences between a safety case based just on a prescriptive standard and the risk-informed safety case that also includes a standard.

We have been coming up to this point for a good long time and this Committee has stressed the importance of having as a baseline what the experts believe to be the real risk and go from that point to whatever issues seem to be important enough that they ought to be dealt with in relation to what the risk is.

Our position is not one of detailed risk assessment on every issue. Our position is one of making sure that we understand what's driving the risk and that whatever it is that's driving the risk is sufficiently transparent that we can see what the supporting evidence is for that contribution.

And so we'll be looking very carefully at the issues throughout the morning, such as the way in which the KTI agreements are importance-ranked. We've read about the attempt to bundle some of the KTI

agreements together which in principle sounds like a good idea and whether or not it's a feasible thing to do in practice, we hope to learn something about that.

We also are hopeful of getting into the issue of the treatment of uncertainty and how uncertainty is propagated through the models. We've seen a new term come into the discussion, namely combined effects contributing to uncertainty. So we have a lot to consider and these presentations are going to be very important in that regard.

And so with that, as I understand it, April Gil is going to lead off for the Department of Energy and we'll introduce herself and her role as well as the subsequent speakers.

April, we're pleased to see you.

MS. GIL: Thank you, Dr. Garrick. Do you want me to sit here and use the mike or do you have a portable mike.

VICE CHAIRPERSON GARRICK: There is one.

MS. GIL: Thank you very much. Good morning. I'm very pleased to be here. It's been many years since I've had the chance to talk to the Advisory Committee and I wanted to say first off on behalf of myself and our DOE team, we're very pleased to be here today to discuss with the Committee our

approach to resolution of KTI agreement items.

My name is April Gil. I'm the Division Director for the Regulatory Interactions and Strategy Division for the Office of Repository Development and my team and myself are based out of Las Vegas.

First off, let me say that we're well aware that there's a lot of interest in the Department's approach to resolution of KTI agreement items. We know that the Committee and the Commission itself is very interested in the schedule and the methodology that the Department will be using to resolve these issues. And let me reassure the Committee and the Commission that we're working very closely with your staff to make sure that all the agreements are explicitly and completely addressed by the time of license application submittal which is currently planned for December of 2004.

I just wanted to provide a little background for folks who either weren't in the program at that time or just a little refresher. I can see a lot of familiar faces here from the KTI agreement technical exchanges in management meetings.

We established 293 agreements with the NRC in a series of very intensive public interactions over a course of about 18 months. They started in April of

2000 and our last one was in September of 2001. These agreements, we believe, were key to the NRC's finding of sufficiency in allowing the Department of Energy to go ahead with site recommendation, to implement national policy for geologic disposal of high level waste. So we feel that the KTI agreement items have been a very effective way to focus the national program and to allow clarify and transparency in what is necessary for the Department to complete prior to submittal of a license application.

And this will be familiar, I think, to everyone in this room. This is NRC's status summary. We get this on a weekly basis and make sure that it's maintained. The accounting and the bookkeeping with the KTIs can be challenging. This, I think, is the most simple, straightforward explanation. Two hundred ninety-three total agreements and 78 remaining -- excuse me, 78 agreements have been closed and 140 remaining.

We have determined that we needed to revise the way we were addressing the key technical issues and we've been working on this for some months. Primary drivers for the changes were program replanning due to the continued resolution from Congress that had a significant impact on our budget

and our program. Also, another significant input to our approach was the availability of the Yucca Mountain Review Plan in draft final form and you will hear more about that later this morning from our other speakers.

Another important thing that we've done over the last year and a half, two years, is met consistently, frequently with the NRC staff to understand better exactly what is necessary to resolve these KTI agreements. And the interactions include public meetings, technical exchanges, Appendix VII visits and also the letters that have gone back and forth between the two agencies.

So I think that this has really been a significant input to us in getting better understanding exactly what's necessary for the agreements.

So in developing responses, we've got an understanding. We've also got an understanding of what the NRC staff expects when we receive Additional Information Needs from the NRC staff. Our goal is always to be successful with the initial submittals of the KTI agreements. We try to be as complete in the documentation and the approach as possible. However, there have been cases where the NRC staff has written

back and said we need additional information in this area on this original KTI agreement. So those are termed Additional Information Needs rather than requests for additional information which I understand is used for licenses.

So we've had clarification of NRC staff expectations and I know the NRC management and NMSS is very aggressive and specific on this point. They want to make sure that there's clear, mutual understanding between NRC and DOE as to what's necessary.

And the discussions that we've had at technical exchanges, I know ACNW members and staff have been present at many of these. They are very lively, open interchange of information that's documented in formal meeting minutes afterwards and we think those have been very helpful.

So our previous approach focused on responses to individual agreements. There were cases that we grouped them, but the vast majority of the agreements we did them one at a time, so to speak. And we realized that addressing the agreements in this way was not as effective as taking an overall integrated approach because many of the agreements are related, not just within a specific key technical issue area, but between KTIs, there are relationships

between the agreements.

So our revised approach, we think, is a substantial improvement over what we've been doing in the past. And I know the Committee and the Commission is well aware that the frequency with which we are submitting agreement items has slowed down considerably in the last few months. We have every intention of getting those submittals back on schedule and we'll do everything we can to make sure that that happens. We're going to address the key technical issues according to the relationship to the overall system. It's a more holistic integrated approach and one real benefit of this approach is with the availability of Yucca Mountain Review Plan in draft final form, we're able to organize the key technical issues around the YMRP and the Safety Analysis Report. And this effort, as I said, has been going on for some months, has been very beneficial to us, to allow us to focus on what's really necessary for the license application.

So really what you're going to see today, I hope you will agree, is a more integrated, systematic approach and eventually more effective approach to address the agreements.

We are still committed to addressing every

single key technical issue agreement prior to submittal of the license application. We're going to explicitly address every KTI agreement and you will see later today more about our approach, but when we have what we call the story or integrated explanation and discussion about the effect of the KTI, we're going to have specific cross walks, we call them, that show where every single KTI has been addressed.

So our goal again is effective resolution. The revised schedule for submittal has been provided to NRC. It just came yesterday. This is under signature of Joe Ziegler to Janet Schleuter.

Now as you know, some of the KTI agreements are not related to post-closure. Some are pre-closure. So those specifically will be handled in a more individual manner. Our grouping or bundling approach that Dr. Garrick referred to is related to the post-closure case. So pre-closure criticality in some of the design KTI agreements will be handled individually.

We're very sensitive to the time demands, constraints and pressure on the NRC staff to review these agreements. We're fully aware of the burden that this places on the staff and the Commission. We want to work with the staff. As we went ahead and did

our schedule, we were very cognizant of what we call levelizing the output of the KTI agreements so that rather than having large groups, discrete points, they come in in a more equal time frame because this does put a burden on the NRC staff for their review.

We want to have interactions, public interactions with the staff to talk through our proposals and our products. And we're hoping to do that prior to submission of the bundles or the groups so that we can gain information in what the NRC staff's feedback is on our approach and make any necessary revisions so that it will be acceptable upon formal submission to the NRC.

And we have -- we already have an aggressive schedule of interactions. We will be revising the schedule as necessary to accommodate the new grouping approach of KTIs.

So I'd like to introduce the next speaker or does the Commission -- excuse me, the Committee, want me to take questions now or do you want to wait until the end of the session?

VICE CHAIRPERSON GARRICK: Any questions at this point? We'll wait a while. We won't commit to the others.

(Laughter.)

MS. GIL: Thank you, Dr. Garrick. I'd like to introduce the next speaker, Dr. Bob Andrews. He's with Bechtel SAIC Company and he's the Performance Assessment Manager and he's been leading the approach to put together the bundles for the KTIs.

And then the final speaker will be Tim Gunter who is with the Department of Energy who is our interactions and KTI lead.

VICE CHAIRPERSON GARRICK: Thanks, April.

DR. ANDREWS: Thank you, April. I'm going to go on to the next level of detail associated with implementation of this in-graded technical KTI responses in the context of the integrated technical basis for the safety analysis report license application, in particular, Chapter 2, the post-closure elements of that, the license application.

I will refrain from using the word safety cases although we will be talking indirectly about elements of a safety case as we walk through this presentation.

If I can have the -- yes, you have the slides.

(Slide change.)

DR. ANDREWS: What I'm going to talk about

is what the previous approach was, just to recalibrate all of us. And that approach has changed for particular KTI agreement items over the last 18 months, 24 months, and we'll talk about that change a little bit now and a little bit this afternoon when we talk about the risk-informed approach to KTI agreement responses and our interchange with NRC staff on that risk-informed approach. I won't talk about the risk-informed approach this morning that much unless there are questions.

And then I'll talk in a little more detail the revised approach that April discussed and how that's been organized, so the bases for the combining of KTI agreements into integrated elements of the technical basis for the license application. We'll then correlate that to various elements. What we've correlated that to in this presentation is the actual KTI groups themselves, container life and source term, repository design and thermo-mechanical effects, etcetera, etcetera. Also correlated to the elements, the 14 abstraction elements of the Yucca Mountain Review Plan and I think or I would guess now that we have the NRC's June 5th risk-informed approach letter we can easily correlate to elements of that letter as well. And I think when you see, I presume somebody is

going to present this afternoon that letter and its basis, you'll see some parallelism here and I'll try to draw some of that parallelism as I'm talking as well.

I won't talk about the individual risk statements that NRC staff determined, but I will talk about the mapping or parallelism of how they grouped, the staff grouped KTI agreement items into like categories, if you will. What you'll see will be similar to this.

I'll take one example, response group. Happens to be a fairly significant one. Happens to be a high risk one. It's the indirect environment, the environment on the waste package and the chemical environment in particular. And show why, even though it's scattered amongst 14 individual KTI agreement items, there's a lot of similarity in how you address them that has to address elements of those in an integrated fashion. You can't -- it's difficult to address any one in a stand alone fashion. And then we'll finish with some conclusions.

If I could have the next slide?

(Slide change.)

DR. ANDREWS: Okay, the previous approach, ever since the KTI agreements were initiated was to do

the work. There was work required to address the agreement item. Sometimes that work was additional testing. Sometimes that work was additional data evaluation or parameter development and discussion of parameter uncertainty. Sometimes it was model related and model uncertainty or the appropriateness of a model o ra process or feature that may have been excluded from a model that was the basis of the agreement item.

All of those, and sometimes it was associated with do some additional analyses of some type or another associated with the agreement item. So there was work and there has been work going on and sometimes that work has been presented as to the Commission. That work is in the process of being documented. The documents are generally controlled documents such as calcs or analyses or model reports or drawings or technical reports. So through the work, you document the work in those controlled processes. It's important to point out that those controlled processes have other quality assurance drivers other than just answer the technical question that was the basis of the key technical agreement or to answer the acceptance criteria of the YMRP individual criteria in particular, the post-closure

criteria which is the focus of this talk.

There is software quality assurance model validation issues, data qualification issues, checking review issues associated with the development of technical products over and above the technical requirements, if you will.

The third step though was given, you have the technical product and you have the work documented in a technical product. It would be to extract the relevant aspects of that work into more or less discrete answers associated with the KTI agreement. Those have, over the last 18 months or so generally been submitted, as April said, as a response at a time or sometimes things were bundled into two or three responses that if they were of a similar topic and the approach to address that particular agreement item was the same type of approach.

The next step would be to actually develop the technical basis and start preparing the draft sections of the Safety Analysis Report in compliance with the requirements, I guess I'll use the word, of the YMRP and to present that into the SAR.

(Slide change.)

DR. ANDREWS: The next slide shows there's some disadvantages of following that approach. One is

that the individual key technical agreement item responses are prepared prior to the integrated technical basis of the safety analysis report being prepared.

I suppose if you are on the receiving end you would look at that as an advantage, rather than a disadvantage. It allows you to have time to review things and comment on them as appropriate prior to them being in the Safety Analysis Report or related to the Safety Analysis Report.

We'll come back to that issue here as we talk later on.

The second item though is probably more important is that taking the KTI agreement out of its context of why is it important, why is it relevant, why was it asked in the first place, what data uncertainty issue was really the focus of that particular KTI agreement item and why is that uncertainty item potentially relevant to post-closure performance or if it was a parameter or model or a testing related question.

So placing them into the context of why the question was asked, why is it potentially important to the overall risk, to the overall importance of the post-closure safety case and the

post-closure performance assessment was sometimes difficult. I'm just trying to answer them in isolation rather than in that context of that technical basis that you're actually going to prepare for the Safety Analysis Report.

If I could have the next slide, please?

(Slide change.)

DR. ANDREWS: So the revised approach, I think April walked through the steps. The first two steps are the same. it's do the work. Do those tests, do those analyses, do those calculations, put those on control products, whether they'll be analyses or models or whatever is the control vehicle for preparing in the QA sense that work and presenting that work. If it's data, it's submitting the data to a controlled source, in this case technical data management system.

And then where you have the idea, if you will, of preparing that technical basis, the integrated technical basis that describes the barriers and the basis for those barrier performance and to organize those integrated technical bases for the barriers in some way that's consistent with the Yucca Mountain Review Plan, so that in some way it will map fairly easily and fairly directly into the individual

subsections of the abstraction sections of the Safety Analysis Report, the 14 abstractions sections. And to within that context, within that technical basis context of that post-closure safety case, if you will, is to address those KTI agreements.

Now in some cases, those KTI, in many cases, I should say, those KTI agreements relate directly to an element of that -- the post-closure performance technical basis and you'll address it in the course of writing the technical bases for element A of that post-closure safety case and I'll come up with what's A, B and C or 1, 2 and 3 here in just a second.

In other cases though they really are a discrete question. The question might relate to a specific aspect of some test that nominally relates to uncertainty associated with interpretation of that test and uncertainty of that interpretation then carries forward into uncertainty of data and uncertainty of a parameter. So those might be addressed more explicitly where they appropriately reside in the technical bases.

VICE CHAIRPERSON GARRICK: Bob, I'm having a little trouble really making the connection between the integration and the technical bases. Both you and

April identified the Yucca Mountain Review Plan and the Safety Analysis Reports as the documents that's guiding your end result here. But when I think of integrating of these issues, I'm asking myself well, what is the road map for this integration? And I would assume that the road map has to be TSPA which you've not mentioned.

If we're really talking about context of the issue, I guess I'm still struggling with what is that context and why isn't it the performance assessment?

DR. ANDREWS: Let me -- if you bear with me for about two more slides. We did not start with the YMRP. We did not start with the Safety Analysis Report outline, if you will. We started with the processes and the integration of processes that are potentially important to performance, that have to be addressed, if you will, in the post-closure performance assessment. And then we had various ways and I'll come to here in a second of combining them or splitting them in a way that developed the most clear distinction of how to integrate individual responses because you're not going to integrate the whole thing when you're really talking about in-drift chemistry.

VICE CHAIRPERSON GARRICK: Yes, I agree

with the integration idea. That's a very good idea. I just have not yet comprehended it.

DR. ANDREWS: Okay, so I appreciate that and bear with me. Maybe too many introductory slides.

So going to slide -- the next slide.

(Slide change.)

DR. ANDREWS: I'll try to get to the methods that we considered. The advantage of this is that developing that integrated technical basis allows us and I believe also NRC staff to identify potential gaps or weaknesses or additional information required in an early enough time frame to gather that additional information or do those additional analyses or whatever might be the activity that's required.

Placing them within that context of the integrated technical basis for the Safety Analysis Report allows more transparent discussion of its role as it affects or potentially affects the inputs that go into the post-closure performance assessment. So it's a bundling of information of like kind that address a component part of the system that affects the total system performance.

The relevance of that, putting that into that context allows us to discuss, I think, more readily why it was a KTI agreement and therefore more

directly address that KTI agreement to begin with. Most of the time, this isn't -- there is always difficulty with generalities here, but most of the time, those KTI agreements relate to either testing -- I'm going to start at the most fundamental level and go up, either relate to a testing uncertainty or an uncertainty associated with an interpretation of a test, data uncertainty, parameter uncertainty that's used in a model that's used to assess performance, a model uncertainty itself, or a screening of features, events or processes that were either included or excluded in a discussion of why and the bases for inclusion or exclusion of a particular process.

All of those, I think those of you who have read the Yucca Mountain Review Plan realize are elements of acceptance criteria for each of the 14 abstraction groups of the Yucca Mountain Review Plan. So we're going to put them into the context of that uncertainty of data parameters model processes and features as they relate to integrated safety technical basis.

The next slide --

(Slide change.)

DR. ANDREWS: The number of ways, I think, one can use to combine like agreements or like issues

or like elements of the system, one way is to look at simply time. What happens in the first 100 years? What happens in the next few hundred years? What happens in the next thousand years and what happens in the remainder of the time? And things are different and change and there are different processes that come into play at different elements of time and the relative importance of those processes changes as a function of time.

One could use space, where you are spatially in the system.

One could use some definitions of state variables, pressure, time, flux, radionuclide concentrations, the elements of variable performance are really written in the form of two state variables, normally flux and water contacting waste and release from waste and concentration, radionuclide concentrations and reductions of radionuclide concentrations as you travel through the engineered system and the natural system.

One could arrange it as barriers or one could arrange it as processes and like processes or different scales. What happens at the mountain scale, what happens at the drift scale, what happens inside the drift, what happens inside the package, what

happens back in the drift as packages degrade, by whatever mechanism they degrade? What happens back in the rock and what happens in the saturated zone and finally the biosphere?

What I just walked through was the seven, if you will, scales. I put those in an attachment to this and those seven scales are nominally the seven groups that the NRC staff used in their organization of the risk-information report. It started with UZ stuff, flow, seepage, climate, infiltration. It went to in-drift things such as degradation of the engineered barriers. It went on to release, transport, mobilization and release from the package and mobilization of radionuclides. It went on to unsaturated zone transport, saturated zone transport and finally the biosphere and then finally low probability of destructive events.

So it was that grouping by scale, nominally, that we started with. Having started with that though we ended up going to the next slide.

(Slide change.)

DR. ANDREWS: The integrated elements of the technical bases for the Safety Analysis Report which became the integrated technical basis for the KTI agreement responses.

And Dr. Garrick, going to your question, I think these 14 elements are well recognized as some of the key elements of the TSPA. In fact, it's all of the elements of the total system performance assessment and their individual linkages. What we haven't shown is the linkage in TSPA because the questions, there are some explicit KTI agreements and I'll come back to those here in a second, that are specifically TSPA-related and how the linkage and how the barriers are described and how the barriers are quantitatively evaluated that are explicit TSPA questions. I don't mean TSPAI, I mean TSPA questions, Total System Performance Assessment, the model, the analyses, the calculations, the validation, etcetera, are explicit to TSPA. I'm talking here about the KTI agreements that related to an element of the post-closure technical basis for the license application or the post-closure performance assessment.

Starting at the top with climate and infiltration, going through unsaturated zone flow, water seeping into drifts and mechanical degradation and the high probability of seismic effects where high is on the order of 10^{-4} or 10^{-5} per year occurrence. The in-drift chemical environments, which are affected by what happens in the rock and what happens in the

drift; the degradation of the waste package and drip shield and I think you can read the rest.

The next slide --

MEMBER LEVENSON: Before you leave that one for a minute, is there any significance in the difference in wording between 13 and 14 and what you've just said? Does that mean you consider volcanic events as 10^{-3} or 10^{-4} that you haven't categorized them as low probability?

DR. ANDREWS: No, the significance is between IV and XIV. There is a distinction between seismic events of annual recurrence of 10^{-4}, 10^{-5} per year and seismic events on annual occurrence of 10^{-6}, 10^{-7}, 10^{-8} per year in terms of their effect on degradation, their effect on package, their effect on the drip shield, etcetera. And how they are handled within the post-closure performance assessment will be a little bit different whether they're in the 10^{-3}, 10^{-4} annual recurrence interval versus if they're in the 10^{-7}, 10^{-8}. No, we have not changed the probability of volcanic events. They are a PDF that goes from 10^{-7} to almost 10^{-9} per year. The mean I think has changed a little bit, 1.6 or 1.8 times 10^{-8}.

So that's the only distinction there. We're not trying to make a distinction between 13 and

14.

(Slide change.)

DR. ANDREWS: If I go to the next slide, this kind of puts them into spatial graphical context, going from larger scale, unsaturated zone flow processes into more local scale effects in the drift and even finer scale effects inside the package with respect to radionuclide mobilization, water contacting waste, the chemistry on the waste, degradation of the waste form itself and then going back out into the rock. So that's more for information purposes.

Going on to the next slide, this maybe gets a little bit at your question, Dr. Garrick and hopefully the next slide as well.

(Slide change.)

DR. ANDREWS: If I just look at RDTME, that's maybe not a good example.

Thermal effects on flow is a good example. There are a number of TEF KTI individual agreement items. Some of those relate to UZ flow, what happens at a sort of large scale with respect to water seeping into drifts. It really is a seepage issue that's being asked and therefore a seepage answer should be provided. Some of those are really related to mechanical degradation and seismic effects even though

it says thermal effects on flow, the real question that's being asked is related to the degradation due to that thermal effect, not thermal effect per se.

And some of those are even in-package environment. They're asking thermal questions, but it's a chemistry issue that is being asked. So we're lumping and combining across individual KTI areas which I know, if somebody has organized by KTI area, then there are multiple people who are affected by a particular KTI area, even though the issue really is the chemistry in the drift or the issue is the hydrology in the drift.

So this gives an initial cut mapping of the KTI areas with the KTI integrated responses that we are preparing.

I put down there for completeness the pre-closure 1, even though it does not, obviously, relate to the post-closure case. And I should point out in the TSPAI one, there are a number of TSPAI agreement items that find their way in individual technical elements of the technical basis discussion. The TSPAI, technical exchange, was the last technical exchange other than the general one on thermal effects and the repository design associated with thermal loading strategy. So there was lot of additional

individual items added there. The features, events and processes discussions all got rolled into TSPAI 201, 202, 203, 204 and those are going to be discussed really where they belong which is in the individual technical elements where that feature, event or process relates.

That's a mapping to the KTIs.

(Slide change.)

DR. ANDREWS: The next slide maps it to the 14 abstraction groups in the order that they are presented in the Yucca Mountain Review Plan, the draft final Yucca Mountain Review Plan. So in some cases there is a one to one mapping. We are mindful, going back to your question, Dr. Garrick, of the Yucca Mountain Review Plan and the organization of the Safety Analysis Report, but we didn't start with that. We started with the integration of technical areas, of technical process areas and like process areas at like scales. So we started with a scale process description and ended up with comparing it to the Yucca Mountain Review Plan and making appropriate changes to align it a little more easily and readily and transparently with the Yucca Mountain Review Plan. You see there are some elements that cross still multiple abstraction groups as defined in the Yucca

Mountain Review Plan. I think you saw that in the NRC's June 5 Risk Summary Report, too, that elements of risk, elements of KTI agreements could map into different elements of the Yucca Mountain Review Plan, multiple elements of the Yucca Mountain Review Plan.

One that encompasses a fairly broad range of categories is that number 3, the quantity and chemistry of water contacting waste packages and waste forms. Well, there's a lot of things in there. First, there's water things associated with seepage and in-drift processes. There's degradation effects on water seepage and effects in the drift. There's chemistry effects in the rock and chemistry effects in the drift. There's water in the package and chemistry in the package and so there's a lot of individual issues and a lot of elements of the post-closure performance assessment that are integral in that chapter 3, if you will, the quantity and chemistry of water contacting waste packages.

If I can go on to the next slide --

(Slide change.)

CHAIRMAN HORNBERGER: Bob, before you move. If I did my sums right, those numbers in parentheses add up to about 60?

DR. ANDREWS: Should be 62.

CHAIRMAN HORNBERGER: Sixty-two? Maybe I missed two. Okay, the remaining 80 or whatever are in TSPAI and other areas in the other abstraction groups?

DR. ANDREWS: Yes, they're in the other abstraction groups. For example, in package environment probably has eight. The waste form degradation and solubility, there's about six in there. In UZ flow or UZ transport -- UZ flow, we've addressed some of those using what we're going to talk about this afternoon, but UZ transport is probably 15 KTI agreements sitting in there.

The actual TSPA ones that are specific to TSPA like barriers, barrier descriptions. There's only about eight really that are totally specific to TSPA. I'm leaving out TSPAI 201, 202 which are really FEPs, features, events, processes related that we're going to map back out to where they really reside.

I think Tim is going to walk through the actual sum of the remaining KTI agreements and their schedules. That might also address your question.

Let me take one example. It's one that was the focus of a lot of discussion. The KTI agreements weren't the focus of a lot of discussion, but we had a lot of technical discussion with the Commission and with yourselves a few months ago

associated with what's the chemical evolution and its potential effect on degradation modes, on the drip shield and the package, just the chemistry effects on the degradation, not mechanical or stress or thermal-related degradation models which also can affect the engineered barrier performance.

These are 14 here, KTI agreements, read between CLST, container life and source term; ENFE, evolution of near-field environment; and TSPAI. I've taken the liberty to always -- it's always very dangerous to take the liberty of shortening the actual words of a KTI agreement because they were very carefully chosen words in the initial agreement and you don't want to lose site of the meaning of those words or the bases for the meaning of those words. So given the fact that I've taken that liberty to put it on to one slide, rather than six slides, you see that most of these questions or all of these questions relate to our uncertainty, either in data or parameters or the model for the evolution of that chemistry that may contact within the water that may contact either the drip shield or the package and the last two -- well, I'm sorry, the next to the last one and the relevance of the testing environments that we have done testing, corrosion, degradation, materials

degradation testing within and compared to that evolution of chemical environments in the drift.

So you see a range of things like an update to one of the analyses documents. Well, that's in the process of being prepared right now. What's the range of chemical compositions that could affect the degradation. That's really the heart of the whole issue is what is the likely range, the uncertainty, if you will, in the chemical constituents and the trace constituents like fluoride, I think it's specifically mentioned, in a couple of these KTI agreements, that could affect the degradation due to corrosion processes predominantly or stress corrosion cracking of the drip shield or the package.

So we are putting these all into one integrated technical response, related to environment in the drip, chemical environment in particular in the drip. It's also affected, chemical environment in the drip, is affected by chemical environment in the rock and the evolution of chemical environment in t he rock to become very intimately tied so there's some of these that relate to the evolution of the chemical environment in the rock. The second one, for example, the thermo-hydro chemical model is in the rock. That's the question there.

So those are being put together in one integrated response.

These 14 integrated responses have been assigned, I guess is probably the best way of saying it, to 7 lead authors; 7 lead authors, senior authors who have been responsible for a lot of the work, but are not currently authors of individual analyses or model documents. The current analyses and model documents that are being prepared and are providing their output for input into the total system performance assessment model for the license application are in various stages of checking and review. Those of you who are technical specialists on QA audits that we've had over the last few months and we'll continue to have over the next few months have seen some of those products in varying stages of development.

So we took seven people, senior people outside of the development of those analyses models and gave them authorship and writing responsibility, if you will, to prepare these integrated responses and integrated development of the technical bases for the SAR.

So I think I have one more slide to conclude.

(Slide change.)

DR. ANDREWS: The conclusion slide. I think there are some distinct advantages to developing, if you will, pre-draft sections of abstraction chapters of the Safety Analysis Report, even though they're going to be arranged a little bit differently, just on how technical areas combine. It puts those key technical issues and the agreements therein into the context of what is really not only important to the post-closure performance, but I think in the context of why they were written as KTI agreements to begin with. It's generally related to the uncertainty associated with data parameters models, etcetera.

It consolidates those like agreements into one response. It allows you to write one response in that it addresses multiple KTI agreements and puts them into that context.

As April said, we realize the downside. This has been not been discussed I don't think formally, although the letter went over yesterday, right, of which KTI agreements were going to come in when and which ones were in which of these 14 groups. But there hasn't been formal discussion with the NRC staff on this. And there will be some burden because

you've developed an answer to 14 questions in an integrated fashion, but those 14 questions may have different owners and different reviewers within NRC staff, so we understand that burden that it may place, but I think it has the upside advantage of early on identifying, and early on means late this summer, essentially, they start and Tim's going to have the schedule here in a second, early on starting those discussions of what goes into the post-closure elements of the Safety Analysis Report itself.

So with that I'll stop there. Some back-up slides that divided this up instead of into KTI groups, divided it up into process groups which is really where we started and ended up with what I showed you. I don't want to show you a sausage being made of how we did this integrated so I kept those in the back-up.

VICE CHAIRPERSON GARRICK: Okay, Mike, any questions? Milt? George? We'll probably have some questions. I'm still very interested in making the connection between -- this is partly an NRC and DOE problem, of making the connection between the key technical issue agreement items and the bottom line. For example, when you say "basis for evolution of brine water chemistry", my question is well, what is

the connection between the importance of brine water chemistry and the CCDF? That's where I'm going.

And if I see that even though there may be several orders of magnitude of uncertainty associated with the impact of brine water chemistry, and that makes a lot of people nervous, I don't much care if it doesn't have an impact. And I haven't quite received, I haven't quite arrived at a comfort zone yet for that mapping, for that particular kind of mapping. But maybe we will as we progress.

DR. ANDREWS: I think we're kind of getting a little bit into this afternoon's discussion.

VICE CHAIRPERSON GARRICK: Right.

DR. ANDREWS: I think as April said, I think both of us -- well, we'll speak for ourselves. For DOE and the contractor receiving NRC responses to KTI agreement items, that we have proposed to be risk-informed, so use either a total risk-informed approach, i.e., it didn't move the needle at all, or use that in context with additional technical discussion and a risk-informed approach and even though they might be low-risk significance and we may even agree that they're low-risk significance, you've seen the letter of some of the ones that we've sent in as low-risk significance and NRC in their letter to

the Commission on June 5th agrees that they're low-risk significance. But there is additional information still requested that we can talk about this afternoon and what the basis for that Additional Information Needs request is.

VICE CHAIRPERSON GARRICK: Yes. I realize that each of these items have to be addressed, but I'm still very much more interested in their impact on the results than any of the other issues.

Before we get too deep into the presentation, we have a note that Dr. Frank Rahn of EPRI wants to make a comment regarding April's talk.

Frank?

DR. RAHN: Yes, thank you. My name is Dr. Frank Rahn. I'm with the Electric Power Research Institute and I'm the manager at risk applications. Can everybody hear me?

First of all, I want to applaud the presentations today because I think this is genuinely a step forward in terms of providing additional insights as to the importance of the various technical issues. We applaud both DOE and the NRC for the risk-informing of this approach and being consistent with modern regulation.

But the question I have is really what are we

going to do with this information? And it has to do with, I think, some of the things you had started to touch upon, John, a few minutes ago is that a license in Yucca Mountain is obviously of great importance with regard to the national policy as well as for public safety, but presumably when the DOE and NRC agreements on the resolutions of the KTI was arrived at, the risk prioritization information was not known at that point.

Now it is available, so now the risk importance we need to have, in my opinion, the prioritization of the issues themselves in terms of which are more important than others in terms of the timing of that resolution, presumably those that are of the highest risk importance would be resolved first; secondly, the allocation of resources in terms of resolving these issues; and lastly, the sufficiency of knowledge required to close out the issues themselves. And again, there is at least in my mind one additional risk which hasn't been addressed and that's the risk of timing. That is there is a risk in not proceeding expeditiously in terms of getting Yucca Mountain licensed according to the agreements and the current schedule calling for a license application in the December 2004 time frame.

Now as I understand it and as the presentation this morning went on, the KTIs have been ranked according to high, medium and low. My specific question really has to do with what are we going to do with those that are ranked in the low category? Presumably, if they are really low, that is if we have sufficient confidence that they're priced in the right category, why are they still on the KTI list?

A second and related question is really, again, if they're really low, do we have to have a resolution of these prior to the license application itself? That is, would it be sufficient that a license application go forward without a full resolution of all the low categorized issues?

Now in the best of all possible worlds, all of the issues would be resolved prior to license application, but we all know that everybody, the project, NRC, industry and what not are under some rather stringent time constraints and timing is important and the question really has to go to is it necessary for a license application to go forward in order for all the so-called low KTIs be resolved?

And likewise, for those that are ranked as medium, what are we going to do with the medium-ly ranked KTIs? Same questions come up. What do we do

with the allocation of resources? What are we going to do in terms of timing, the resolution of these issues? And lastly, what is the "standard of proof" that we need to resolve these in some way that's consistent within NRC regulation? So again, as I stated, if we can, it's the best, if we can resolve all the issues and we can't, what is the timing for prioritization and I really would like to hear out of this meeting either now or later this afternoon some clarification from DOE and perhaps NRC as to some of these issues.

Thank you.

VICE CHAIRPERSON GARRICK: Okay, thanks, Frank. I think you've provided some interesting points as background for our upcoming talks as well as the ones we've had.

This issue of the schedule of the project is indeed a critical one and the whole idea of a risk perspective is to put ourselves in a position that we are spending most of our time on what's really important and I hope that that's the direction it goes.

Okay, with that, unless there are other comments, I guess we go to the third speaker and that's Tim Gunter, right?

MR. GUNTER: Right. Good morning. Can everyone hear me okay?

My name is Tim Gunter. I'm with the Department of Energy in Las Vegas and I'm the lead for NRC interactions and KTI resolution.

I'm going to talk a little more about basically what NRC would expect to see in terms of KTI resolution products and when you might expect to see them, following on April's and Bob's -- they sort of laid the strategy in how we developed our approach, so I'm going to talk a little more, in a little more detail about what you will see and when.

As we've already mentioned, the primary objective is to explicitly and transparently address each KTI agreement and additional information that has been requested by NRC staff. And we've already discussed that we want to do this in the context of the total system, so I'm not going to go into much detail on these bullets. I think we've probably discussed most of this, but we want to put in a total system context and not address it individually and separately.

We want to use a technical basis for the license application as far as the base for the discussions that we'll refer back to and as mentioned,

we think this is one of the strongest advantages of this approach is this technical basis document will give NRC staff sort of a preview of what it expects to make up the Safety Analysis Report.

And then as we also discussed it's consistent with the Yucca Mountain Review Plan and we've showed you the mapping in Bob Andrews' talk of how it relates to the plan format.

Also, I want to mention that Don Beckman is our contractor lead for this effort and he has a senior staff of BSC and lab managers that are assisting him. Bob Andrews is, of course, one of those. And they have an almost dedicated effort to this and they've been working hard over the last couple of months to put this approach together and to lay out, help us to lay out the strategy that we're showing you today.

Next slide.

(Slide change.)

MR. GUNTER: There's 194 KTIs and Additional Information Needs that we've mapped into the logical groupings that we've showed you in the earlier presentations. And we're preparing the technical basis documents basically being in two phases. The first phase we have begun -- actually,

we've begun both phases, but primarily we're working more intently on Phase 1 and we expect to that completed this fall.

Late this winter and into the spring of 2004, after we complete the Phase 1, we will shift more of our attention to the Phase 2 products which I'll show you more in detail in the later slide.

So the NRC staff should start seeing products delivered to them in the fall of this year and that would continue through 2004.

And also, as we have discussed there, there are a few KTI agreements that do not logically fall in any defined group. There's about 13 of those, primarily related with -- not related to post-closure processes and we've scheduled those individually. But we'll be working in parallel on those with the other phases and those also go out through mid-2004.

MR. LEVENSON: Let me just ask a question of semantics. I don't think there are 194 key technical issues. You really mean agreements?

MR. GUNTER: Key technical issues and agreements, and it also includes Additional Information Needed, that has been requested by the staff.

MEMBER LEVENSON: Because the KTIs, per

se, there aren't that many.

MR. GUNTER: There's a total of 293 --

MR. LEVENSON: Agreements, not issues.

MR. GUNTER: Right. There's basically 9 KTIs.

MEMBER LEVENSON: Right.

MR. GUNTER: So it's 194 issues and Additional Information Needs.

Next slide.

(Slide change.)

MR. GUNTER: Okay, we've talked about we're going to provide the technical basis description for each group topic and individual KTI agreements and Additional Information Needs responses will be discretely addressed.

What we envision is you'll have the technical basis document and what we want to make sure that we do is that either in that document each KTI will be adequately addressed and identified or we will provide, in some cases, additional information in terms of an appendix to that document where it may not be appropriate to go into that level of detail in the technical basis document, but we would provide that additional detail in the appendices.

But at any rate, we're going to identify

in the appendices to the document so that each KTI agreement will be explicitly called out and addressed, either in the appendices or a combination of referencing back to the technical basis document to address each KTI.

So we want to make sure that we're clear and transparent, that we address each KTI agreement.

I think that covered basically that whole slide. We'll go on to the last page which is sort of a general schedule of what I've discussed.

(Slide change.)

MR. GUNTER: It shows the top line there, the Phase 1 licensing case development. There are seven groups in Phase 1 which we have started, work is in progress on that now. And as I mentioned products from that effort, you should begin seeing this fall. That's in parallel with the specific KTI responses. KTI agreement responses. There's about 62 of those related to Phase 1. Those are in progress parallel with the licensing case. And you'll see those submitted either in parallel or within short time frames of each other.

And then there's a few remaining agreements that will continue on after the initial submittal this fall.

The second phase, about the middle of the page there, Phase 2, is the second group of 7. As I mentioned, we have started on that to some extent, but primarily we're focused right now on Phase 1. As Phase 1 completes we'll shift our attention and resources to those groups in Phase 2. And the process is similar. We'll work in parallel to develop specific KTI agreement responses as necessary and submit those through the end of 2004.

In the bottom section of the schedule shows those 13 ungrouped KTI responses. We'll be working those again in parallel with Phase 1 and Phase 2 and submit those primarily on an individual schedule throughout the 2003-2004 and some into early calendar 2005.

As April had mentioned, we basically finalized the schedule last Friday and transmitted it to NRC staff yesterday. So we don't have a lot of the details in this presentation, but we did try to levelize the submittals of the agreements to the extent possible. There is somewhat of a peak this fall in the August-September-October time frame which is primarily the result we're trying to catch up from early this year where we haven't submitted any agreements since I believe January with the exception,

we submitted one last week. But as April mentioned, there's a number that were due originally on the schedule early this year, so we're trying to catch up with those this fall as soon as possible. That's part of the reason for the peak.

But to the extent possible, we tried to levelize it so that it would be -- not make such an impact on either our staff or NRC staff.

And for the remainder of this fiscal year, it looks like about 46 agreements and Additional Information Needs that we intend to respond to that will be a carryover into the first part of fiscal 2004 into October time frame. There will be a number submitted there that were originally in the 2003 schedule. So that's why that number is a little bit low, but it will catch up early to fiscal 2004.

And overall, we believe we've pulled back some of the outlying KTI agreements that were further out in the schedule. We've shifted the peak from out in 2004 into late of this year.

And that's the end of my presentation. I'd be glad to take any questions anyone might have.

VICE CHAIRPERSON GARRICK: All right. George?

CHAIRMAN HORNBERGER: So this all, of

course, appears to make perfect sense, that is, things that are related should be treated in related fashion.

It strikes me though that there is, at least, the potential for a glitch here in that the DOE staff groups things in a certain way, but unless the NRC staff accepts that grouping, it strikes me that there is at least the potential for a mismatch and so you did all of your key technical exchanges on the basis of KTIs and came to the specific agreements and now you're going to transmit information even with a cross walk to NRC staff. So I mean I can envision at least whether this would happen or not, is that Bob's example, you'd have CLST 1.01 and ENFE 2.04 in the same group and the NRC staff might have different people looking at this and the different groups in NRC might come to different conclusions as to the adequacy of the material presented.

Do you have either plans for on-going dialogue with NRC staff to avoid this or contingency plans for dealing with such disconnects, if they arise?

MR. GUNTER: Yes, I think you point out a real possibility and one of the potential drawbacks to the plan.

What we have to try to work through that

is, as you mentioned, dialogue with NRC staff. April mentioned our interaction schedule that we have throughout the rest of this year and into next year. Based on this new approach, we're going to go back and look at that schedule and see where it makes sense, maybe to change topics at meetings or add new discussion topics. And it would be our desire to discuss with the NRC staff ahead of time before we make a submittal for a group, so that they're aware of what we're doing and understand how it might cross relate in their different technical staff areas.

It may not be feasible to do that, because the schedule for everyone, but that would certainly be our desire.

MR. McCARTIN: Tim McCartin, NRC staff. Certainly, I guess I wouldn't want the impression that when an agreement comes in to NRC and it's CLST, say, 1.03, that the CLST people look at it and that's it. As noted, many of these agreements have tentacles that go to other KTIs and other ideas and certainly the appropriate staff are consulted and get together so that yes, it goes out under a CLST KTI, but NFE people, as appropriate, have been talked to, so it's a single NRC voice that's going back. It would occur whether they're grouped or not.

MR. GUNTER: Right, and in fact, I think we see evidence of that in the meetings with NRC and also in their request for additional information where we may be focused on a specific KTI agreement discussion and more times than not get related type questions from the staff as we're discussing that. They are so interrelated to different areas.

VICE CHAIRPERSON GARRICK: Okay, any more? Milt?

MR. LEVENSON: No.

VICE CHAIRPERSON GARRICK: I wanted to ask the specific question on your schedule where you say "prepare and submit the ungrouped KTI responses" and that would continue through Fiscal Year 2005.

What is going to end up in that group again?

MR. GUNTER: Right now, I believe it's some long-term corrosion testing and some criticality model validation reports. And what we would do -- we plan on addressing all of them before license application. So if anything extends beyond that, we would envision before license application, making a submittal that basically responds to the question and it may have to FAR reference to data that is still coming in, but -- in other words, we believe in

adequately defined path forward for that.

And we are still looking at those agreements that are out before 2004 to see if there's a way that we can pull those back and get them submitted earlier.

VICE CHAIRPERSON GARRICK: Okay, I want to pick up on George's question and comment a little bit on this business of importance ranking of the agreements. We're going to a lot more about that from the NRC later where they have a specific approach to ranking the agreements by high, medium and low.

And your goal, as it was pointed out by Bob Andrews, "is to focus resources on those key technical issue agreements for which unresolved technical issues could impact the repository's ability to meet
post-closure compliance standards."

That's very carefully written. But I guess we're struggling a little bit with and we're going to deal with this from the NRC's perspective as well, but we're still struggling a great deal with how you are going to actually importance-rank these and how the contextualizing exercise is going to take place. Certainly Andrews gave some clues on that, but I'm curious as to what's going to happen there,

whether you're going to take the ranking that's done by NRC and address that in a kind of a feedback fashion or whether you're going to take the initiative when you submit your responses and go out on a limb a little bit as to the importance of the issue with respect to compliance.

Can you elaborate on the importance ranking issue, you or Bob?

MR. GUNTER: I'll start and maybe Bob or April would like to also jump in.

VICE CHAIRPERSON GARRICK: Okay.

MR. GUNTER: I think as we went through this schedule, we didn't have the NRC's rankings that they just issues, so to the extent possible when we received it, we tried to, if not incorporate it, at least see where maybe there were some disparities between what we had ranked and what NRC had ranked.

So that would be the reviewing process to sort of like a continuing process to try and match those and -- I guess two things, where there are differences and one, where there are similarities and how we treat those as -- I think the question that Frank asked, if it's low importance and everyone agrees that it's low importance, do we treat it differently? It seems that we should. But your

question is very valid. The question is how do you treat it and I think we still have some dialogue and discussions with NRC staff to clarify that.

Bob or April, would you like to add to that?

DR. ANDREWS: Yes, let me add. This is Bob Andrews. Tim's right. We didn't have the benefit of NRC's June 5th letter to the Commissioners, but interestingly enough, looking at that letter now, we identified the ones first that we felt were potentially the most significant and wanted to do those first. The environment ones, the waste package degradation ones, igneous activity, saturated zone, flow and transport and those interestingly enough are in NRC's letter what they viewed as the most significant to risk. They broke the package up into two particular ones, one in mechanical degradation and one in corrosion degradation. Having said that, I think it's fair when we look at the guidance in the YMRP, it says evaluate uncertainty in X commensurate with its significance. And what we are doing in developing these draft sections of the technical bases for the Safety Analysis Report, I was being very mindful of that guidance addressing them in the context of their potential significance.

Having NRC's views of that I think is extremely helpful to us because it allows us to say okay, I'll take saturated zone and flow transport as an example here. There are, I think, 16 KTI agreements related to saturated zone flow and transport. Twelve of those are either low or medium and there's two, I think, that are high. Both of the high ones relate to transport in the alluvium and they relate specifically to absorption properties in the alluvium.

So I think that helps us identify where we need to pay most particular attention as we are preparing the integrated technical basis discussion. Clearly, flow is still important. You need saturated zone flow. You need to understand boundary conditions. You need to understand the geology sufficiently in the context of its importance.

You also need to understand transport and transport characteristics sufficiently. I think NRC's high, medium and low kind of says how high that bar is for saturated zone flow versus saturated zone transport. I think we can talk more about it this afternoon when we specifically talk about that report, but I think that would be a very useful example.

VICE CHAIRPERSON GARRICK: Thank you.

Mike, you had a comment or question?

MR. LEE: Yes, thank you. Tim, I'm looking at your slide 5 and am I to interpret the Phase 1, 7 groups that mean 62 KTIs are going to be covered by those 7 groups and similarly for Phase 2, you'll have 121 KTIs covered by those 7 groups?

MR. GUNTER: That's for the initial submittal this fall. There will be a few remaining KTIs.

MR. LEE: And that letter that you referred to yesterday, does that provide a road map, if you will, for what agreements go to what bundle or group?

MR. GUNTER: Yes. It lays out each group and which KTI agreements fall under the group and a schedule for submittal.

MR. LEE: Thank you.

VICE CHAIRPERSON GARRICK: Milt, did you have a question?

MR. LEVENSON: No.

VICE CHAIRPERSON GARRICK: I think one of the things that I'm sure the public is looking for and we're still looking for is the packaging of these agreements in such a way that we can make a real connection between the agreement, the package and the

bottom line results of performance, because otherwise you can get lost in a sea of numbers and items and detail that makes it very confusing to everybody. So I would hope that the importance ranking would be done in such a way that one could aggregate this into the performance assessment in some effective way because the performance assessment is the only document that I know of that is designed to put issues in context, in a numerical and analytical way. The Yucca Mountain Review Plan and the Safety Analysis Reports are products, if you wish, of trying to assimilate the information for purposes of compliance, but it's not -- they're not the documents that are going to provide the real insights into the importance of specific issues.

So I think the grouping and the integration are absolutely critical and essential, but I hope it's done in a way that one can -- to borrow Bob Andrews' word, do an intelligent mapping from the key technical issue agreement to the key technical issues to the contributors to the performance of the repository. That road map is extremely important and I think we're still struggling with that.

Are there any other questions from the floor? I think the comment that Frank Rahn made was

very important. I think timing in this whole process is critical and I think we have the challenge of not only deciding what's high and medium and low, but being able to convince ourselves that what's in each of these categories such as low and medium is not, in fact, with a few different insights and assumptions you could move into the high category and that's why we cannot dispense with them quite as easily as we'd like. We've seen this happen particularly in risk assessment work in the past.

All right.

MS. GUE: Thank you, Mr. Chairman, It's Lisa Gue with Public Citizen. I also wanted to thank the Committee for devoting the time today to the issue of key technical issue resolution which is also an important problem for those of us with concerns about the Yucca Mountain repository plan and as I'm sure you're aware, the technical -- the Nuclear Waste Technical Review Board, again, this spring reported to Congress that the Department of Energy's technical work on Yucca Mountain has a weak to moderate basis and we hope that the NRC and the Committee will hold a higher standard.

I just wanted to say perhaps needlessly that Public Citizen does not share their views

expressed earlier by EPRI, that the key technical issues should be addressed so as to expedite the licensing of a Yucca Mountain repository. In fact, we're increasingly concerned to the extent that this process seems to be a little bit turned on its head, leaving the impression that there's a foregoing conclusion in support of Yucca Mountain licensing and the resolution of various technical issues are merely a set of hoops to be jumped through first. It feels a little bit like attempting to build a foundation after you've already constructed the house.

We just really hope that the Committee might be able to weigh in with the NRC in support of what should be the obvious process of a confidence in repository licensing, if it is warranted, flowing from a sound technical basis and not the other way around. Thank you.

VICE CHAIRPERSON GARRICK: Thanks. thanks for that comment.

MR. LEVENSON: John, I have --

VICE CHAIRPERSON GARRICK: Go ahead.

MEMBER LEVENSON: Yes, I have a kind of a generic question and that is in responding to the agreements where you're submitting information that's either been calculated or has been obtained

experimentally, is there a policy of your submitting best estimates or are you rounding everything upward to bounding values?

The Committee, as you know, has been very concerned about the fact that unless we deal with best estimates and best evidence, we completely lose track of what might or might not be risks. And so it's -- I'm curious as to what is the philosophy of submitting data as part of this program.

MR. GUNTER: I'm going to see if maybe Bob, maybe you can help on that? I think it's a sort of mix.

DR. ANDREWS: Yes, I mean, the objective is to reasonably characterize the uncertainty that we have in data, in information, in the extrapolation of those data to places where we don't' have date, for example, in spatial domain or in temporal domain.

So we're trying to reasonably capture that uncertainty for a reasonable assessment of overall system performance. And the individual components that lead into that overall system performance.

Where there is very large uncertainty or conflicting information, we might either expand the range to encompass the whole range of uncertainty, or if it's easier to defend, so now you have a

defensibility issue. Take that more conservative answer --

MR. LEVENSON: Let me interrupt you and object to the use of the word "conservative" in a meaning where it isn't necessarily conservative at all.

I think that this Committee has really focused a great deal on trying to say you need to identify and carry the uncertainty, but that's a whole separate issue from the question I'm asking. If there is uncertainty when you present data, are you including the uncertainty without identifying it as uncertainty and just getting a rounded, upward number?

DR. ANDREWS: No, no, no. If it's data, then it's the full range of the available data, whether those data are project-specific data or whether that information is other information available in the literature. There's no --

MEMBER LEVENSON: Is that also true of calculation? Calculated data?

DR. ANDREWS: Give me an example. Data are generally observed and measured, not calculated.

MEMBER LEVENSON: A lot of the KTI agreements, I think, require additional analysis in calculations. And one of the things that we've

encountered in looking into the detail is almost every analyst tends to round things upward beyond the range of real evidence and what we're saying is is that being watched for as you respond so that you are, in fact, presenting best evidence that you have, plus the uncertainties.

DR. ANDREWS: I believe the answer is yes, but if you have an example, probably it may be more useful to talk about a particular example.

MR. LEVENSON: Well, if you sit through the meeting of this Committee, you'll find at almost eery meeting, we dig up a half of dozen in presentations that come to us when people are talking about data and facts and numbers.

I was just wondering if you had a policy in preparing these responses to, in fact, try to provide best estimates to the best of your ability?

DR. ANDREWS: Yes. Best estimate with their uncertainty, yes.

VICE CHAIRPERSON GARRICK: Okay, I think unless there's more questions, we've come to a point where we're supposed to break and I'll turn it back over to the Chairman.

CHAIRMAN HORNBERGER: And, in fact, John is exactly right, we are going to break for lunch.

We'll reconvene at 1 o'clock.

(Whereupon, the foregoing matter went off the record at 12:04 p.m. and went back on the record at 1:03 p.m.)

CHAIRMAN HORNBERGER: The meeting will come to order. This afternoon we are going to hear presentations on risk significance ranking. And, again, John Garrick is the cognizant member, so I'll turn the meeting over to John.

MEMBER GARRICK: Okay. We're going to first hear about the use of risk information as a basis for agreement closure, and we're going to hear from both NRC and DOE experts on this subject. And I think Andy Campbell is going to set the stage -- or he was.

MR. CAMPBELL: Yes, I'm here.

MEMBER GARRICK: Oh, okay.

MR. CAMPBELL: I'm Andy Campbell. I'm Chief of the Performance Assessment Section at the NRC. I just wanted to briefly introduce NRC speakers today. Dave Esh is going to be talking about risk-informed issue resolution. In essence, Dave's presentation and I assume the follow-on presentation by Bob Andrews by DOE are going to cover topics discussed at a May 15 technical exchange between NRC

and DOE concerning kind of methodological issues in terms of closing agreements on the basis of risk analysis. And then after the break Tim McCartin and Jim Danna from the NRC staff will be talking about the NRC's risk ranking of the 293 agreements.

Today's presentations from the NRC are intended to provide a status to the Committee, and the final risk insights report from Tim McCartin's and Jim Danna's presentation will be at the end of the fiscal year, end of September this year, and we expect that we would make a presentation to the Committee on that final report. It will be a much thicker report. What we're presenting today is essentially an executive summary and a status report.

We're not necessarily looking for a letter at this time; however, we are interested in the Committee's ideas, thoughts and suggestions on communicating risk insights and understanding of these insights.

MEMBER GARRICK: Good. Thank you. Okay. Dave?

DR. ESH: It's my pleasure to be here today. Can everybody hear me okay? All right. I think we need to get our presentation out. I'm going to talk about the risk-informed process, give you some

of NRC's perspective. We had a recent technical exchange with the DOE on May 15 on this topic, and I'm going to be talking primarily about methodology, maybe some practical aspects. Whereas the talks that follow later in the day are going to cover more of the implementation of this philosophy. But this process is specific to issue resolution.

In some cases here, in most cases, when we're talking about risk-informed issue resolution, there is a subset of agreements that DOE wants to resolve with risk information in lieu of the originally agreed upon information, and NRC supports that approach. The terminology that has been used has been to refer to those agreements, but that's not really important. What you do need to know is that these agreements are pretty much two different types. They represent in some cases an agreement to evaluate the uncertainty associated with the model and whether the treatment of uncertainty was appropriate in the TSPA or in the sub-models.

And then some of those agreements represent information where the actual uncertainty range or uncertainty values or conceptual model were questioned. So it's not necessarily a basis of reducing the uncertainty but whether the treatment of

uncertainty was appropriate. And this is a direct quote from our first letter on this topic to DOE, and basically we wanted to reiterate that we encourage the use of risk information for models data and barriers.

Just some overview and background, as of 9-21-02, which when we had the technical exchange was the most recent information we had, DOE had proposed 31 agreements to use this risk information, and we had received nine of those. The agreements cover multiple areas of the TSPA, and one of our main concerns was that the quantitative analysis that's performed to evaluate the risk significance of those agreements should address the system nature of the TSPA model, and the uncertainties should be propagated through that model. And a lot of this presentation I'm going to cover that last aspect, but I'm also going to summarize the main elements that we thought were appropriate for risk-informed agreement resolution.

The overview of the DOE analysis is basically DOE performed sensitivity analysis using the TSPA model, so that's good. The uncertainty associated with an agreement is evaluated, and typically what was done is the behavior of a model, whether it's from a parameter distribution, the model itself or the uncertainty in a parameter distribution

is set to a very, it's subjective, of course, but a pessimistic state, so you've made the uncertainty to -- or you've made the parameter and model behave at a state that you don't expect. And then from that analysis where they looked at an agreement, they concluded that if the absolute change in the dose is less than one millirem, then that agreement is not important to meeting the performance objectives.

The main concern we have with this approach is in and to itself it doesn't necessarily recognize the system nature of the model and the propagation of the uncertainty. Because the TSPA model, you could probably take every parameter in it and set it to a pessimistic value except maybe the general corrosion rate and you would reach that conclusion on the bottom line, which would say I don't need to know anything about any of these parameters except for one, and I don't know if that's necessarily the right answer, maybe it is.

So what we get is this is a figure out of one of the agreement submittals. It's also out of the risk prioritization report by DOE. They'll take the base case state, which is given by the solid lines. The green is the nominal scenario, and then the blue is with the igneous activity groundwater scenario.

And then they'll set an agreement item, a parameter, a model to a pessimistic state and evaluate what the change in the dose is. So here you see relative changes. The change in the base case dose is very small. There's a more moderate change in the igneous scenario from the sensitivity analysis. And from this they would conclude that the model is not sensitive to the changes in the infiltration rate.

Whenever we receive these agreements, or originally proposed, I should say, these were the areas that the agreements covered. The infiltration, seepage, unsaturated zone flow, drip shield performance, THC effects on seepage, this is thermal-hydrochemical effects on seepage -- sorry for the use of the acronyms -- and thermal-hydrological mechanical effects on permeability. Those all impact water flow in one way or another.

And then there were a couple of other areas, in-drift chemistry and cladding performance, which are -- sorry, in-package chemistry and cladding performance, which are related to the source term, and in-drift chemistry. And this middle one here was probably the big hang-up that we had. Because in the risk prioritization report, DOE did a propagation of the uncertainty associated with these agreements, but

the feedback that we had from our process level experts is the uncertainty that was added into the analysis for the in-drift chemistry was not appropriate. And so that was our big sticking point when it came to this problem.

This figure on Slide 8 is from the methods and approach document, and it gives -- you don't need to read the labels. Up here at the top it says --

PARTICIPANT: That's good.

(Laughter.)

DR. ESH: I did that on purpose. I wanted to illustrate a concept without you getting tied down in the details. The TSPA LA model is up here at the top, and then all of these are documents or you can think of them as documents or models that are going to support that TSPA LA. And what I did is I took a red block and I put it over the documents that were associated with the agreement areas on that previous page. So what you can see is that there's a number of areas that may be connected or interacting that would be influenced by that approach to resolve those agreements using risk information.

This is the idea. TSPA is a system model. So then in our responses to DOE when we started receiving these, we had had a number of elements that

we needed in the information to resolve the agreements with the use of risk information. And the elements I'll cover in a summary on the next slide and then provide a little more detail on the slides that follow.

The main elements, and I'll paraphrase these, the first one is why the analysis appropriate? The second one is what did you do? The third one is how much is it influenced by uncertainty? The fourth one is, well, why do the results make sense? Why are they believable? And the last one is partly due to quality assurance but also to recognize that the process that we are in is dynamic. So the model that they may use right now to get their results on the curve with the base case and the igneous case will be an old model by the time we get a license application.

There will be a different model that's used for the license application. That different model may behave differently if you perform this same analysis with it. And the analysis that we receive now for these risk-informed agreements was also done under an unqualified status even though DOE will tell you, I'm sure, they have confidence in that analysis and the conclusions they're making.

So for that reason, for those two reasons,

we believe an element of this process is that we get a confirmatory analysis that supports the current conclusions that would be made.

Now, the technical basis for quantitative analysis, this is kind of a check balance situation. You wouldn't expect that you provide a very high degree of technical basis if you're being very pessimistic in your analysis. So if you have an uncertainty that maybe it is evapotransportation in the infiltration model and you say, "I'm going to be very pessimistic and bound that effect in this analysis," then we wouldn't expect a lot of analysis or a lot of documentation expressing why that analysis is appropriate. If it's easy to see that it's bounding, then that's okay with us.

We would prefer that the analysis is as realistic as possible, but that comes with a price. It comes with a price of effort that you have to put into developing whether that analysis is realistic or not. So we have to deal with whatever the DOE gives us, and if the DOE wants to be pessimistic, then that's what we will review.

MEMBER GARRICK: Dave, isn't the problem when you start using words like, "pessimistic," and words like "ten times higher," isn't the problem is

that you're implying that you know what the answer is?

DR. ESH: Yes. And that's -- I choose pessimism, maybe it's still not the right word. Conservatism, to me, implies that I know what the answer is. Pessimism says based on my level of knowledge I'm going to say it performs worse than that, but I'm acknowledging that I don't know what the true answer is. So, yes, I agree with you.

So we believe with this scaled approach to how much detail you provide for your information for the analysis, but we do need a documentation of the analysis that explains what was done so that we can review it and understand it, because these models are complicated. There's many parameters, they're integrated, and we'd just like an understanding of what went into that analysis so we can tell whether we're seeing an analysis of the effect of the uncertainty that we were originally looking into.

So the treatment of model and parameter uncertainty is the focus of this process, and we expect just a reasoned argument why the analysis appropriately represents the uncertainty or is sufficiently bounding. We don't have an extremely high information need for the appropriateness of the analysis.

And this is an example, I took an agreement, TSPA 319, which related to evapotransportation and the use of site temperature data, to give you an idea of the problem that we're dealing with. The agreement was addressed -- it addresses infiltration and the infiltration rate in the TSPA-FEIS model, according to DOE's documentation, is about 12 millimeters per year, so the question becomes, well, how do I change infiltration to represent this agreement. And in this case, the infiltration was set to a value over ten times higher and an argument was made as to -- I don't know if it was in TSPAI 319 or in a later agreement. In particular, I know this agreement, unsaturated flow under isothermal conditions 302, they provided what I felt was an appropriate justification for the distribution of the infiltration rates used in the sensitivity analysis. So if somebody in the audience wants to get an idea of what we're expecting and what we're looking for, I think this is a good place to look, and I could give somebody a reference to that document if needed.

The second element is that adequate documentation of the analysis, and basically we're looking for enough information to allow for us to

understand what was done without recourse to the author. We don't want -- and I think that's part of the normal quality assurance process is that there is enough documentation that you don't have to rely on the individual who generated the analysis.

And then, in addition, we have that some models and assumptions within the TSPA may not be integrated, so that's why we're asking for this information. It is complicated, we'd like to know what was done, but we're not asking for a detailed description of -- we had stated that even in a summary form like a table these are the changes that were done for this analysis. That would be appropriate for us to be able to tell what was done. We don't need to be walked through the model in detail.

Consideration representation of uncertainties, this is a big element for us. The analysis should appropriately consider and represent uncertainties, and I've talked about or written here potential effects, related potential effects being considered. And if not directly included, they should be discussed at least in a qualitative manner. I'll give you an example of this. Say you have an agreement that deals with the performance of the drip shield, and so in your model you say, "Well, I'm going

to degrade the performance of the drip shield or I'm going to take it out or I'm going to do something to the drip shield and evaluate what the effect of this uncertainty is." Well, in that case, you're saying that the function of the drip shield is only to limit water contact with the waste, but the drip shield may have other functions in the model that aren't represented in the calculation, such as the minimization of the seismic effects on the waste package or the protection of the waste package from aggressive chemical environments. So when we're talking about related potential effects, that's what we're talking about. These other things that are in this integrated system model, how may they influence the output?

So this is the main point: The TSPA is a system model designed to integrate these abstractions, process models. Abstractions are simplifications of a process model. So for those of you that may not know, the step in the process is you have fundamental information, you develop a process model to represent that information, and then in some cases you may use those process models directly in your TSPA, but in many other cases you have to simplify them to make your model execution time reasonable or the

understanding of the model at an appropriate level of detail. And so the abstractions that I mentioned here are in some cases the simplification of the process models that go into the TSPA.

And here we mention the combined effects of uncertainty should be quantitatively assessed. I believe Dr. Garrick mentioned in his opening remarks somewhat of a new term, combined effects, but really we're just talking about the propagation of uncertainties. And combined effect came from Section 3.4 of DOE's risk prioritization report.

And one of the most important elements besides the propagation of uncertainty and the evaluation of it, we believe, is the understanding and explanation of the results. Sometimes they may be counterintuitive, and one of the reasons we use our performance assessment code it's a simpler model, we probably have, at least at this point, a higher degree of understanding in that model, and we'll use it and evaluate whether we get something consistent with DOE, and if we don't, we then try to understand why and that may lead us to a question of what they've done their analysis with.

MEMBER RYAN: Could you give us a good example there?

DR. ESH: Yes. The example of the infiltration rates that I showed earlier and they had the two curves, we performed a similar analysis to that with our TPA code. We increased the infiltration rates to a large amount, did the analysis and saw if we got the same result or not.

The demonstration of understanding of the model and results we believe is essential to developing confidence in the conclusions. And this is important for any scientific process for your modeling, but in particular when your model is complicated and there's lots of uncertainties, we really find that this -- if you're not doing this step in the modeling process, then you should be reasonably uncomfortable with the conclusions you should be making.

And we believe strongly in simple physical arguments and presentation of intermediate outputs. We believe that enhances confidence in the results. And that's a really good step in the modeling process. We get caught up in the details of the models, but sometimes we need to step back and say, "Does this make sense? Even if I can present a simple argument, why does my model make sense? How would I convince somebody that's not an expert in this field that this

is a reasonable model?"

Now I'm going to go into in some detail the combined effect of uncertainty, and I have some examples in here, they're fairly quantitative, so bear with me. Insights from our performance assessment model, we use the stochastic performance assessment to evaluate the impact of uncertainty on performance, which we call risk, for this repository system. For our base case, ten percent of our realizations, and a realization is just a probablistic state of the model that we use to represent uncertainty, ten percent of those contribute 95 percent of the peak mean dose. So it's not -- you get a non-linear response of the performance assessment model. And usually it's this propagation of uncertainty, which we call combined effects also, which is driving the risk in the model. That's what we observed from our performance assessment model.

And here's an example from our code where we've taken the high realizations -- this was a run of the TPA 4.1j base case with 250 realizations, and I semi-quantitatively pulled out parameters which I thought would make a difference in the analysis. I didn't perform a statistical analysis to pull out these parameters. I did it based on my experience.

I took the five highest realizations, and I'm showing the percentile that each of these parameter distributions were samples at for each realization. And then the fifth column here shows the mean, so for this case waste package flow multiplication factor the mean state that it was sampled at for these five highest dose realizations was the 87 percentile. Now, the highest realization contributed about 16 percent to the mean, and what we would like to conclude is that it's not necessary for key parameters to be at their extremes in order to have a meaningful contribution to risk. It just takes some of the parameters to be at higher values in combinations and they lead to higher realizations. So the propagation of uncertainty can significantly influence the risk.

And this is another example that is more directly tied up -- or made to address the approach that DOE was using, which is this is a hypothetical model, it's done with the GoldSim software package, which is really strong to propagate uncertainty and evaluate simple models. I've identified three parameters, A, B and C. The first one is a normal distribution with a mean of five and a standard deviation of one, so does the second parameter, and the third parameter is uniform, from minus one to one.

And then just made a simple equation, and so these three parameters are going into the equation, and they're all uncertain. And if we run that, I ran it for I think 10,000 realizations, and I checked the stability, you get a mean of about 3.84.

And say this is the problem we're faced with where we're looking at uncertainties in a system model and we had a limit of 15. So we would say, okay, we're good. Our result is below the limit. Now say somebody comes along and they say, well, you have additional uncertainty with A, B and C that's not in this model, and now I want you to evaluate what the effect of the uncertainties of A, B and C are on the model.

Well, to evaluate them, labeled Uncertainty 1, 2 and 3, I perform an analysis which could be analogous to Agreements 1, 2 and 3. I perform three analyses. The first one I change my distribution. Remember it was five before and one; now it's six and 1.5, and I leave the other two the same. So this is similar to one-off sensitivity analysis. And then I take my B and I change it and then I take C and I change it, and I run each of those cases.

And what I get is that for this local --

I'll call it a local sensitivity analysis, that each of the means are below my limit of 15. So I would conclude that, well, none of those uncertainties are important to add into this model because I'm below the limit in each case. However, if you do a combined effect analysis that probablistically looks at those uncertainties, you get a different result, you get a mean of about 20. And this is common in uncertainty propagation. But the issue becomes what needs to be the set of analysis that you're putting together to get this result?

And in this case, we had received 31 agreements. Those agreements that were addressing the basis for models or parameters I believe you have to do some sort of analysis like this that's looking at the combination of those uncertainties. The ones that are addressing whether the range of -- or whether the uncertainties should be reduced, and you can do -- then I think you can do a one-off sensitivity analysis and show that that doesn't impact the output.

MEMBER GARRICK: Yes. One of the things, Dave, you have to really be careful with in this, and I'm sure you are, is that you have to establish consistency between parameter treatment. For example, in some of the early results where there was

uncertainty analysis performed, on closer examination some of the critical parameters were assumed constant.

DR. ESH: Yes.

MEMBER GARRICK: And there was a temptation to say that because you assumed it was constant, such as solubility or something like that, that it doesn't contribute to uncertainty. So the parameter consistency check is really important when you start doing this kind of thing.

DR. ESH: Yes. There are other complications too. Say you have a parameter distribution and you set it to its 95th percentile in order to represent this uncertainty that you don't have put in there, so you fix it to a deterministic state.

MEMBER GARRICK: Right.

DR. ESH: The 95th percentile might not be the most pessimistic state.

MEMBER GARRICK: That's right. That's right.

DR. ESH: There might be some intermediate value or additional complications in addition to the one you mentioned to doing this analysis on these complicated models.

So that's a second example of, okay,

uncertainty propagation in a system model, the first being more directly relevant using the TPA code, but each of those demonstrate the same sort of thing, which is you need to consider the interaction of these uncertainties and how they propagate through this system model.

So in conclusion, though, we would say that these extremely pessimistic analyses, or what I believe are extremely pessimistic where individual uncertainties are not required by the NRC. And we agree that the margin between your analysis results and the performance objective can be considered. So, basically, that means if you're down at 1e to the minus 8 millirem and you can go to 15, then, yes, you have a lot more leeway in what you consider risk significant then if you're at 10 millirem and your limit is 15. That should be considered in this process.

But where we somewhat disagreed with the DOE was that the potential combined effects, this propagation of uncertainty on risk, of these agreement items that in some cases you can think of, you want to drop that information out of the performance assessment or not permanently represent it, one or the other. That's the argument that you're basically

trying to make. So we believe that you need to look at that combined effect and evaluate how significant it may be with respect with risk. And this technical analysis should appropriately consider the system nature of this performance assessment model.

And in summary, here's -- the risk-informed resolution can be done in lieu of the original agreements. We believe that the technical analysis should consider the system nature of the model, the propagation of uncertainty, that confidence in the supporting analysis and resulting conclusions is an essential aspect to the risk-informed issue resolution process.

Now, as I said, we did have a meeting on May 15 that many of you were present, so you can -- I'm going to end now, you can turn your mental snooze off and come back up to listen to the rest of the day, but we have -- the summary of our meeting was basically DOE was in agreement with us on the additional information needs, such as the documentation of the analysis, the explanation of the results, those sort of things, except for the combined effects of uncertainty analysis.

Here's a key point that, the next two, that DOE is possibly reducing the number of agreements

or at least redistributing them. They said maybe 31 to approximately 20. But here was the big sticking point. If you remember I mentioned the environmental conditions for corrosion. As I think you'll hear Tim and Jim Danna talk about this afternoon, that's an area that we believe is high risk significance, and originally in this approach that was an area of low risk significance for DOE. So that was a stumbling point, and it was a stumbling point in the combined effect analyses too. But because DOE isn't taking this approach for the environmental conditions, I don't see that we're that far apart on the combined effect of analyses anymore -- the combined effect of uncertainty, I'm sorry.

So DOE will perform -- they agreed they will perform an analysis with the final fully qualified TSPA model that supports the conclusions that they may have made with these preliminary models. And if that turns out to be unsuccessful, then they'll develop an alternative approach. So I'll be happy to address any questions that you may have.

MEMBER GARRICK: George?

CHAIRMAN HORNBERGER: Just a clarification, Dave. On your last slide, you started out -- the first one says the DOE is in agreement

except for the combined effect of uncertainty analysis. And then farther on down I thought I heard you say that you didn't think that you're very far apart on treatment of the combined effect of uncertainty. So have they agreed now or --

DR. ESH: Well, the difference was -- which slide are you on?

CHAIRMAN HORNBERGER: The very last one.

DR. ESH: Last one.

CHAIRMAN HORNBERGER: Very last one, there. See the first one says that they don't agree with you on the combined effect of uncertainty analysis.

DR. ESH: Yes. This was -- and it's written poorly. This was prior -- we disagreed with them on the need to perform a combined effects uncertainty analysis when they were including the environmental conditions for corrosion. So they said, "We don't need to do that," and we said, "Yes, it is a part of this process, it is something you need to consider, and the analysis that you did in Section 3.4 of the risk prioritization report didn't adequately address this part of the problem." Then DOE said, "Well, we're not going to evaluate the environmental conditions for corrosion of the waste package with

this approach anymore," and so we still believe that they need to consider the combined effect of uncertainty, but that analysis that's in Section 3.4 of the risk prioritization report may be sufficient, that we just need to get the other parts of it, which were what was done in the analysis and an explanation of the results and why they're reasonable.

So that's why I'm saying that I think we're closer together. It will depend on those other information elements which is the description of the analysis and the understanding of the results, et cetera, whether we would find that analysis -- and it's my understanding that they have a resource problem. They have key skills to do TSPA analysis, and those skills are completely tied up with development of the TSPA LA model, and they would probably agree with that. So to do another analysis, this type of analysis, that skill is locked up right now doing something that they believe is more important. So that's why there is this little bit of a disagreement in that area.

CHAIRMAN HORNBERGER: Okay. But see if I have it right now. Well, tell me this is wrong. I'll rephrase it. So I might have heard you just say that DOE has taken out the environmental conditions for

corrosion from the combined effects of uncertainty analysis. And if that were so, then it would worry me based upon the rest of your presentation because if you're fixing all of the corrosion parameters at a constant value, you're missing out on what you just described as potential non-linear effects.

DR. ESH: Yes. I think I confused you.

CHAIRMAN HORNBERGER: Oh, okay.

DR. ESH: Remember we're talking about the subset of agreements that they want to resolve with this approach. So when they're resolving it with this approach, then we're saying you need to do a combined effect of uncertainty analysis. If it's not being resolved with this approach, then it's going to go into the TSPA LA model, and so the combined effect of uncertainties in the LA model will be represented. So think of it as this is an approach to evaluate some of the agreements and they don't go forward from this point into the LA or DOE's arguing that they're already appropriately represented in our models, et cetera. I know that's the case in some areas.

There was an agreement that talked about fast flow paths, and all DOE did -- one of the things they did in their response was summarize what their model already has in it, which is one percent of the

time it has fast flow paths in the unsaturated zone. Is that more clear?

CHAIRMAN HORNBERGER: Yes.

DR. ESH: Okay.

MEMBER GARRICK: Milt? Mike?

MEMBER RYAN: It's a real clear presentation. It's very helpful to see the treatment of uncertainty and how you do it.

MEMBER GARRICK: Of course, when you're doing this sort of work and you're trying to reach some sort of judgment about the importance of different agreements in this case, the reference has to be the risk assessment and what changes in that agreement how that would affect the risk assessment.

The other exercise you're going through there are other ways to get risk insights, and one exercise that you're doing right now is backtracking from the results, such as the principal contributors to dose and peeling the onion, so to speak, to see exactly how that dose came about, which, is as we recommended in the past, an effective way to get a handle on the details of what's driving the risk.

Now, is the work that you're doing in that area also being used to benchmark the importance of the agreements?

DR. ESH: Yes. I can't answer for DOE but, as Tim and Jim Danna will talk about later, we consider that sort of information whenever we develop our risk insights. So I think that what they'll -- I don't know if they'll go into detail on it, but we come at it from a top down and a bottoms up, and in some cases you learn different things. So we may do a barrier analysis that we're looking at underperformance of barriers, and we may also do what's the potential contribution of a barrier from the other direction, and you learn -- you get different insights depending on those analyses that you do.

MEMBER GARRICK: See, what we're really looking for always is what is your reference for reaching the judgments that you're reaching?

DR. ESH: Yes.

MEMBER GARRICK: And how much of it is really analytically based? And what's the context of that analysis? Is it the risk assessment, is it the backtracking analyses, and I'm assuming it's all of these. But if we're really talking about being risk informed, it's got to be accurate to some sort of a systematic, analytical process.

DR. ESH: Yes. I'd say we strongly -- if

I could paraphrase what we do, and they'll cover it in more detail, is we strongly use quantitative information but we're open-minded about you have to understand the context of that quantitative information that was generated. So we recognize that some of the models may have limitations that don't represent an effect or a process in the performance assessment, but if we can do an analysis or do an evaluation, sort of a "what if" type of thought process, then that factors into our determination of the significance. And, remember, we're on the receiving end but ultimately it's DOE's responsibility to make those determinations of significance or not, but we try to be as informed of reviewers as possible.

MEMBER GARRICK: Yes. One of the things that is very important about this whole process is to see if carrying out these kind of exercises that are more systematic and more risk oriented you have some surprises over the knowledge base that existed, for example, when you created the key technical issues in the first place. Now, I realize that the key technical issues, the nine issues, are at such a high level that it's not likely that they all aren't very important. But when you get down into the subissues, that's where you may find some surprises. And if

there's one thing that has come from a comprehensive application of the risk thought process it's been surprises, it's been that you expose contributors to risk that you really didn't think were that important, number one. And, number two, things that you thought were important are not so important. Has there been any surprises in where you were a few months ago or maybe a couple of years ago with respect to what you think was driving the risk and where you are now as a result of these kind of exercises? And maybe Tim is going to come to that, I don't know.

DR. ESH: Yes. I can't personally speak for programmatic surprises, but I can give you a personal surprise, which was when I started at NRC I was in charge of the TPA code development, did a lot of analyses and even did a lot of barrier analyses to evaluate how significant, and in that case I was looking at integrated subissues, or ISI. So I was trying to get a handle on which of the integrated subissues. And it might have come from a request by you what are the important ISIs, and I was assigned that project.

So I was doing analysis to evaluate the integrated subissues, and one of the results that I had was that the source term wasn't very significant,

the actual waste form dissolution rates, the spent fuel dissolution rates. In recent analyses that I think I've presented to you, whenever I got down into that model and actually put it together and put it in a spreadsheet and looked at what it was doing, there's a broad range of spent fuel degradation times or dissolution rates that come out of that model. On one end, it could provide for very long delays. On the other end, it could provide for not so long delays. So in my mind, it completely changed my thinking about that part of the problem.

From the quantitative output of just looking at a barrier, it doesn't show up, and I would say this isn't very important. But when I get down into it, that could be an artifact of the way the uncertainty is treated or the way that pessimism may have been introduced into that model. And, ultimately, you have to defend the model that you're using, and it may be that it's too expensive to defend that one end of that parameter distribution, and I'm going to have it towards the other end of the parameter distribution. So that's a personal example of a surprise I had from doing this sort of analysis, this sort of exercise.

MEMBER GARRICK: Okay. Any other

questions from the staff? Anybody? I guess we go to the next speech. We'll hear from DOE again, Bob Andrews in particular.

DR. ANDREWS: Well, the objective -- is this on well enough? The objective of this, I think at your request, was to summarize that meeting, and it's good that our summaries look pretty well the same, so I cut through the chase and go to a few examples that are different than Dave's and a few numbers that are different and explain why they're different.

But before I do that, I think it's worthwhile to talk about a little of the history of these risk-informed performance-based KTI agreement responses. I think we talked to this group roughly a year ago, maybe a little more than a year ago, about the whole approach to prioritizing not just KTI agreements but prioritizing the technical work required to develop the bases for the license application and address the KTI agreements and the fairly elaborate approach we did to prioritize that in light of funding limitations where the Department did have to prioritize its work scope. And we presented that to you roughly a year, maybe a little more than a year ago.

Part of that approach necessitated the addressing of some of the KTI agreements using more TSPA-based risk-informed based approach. We started addressing them last summer. There was probably three or four that were submitted last summer that only used a TSPA sensitivity analysis, vary the parameter distribution outside of its range or to an extreme value within its range and see what effect it has. And say based on that and that alone, so there was probably four or five agreement responses done in July-August of last year that were written that way.

The initial feedback we had from those was, well, you didn't put them into the context of the technical basis for that question, whatever that question might have been. I think generally there was a drip shield cracking issue and crack plugging KTI agreement, there was a couple of infiltration issues and the infiltration model issues that were being addressed at that time using totally a TSPA sensitivity analysis approach. The Department agreed with the NRC staff comments made on those initial submittals and revised how it was writing those responses to add in addition to just, if you will, the movement of the needle on the dose also provide some additional discussion of why that uncertainty

distribution for that particular parameter or model was appropriate, use other lines of evidence or other information available to address the KTI agreement in addition to the risk-based TSPA-based sensitivity analyses.

There have been five submitted since last summer. One was in November, the other four were in January of this year. They were generally UZ flow, unsaturated zone flow, heterogeneity and unsaturated zone flow and uncertainty in infiltration. So the total number was nine; however, one was closed, one of those nine was closed on the basis not of the risk-informed information that was provided but on the basis of the additional technical information that was provided. I just wanted to lay out that schedule process with you. And that led up to last month's technical exchange.

So if I can go to the next slide, I just want to walk through that approach, the implementation of that approach, take a different example than what Dave took, and then my summary of NRC concerns that I think Dave went through in sufficient detail so I'll probably skip over that one and our planned path forward. So if I could have the next slide, please.

Okay. I think I have talked about the

alternative approaches that we followed for all KTI agreements. Some KTI agreements was go do X, whatever X was said to be, go do that test, write that test plan, submit those test data, revise or look at the parameter distribution, whatever that issue was based on that new science or revised engineering information. But as Dave said, we had proposed on the order of 30, I think 31 was the exact number, that might be addressed in more of a TSPA risk-informed process, i.e. it does not significantly affect the compliance with the regulatory standard. We actually did submit nine, it was really eight agreements that were directly related to this, and the ninth one was closed with other information, not the risk-informed information. And the rest of this talk primarily goes through things that we talked about during that technical exchange in the middle of May. Next slide, please.

Okay. The whole basis of using the risk information, in particular using the total system risk information, and here I'm going to focus now on the use of the total system model, the total system parameters, the total system analyses as that definition of risk from the compliance point of view. There might be other very logical definitions of risk,

such as risk to a barrier or risk to understanding, but we focused here on risk as it's defined with respect to dose being the performance measure of risk. Next slide, please.

Okay. The whole goal of this was to allow ourselves to prioritize where to focus the limited resources, on which KTI agreements, on which issues, if you will, focus on those that either had the greatest uncertainty or the greatest significance or a combination of those as they affected risk. Okay. Next slide, please.

Okay. So there was three criteria that we used in trying to ascertain which KTI agreements were in fact amenable to the use of total system risk information as a means of potentially closing the agreement. They're shown on this slide and the next. We'll stay on this one for the time being. First is the information requested is shown to have limited significance to risk based on the importance to repository performance during the 10,000-year regulatory time period. Next slide.

And that information that is explicitly requested in the agreement item is not required to support the technical basis for that treatment of uncertainty. So in other words, the uncertainty

treatment was, in our opinion, adequate within the TSPA SR and TSPA-FEIS, the final environmental impact statement TSPA, such that that range accommodated the range of understanding and no more information was required to expand that range, if you will. And the information is not needed to support the description of the barrier. So we were looking at barrier capability and the description of barrier capability as required in the regulation. And if it did require that, then it was not a candidate for using total system risk information as a means or a criteria for addressing the KTI agreement. Next slide.

Okay. So I think Dave captured this as well. Some agreement items called for additional information to reduce uncertainty, and if we felt that uncertainty was adequately captured and there was no necessity to reduce the uncertainty and that it was insensitive to that uncertainty, then it was okay, and that was a basis for potentially addressing the agreement item. Secondly, if there was additional work needed to defend the current range of uncertainty, i.e. additional information required, not necessarily of questioning the uncertainty range but defend that uncertainty range, and we can still demonstrate that it's insensitive, then that was a

candidate for using risk information for. Next slide.

Okay. As I said, there have actually been nine but eight were using risk information and nine had additional technical information, that's my last bullet there. Five of them related to climate and infiltration, two, to flow and transport -- actually, three were flow and transport, because the third one that was closed was closed, it was UZ flow issue associated with the heterogeneity in the unsaturated zone flow model and the effect of that heterogeneity on localized flow paths and on potential for seepage where the flow might be increased. And so far with the exception of the one that I just described additional information needs have been identified for all of the others.

I should say that of the UZ flow and transport ones, they were all flow related, they weren't transport related. I should also say that when you map these nine or these -- let's talk about these eight and not the one that was closed, these eight to the June 5 NRC report on risk prioritization, six of these are what have been classified as low, and two of these have been classified as medium. The two that have been classified as medium are associated with the infiltration representation and the

uncertainty in the infiltration representation. The other ones have all been classified as low risk significance. So we in a way agree that they're low risk significance. The issue is did you provide enough information to close those agreement items even though you might agree that they're low risk significance. So if we go onto the next slide, I think I have an example more of an approach.

The approach had -- once we had the first four and had gotten some feedback on those saying additional technical information was desirable, we revised the last five submitted in December and January to include a section where additional technical basis was presented. So each KTI agreement had additional discussion of that particular uncertainty, that was the focus of that KTI agreement, and additional discussion of additional information used to support that distribution. I'll come here with an example on infiltration in just a second. So there's a section in there on additional technical bases, if you will.

There's then a discussion using variety of different outputs associated with the TSPA model, whether it be extreme value, one-offs, whether we use some nominal neutralizations or some combined effect

analyses, limited as they were. We haven't submitted, I don't think, any combined effect analyses to date, but they are in the risk prioritization report, using some combination of these to provide that information in the context of that particular KTI agreement. So there's two sections. There's actually an additional qualitative discussion of the barrier and the barrier capability and the impact of that KTI agreement vis-a-vis that barrier and barrier capability. If I go to the next slide --

CHAIRMAN HORNBERGER: Bob, your combined effect analyses seems -- the way you describe there seems to be not similar to what Dave Esh described; that is, you're talking about the words say assumption of extreme values occurring simultaneously in multiple components, and it strikes me that -- I infer from that that you're talking about doing, again, a one-off analysis but with, to use Dave's words, pessimistic values for five or six different things simultaneously?

DR. ANDREWS: Yes. Yes.

CHAIRMAN HORNBERGER: Dave, am I right that that isn't the approach that you had envisioned?

DR. ESH: Yes. I think the distinction is that we're saying that the combined effect of

uncertainty is an important part of the process, and DOE has selected to be pessimistic in each of the individual analyses, and it puts -- there's a difficult point in between there, so what does that mean? Does that mean that you do a combined effect of a whole bunch of very pessimistic things? We don't want that, and DOE is saying, "We don't want to give you that." But there's still that answer of what's the combined effect of uncertainty.

DR. ANDREWS: Yes. I think another way to think of it is in the risk report, just for illustration purposes, the one we produced last summer, wasn't -- it itself was not a KTI agreement, it was a separate technical report. We present some combined effect analyses in that as representative examples of types of combined effect analyses. But those analyses have not been used as a basis of any KTI agreement responses to date, the combined effect analyses. The one-offs and neutralizations have been but not the combined effect. If I can go to the next slide, please.

Okay. I picked -- Dave picked TSPA 319, I think; I have 318. It's also infiltration. As I said, a number of these were infiltration related. We picked those, not only because we felt that we'd

adequately captured the uncertainty in our TSPA but also because most of the active field testing program for infiltration had been completed. The USGS, the prime area of people collecting that information, although they collect related information for other projects in the arid Southwest, the specific application of the infiltration model for the TSPA was pretty much done, and we felt we had a lot of multiple lines of evidence to support the range of infiltration rates that we were using in the TSPA.

The question here specifically relates to that infiltration model and some assumptions embedded within that infiltration model and some comments made of the time of the technical exchange when that infiltration model was being reviewed by NRC staff. And the issue was a more realistic representation of infiltration rates using an alternative model, if you will.

We wrote that response in January of this year and broke up the answer into two separate answers. One part of the answer says that using multiple lines of evidence and alternative representations from those other lines of evidence, thermal information, chloride information, information from carbon-14 and the perched water zones and other

water balance type information, regional water balance type information, that we believe our range of infiltration rates represented over the mountain, which was quite a broad range, it not only had a mean and uncertainty on the mean but also had a spatial, very wide spatial distribution over the crest of the mountain with that spacial distribution being a function of slope and angle and soil type and soil thickness and vegetation, et cetera, that that was adequate to represent the range of uncertainty distribution. So we added some additional technical discussion of those alternative lines of evidence.

In addition, we did a couple of extreme value one-off sensitivity analyses using the TSPA, one where we just changed the infiltration rate and the other one where we changed the seepage. The next slide shows the change in the infiltration rate slide, which then changed a saturated zone flow and therefore unsaturated zone transport. Although the range is from zero to 250 millimeters per year, the average can increase during climate changes over the 10,000 years to roughly 12.5, so we'll say 13 millimeters per year. But it's quite a wide spacial range.

The one-off sensitivity analysis increased that and fixed it at the glacial maximum climate

infiltration rate. It still had spacial distribution but it fixed it at that glacial maximum climate state. That glacial maximum climate state occurs in the climate model at about 70,000 years, I think, so we just kind of moved that glacial maximum climate state and said it occurs tomorrow and then evaluated the effect of that on dose, what you see here. We did a separate analyses of the effect of that on increased seepage.

The next slide I think summarizes the comments -- yes -- the comments back on this particular KTI agreement, and the NRC staff said if you continue down the technical-based approach, here's the information we think is still required, additional information needed to address that KTI agreement. And if you choose to go down the significance or risk-based approach, then here's the additional information that we believe is still needed.

On the technical basis approach, the second major bullet, gave us kind of, if you will, two options, one to show that non-linear processes have been adequately represented, and, two, that the model that we've used is not underpredicting the infiltration rate. So we do an additional comparison of our infiltration rates and their distribution to

these other lines of evidence to show that we're not underpredicting and other people's assessments of potential infiltration rates to show that we're not underpredicting it.

If we chose to go down the route of addressing it from a risk significance point of view, then for this particular KTI agreement it captures three of the five elements that I think were in Dave's closing slide. One was combine the effects of this with all other KTI agreements that are being addressed by risk significance, by low risk significance. So if it's infiltration and it's flow and it's drip shield, take those three as examples, then combine those three effects and make sure those combined have a low risk significance.

As Dave also said, they require, if we're going to address it from a risk point of view, additional description of the changes made so that there's a greater understanding of what exactly was changed. The documentation to date was inadequate, if you will, for an independent reviewer to pick it up without access to the analyst and determine exactly what parameter was changed within the TSPA.

And the third thing was additional descriptions of the uncertainties. We presented them

as means and variations of the means. We did not show the full distribution upon which that mean was based and look at portions of that distribution. I think Dave presented an example just a few minutes ago of looking at the top five realizations or the top ten percent of all realizations and try to determine from those is there any additional insights that can be gained on what was driving the risk. So that's the letter at the end of April. If I can go to the next slide.

CHAIRMAN HORNBERGER: So when you -- so on that last point now when you talk about realizations, it leads me to believe that you're talking about addressing these, say, combined effects by using TSPA.

DR. ANDREWS: That was their request. If you're going to bullet two, if you choose door two --

CHAIRMAN HORNBERGER: Okay. Okay.

DR. ANDREWS: -- DOE, then you've got these two choices.

CHAIRMAN HORNBERGER: No, I understand. Okay.

DR. ANDREWS: If you choose door three, then make sure all these three elements are addressed.

CHAIRMAN HORNBERGER: And is it your understanding that the combined effects would involve

the use of TSPA with all the other parameter values fixed at the base case level or are you talking about doing a full-blown --

DR. ANDREWS: They would be sampled. They would be fully sampled.

CHAIRMAN HORNBERGER: -- everything. So it's a full TSPA analysis.

DR. ANDREWS: Yes. Yes. You would just combine the effects of those elements that you were risk informing. So maybe you would choose infiltration, UZ flow, seepage and drip shield degradation and look at those four elements at a pessimistic value or an extreme value of the current distribution and evaluate what that combined effect is, other things all being kept at their uncertain nominal distributions.

CHAIRMAN HORNBERGER: It still seems odd to me that when you're talking about looking at propagation of uncertainty, that you would do that by fixing values at a 95th percentile value. Where is the additional uncertainty? It doesn't -- somehow doesn't compute for me.

DR. ANDREWS: There's no -- we have a distribution --let me try to back up and see if this will help. We have a distribution on infiltration

rates. We have three infiltration distributions and each of those distributions has a wide range of localized infiltration rates at a 30 meter-by-30 meter sort of scale that come out of this model that's the model in question. We've used that and compared those to other indirect lines of percolation. There's no other indirect measures of infiltration other than global -- not global but kind of regional water balance type information, maxi eken type average infiltrations in arid regions, whether you're in Israel or southern Nevada, which we also have used as a basis to define reasonable infiltration rate distributions. So we think we have a reasonable uncertainty characterized.

Now, if you're going to evaluate the effect of that uncertainty, one way is to just take it -- to do its significance is to take it at extreme values and see how it behaves given that that uncertainty is picked at its extreme value. So it's not doing, if you will, a regression on the uncertainty of infiltration, because it might be masked by 50 or 100 other things downstream of it. You could do that by slowly, as John said, peeling the onion off and limiting those and the uncertainty in those until you got back to show me the uncertainty on

infiltration rate and its impact on system performance, but then you would have fixed a lot of things downstream of it. So in this case we're just trying to fix the upstream thing, which is infiltration and see its propagation by just fixing it.

MEMBER RYAN: I appreciate that explanation because that helped me a lot. I've been struggling to think this through myself. But if you look at David's Slide 18 where he showed the analysis of the TPA 4.1j realizations, he showed that if you look at the mean of the parameter uncertainties and how that gave you insight for the system behavior, my question is how do I get from this kind of individual parametric evaluation of say infiltration rate that you've described and then somehow translate that into the behavior of the system where you might have six or eight or other ten key parameters behaving across some range of values?

DR. ANDREWS: Well, all the other elements of the system are in that calculation and their uncertainty.

MEMBER RYAN: But are they held constant or are they --

DR. ANDREWS: No. No. They're allowed to

-- they're sampled off of their distributions.

MEMBER RYAN: Oh, they're sampled in the same way as infiltration rate.

DR. ANDREWS: Yes.

MEMBER RYAN: Okay.

DR. ANDREWS: Yes.

MEMBER RYAN: That's helpful.

DR. ANDREWS: Yes. And I just do one case where I fix infiltration, and everything else is still sampled, so there's still 300 realizations or 100 realizations, I forget how many we used, and so everything else is being sampled. Corrosion rates are being sampled and solubilities are being sampled and retardation coefficients are being sampled.

MEMBER RYAN: So you fix infiltration. You then run it for different infiltration rates and look at how infiltration --

DR. ANDREWS: Right. Right. In this case, we just fixed it high. Let me go to the next slide.

Okay. I think these five bullets capture, at least in my words, the same five bullets that Dave had -- test me on that. So let's go on to the next slide.

Okay. For those KTI agreements that we

believe still are most appropriately addressed using risk significance information, we agreed in that technical exchange to provide some additional information that was on Dave's slide: Additional discussion of the technical basis for the change, why the change was made the way it was, the basis for that number chosen in that change, additional details on the change, additional discussion of the results of that change and the understanding of the results of that change and additional discussion of the full range of uncertainty associated with that change, not just look at the mean and the mean response behavior but look at the whole distribution, if you will, and examine whether there are any other outliers.

Those results are all readily accessible. We save all of the output files, so going in and grabbing additional interim results from an output file is relatively straightforward. What we said, I think maybe we put it on the next slide -- wait a minute, let me make sure I covered all these. Let me go back to the previous slide, I'm sorry about that. Yes, I think I covered those. Let's go on to the next slide.

Okay. The combined effects analysis that we have documented in the risk information report,

which was last summer, we don't propose -- and as Dave said, it's mostly a resource timing issue -- we don't propose redoing or adding to any of those here in the short time. When we -- the reason being is simply that the TSPA for the license application is being developed as we speak. The individual outputs from those 28 abstractions that were on Dave's slide, the little colorful slide that you couldn't read, those 28 outputs are being integrated into the TSPA model right now. That model has to be developed, has to be tested, has to be checked, has to be reviewed before any results of that model are produced.

So the Department decided to focus its energy on that model and the development of that model, not additional, if you will, sensitivity analyses based on a model that right now is a year and a half old. So the model will be different. There are component parts that are significantly different from the TSPA SR, and it almost seemed not quite meaningless but not productive exercise to do additional combined effect analyses on that one now. But those combined effect analyses and the effects of uncertainty, as required in 63 and the guidance in the YMRP, will be addressed using the TSPA LA model and presented in the license application whenever those

analyses are done which will probably be next spring-ish time frame.

I think -- is that it? I think that's it. Yes, that's it. So that's all I have, and I'd like to address any questions you might have.

MEMBER GARRICK: Okay. Milt, you got some questions? George?

CHAIRMAN HORNBERGER: Bob, it seems that we often get into situations where we can appreciate Harry Truman's request for a one-armed economist, so tell me why -- how you're going to explain this. On one hand, DOE says that the unsaturated zone is a significant barrier. On the other hand, the sensitivity analysis says that it doesn't matter if infiltration rates are an order of magnitude higher.

DR. ANDREWS: Okay. I think you have to look at the definition of barrier. The definition of barrier is anything that keeps water away from waste or anything that slows or retards radionuclide migration away from the waste. I'm paraphrasing now, so it might not be the exact words, and Tim or somebody would give me the exact words probably verbatim. So those are the two definitions of barrier, and using those definitions of barrier, flow and transport, I mean I'll take the UZ as an example,

the unsaturated zone does affect how much water can contact waste. It sheds it off at the surface, and it limits how much can seep, so it is a barrier if I look at it from a water flow perspective.

If I look at it from a radionuclide transport perspective, just looking at the unsaturated zone again, your example, then also there are many nuclides that it does retard, or filter if it was colloidally transported. There are other nuclides that the delay time, if you will, from the repository to the water table is not delayed significantly. There's some delay but not significant. But it's significant for others. So if I look at it from a nuclide-by-nuclide perspective for transport and look at it from a water flow perspective, from a flow water contacting waste perspective, it is a barrier.

Does it significantly affect a dose calculation? No, because there's other factors that are more significant: The drip shield, the environment, the waste package, the solubility. Things like that are more significant than the -- and I'm talking nominal performance now, not volcanic event type performance, because there, of course, the unsaturated zone, except for the case of indirect

intrusion, plays no role. But using a nominal performance perspective those other factors are more significant and, if you will, mask that contribution of UZ.

Now, if you go out -- and I think we did this in the SR -- if you go out there far enough in time and you start looking at those nuclides that are particularly solubility limited, and now I'm just looking at the transport aspect of the UZ barrier, you see that delay for different assumptions of absorption characteristics in the unsaturated zone you see that delay manifested itself in a TSPA type curve, but it's out at 30,000 years or 20,000 years when the neptunium solubility and neptunium releases end up being more dominant than the technetium and iodine and carbon-14 type releases. So it is a barrier; in fact, it's two elements of a barrier. It's flow barrier and it's a transport barrier. It's just not as significant to risk.

I think -- well, I think somebody's going to talk about the June 5 risk report, and I think UZ flow things were generally low and medium and UZ transport things were generally medium risk from NRC's perspective. But I think they also characterize it as a -- they probably don't use the word, "barrier," but

an element of the abstraction case.

MEMBER GARRICK: Mike?

MEMBER RYAN: Nothing else.

MEMBER GARRICK: Maintaining a perspective on these different concepts and terms is a challenge. You know, aside from the suggestion that risk information is not technical information, I guess I'm reasonably satisfied with what I've heard, but these terms are very difficult to discriminate. When you talk about something being technical basis and something being risk-informed basis or risk information approach, and I think we're going to have to be very careful about how we use such expressions in the public documents if we want them to understand it. And I don't know if you have any thoughts about that, but when I look at technical information and risk information and technical basis and try to resolve in my own mind, yes, I can do it after awhile, but it's not a particularly good set of descriptors for adding clarity to the process. And anything you can do to make that more straightforward I think would be greatly appreciated.

DR. ANDREWS: I appreciate the comment.

MEMBER LEVENSON: John, I think a perfect example of that contributing to the confusion is on

your first backup slide the first bullet says, "Risk informed analyses are not meant to be realistic projections of performance," and I think there's a lot of us that don't understand that at all, because it's what you're interpreting in this case that you have done as part of a risk-informed analysis. As a generic statement, it's just plain not right.

DR. ANDREWS: Yes. We investigated or I guess discussed a number of ways of doing the risk-informed analysis. I mean do you try to totally just keep peeling off the onion until you get to that particular parameter so that you can see its contribution by itself? That's a worthwhile exercise but also a very difficult exercise to keep peeling it off.

MEMBER LEVENSON: Yes. And I think the point that John was trying to make that I was trying to emphasize is that this is not -- the language is not for primarily discussion between experts who understand what's intended. I think we just have to be much more careful about the language we're using.

DR. ANDREWS: I appreciate that.

MEMBER LEVENSON: So that we don't give false impressions of what's going on.

MEMBER GARRICK: Certainly, that's a

contradiction to why risk assessment was invented.

(Laughter.)

DR. ANDREWS: Yes. Yes. Yes.

MEMBER RYAN: You know, the next bullet under it, I'll pick on the next one and second the terminology question because it is a struggle if you're not truly an expert to understand the usage of the terminology, given the words are clear, but sometimes what you intend to mean is hard. If something has a probability of one of occurring, whether it's a single event or a set of events, that's deterministic.

DR. ANDREWS: Right, for that particular event.

MEMBER RYAN: Not risk informed, it's risk based.

DR. ANDREWS: Right.

MEMBER RYAN: So it would be, I think, helpful to think about how do you get everybody on the same page for terminology, and that's you and NRC and the public and everybody in terms of understanding what these words mean. That's very different from what I would have defined as something that has a probability of one.

DR. ANDREWS: I appreciate that comment.

MEMBER GARRICK: Any questions from staff. Neil? Rich? Mike? Anybody else? Okay. Thank you very much. I guess that brings us to break time, Mr. Chairman?

CHAIRMAN HORNBERGER: It brings us to break time, Mr. Vice Chairman. So let's see, let's take a 20-minute break.

(Whereupon, the foregoing matter went off the record at 2:28 p.m. and went back on the record at 2:49 p.m.)

CHAIRMAN HORNBERGER: We are now reconvened officially.

Okay. We're going to continue our discussion on risk-related topics. And, once again, John Garrick is the person in charge, so I'll turn it back over to John.

VICE CHAIRMAN GARRICK: Thanks, George.

I think without further ado, we'll introduce Tim McCartin.

CHAIRMAN HORNBERGER: Okay.

VICE CHAIRMAN GARRICK: He's going to talk to us about status of the high-level waste risk insights initiative, something we're all very interested in.

MR. McCARTIN: Okay. Thank you, Dr.

Garrick.

Jim Danna and I will be presenting today. I'll do the first half on the risk baseline, and Jim will do the second half on the risk ranking.

As the cover slide indicates, this is a status. We got the Commission SRM -- staff requirements memorandum -- requesting this information. We provided it to the Commission. We did acknowledge that in October, as Andy indicated, there is a final report. And I'll indicate this is sort of an advertisement for what will be in that final report.

Things might change as we do further analyses, etcetera. I would like to say, although Jim and I are doing the presentation, anything that covers all of the performance of Yucca Mountain, and all of the different issues, clearly there was contributions from the NRC staff as well as the Center, and it really was a group effort. We have the benefit of making the presentation.

And I would like to say for people who didn't catch it, there is a typo in the area code. I am not at 302, wherever that may be.

(Laughter.)

It should be 301, but --

MEMBER LEVENSON: I thought you did that to reduce phone calls.

MR. McCARTIN: It would reduce phone calls. Yes, I've noticed that over time.

(Laughter.)

Let me go to the next slide. Or I can do that, that's right.

And, once again, I will be going over the risk insights baseline. And in that I'm going to try to give you some context for what we did, how we did it, and then I'll go through some of the examples that I think will get into some of the questions that were asked this morning and earlier this afternoon. And then Jim will go over the risk ranking and the next steps in this effort.

With that, we'll go into the risk baseline. In terms of the benefit of this risk baseline, and certainly everyone is aware that the Commission requested the information, the risk ranking, but this risk baseline, as we started developing it, we felt really serves a very useful purpose in terms of communicating our insights to others.

And over the years, I think in performance assessment we've done a good job of analyzing

different problems, looking at the technical issues. We haven't done as good a job giving people a sense of pulling all this information together, and what does it mean, and how does it affect the risk?

And I think this risk baseline is an integrated system-level approach for risk-informing our activities. It provides consistency in risk-informed activities among the staff.

This is one of those activities that -- the staff is engaged in this one, in that you have a lot of good, useful dialogue, conversation, arguments, discussion. When you start saying I think this is important, because we challenge each other on it -- it's a source of communication, and I think it's very useful in that sense.

And also, as we heard from DOE, they've read the document. We look on this document -- it's a first step. We aren't saying this is the end in all. It is a first look for us, but it's a source of information that we can have discussions with the Department to get a better sense of what's important and why. And we think it will be very useful for the program.

In terms of the process getting to this point -- and this probably is the hardest, the next

two or three slides -- how did we develop these risk insights? It isn't as simple as just running the TPA code and getting a dose number. There are many other things that you have to factor in. We want to try to explain that.

It's certainly -- you're always coming back to the potential effect on dose, but we're using all our information to date. And that information comes from running the TPA code, subsystem analyses, auxiliary calculations, and review of performance assessments. DOE and EPRI have done performance assessments, a review of those assessments, and I'll point to some of the things that we have in our risk ranking that really is related to other PAs, not necessarily NRC's.

And so it's all that information you're bringing to bear to get a sense of, what are the risk significant aspects of a Yucca Mountain performance assessment?

The way we did it, the initial draft was developed by the performance assessment staff. We then had it reviewed by the engineering and geosciences staff, both here and at the Center. And, clearly, I want to point out the insights continue to evolve.

This is a first step of putting down the insights in this way, as you'll see. We're continuing to do analyses, and I'll try to point to the work we hope to get done prior to October to help us.

But I'll say, in October, will we have all the quantitative analyses done we'd like to? I'd say no. But what we'll do is we'll point to areas where we need to do further quantitative analyses to give a better understanding of some of these risk insights.

In terms of what gets you into a high-risk significance, what did we use as our measures, we were looking for potential effects on a large number of waste packages, effects on the release of radionuclides, and the transport of radionuclides.

Multiple barriers is a consideration, and this is the part that, clearly, if you only have a handful of waste packages failing in your base case in 10,000 years, you're not going to get a high dose. Does that mean nothing else matters other than the waste package? We would say no. There is a requirement for multiple barriers.

You'll see this more as I walk through some of our insights, and I've chosen some that are -- that in my mind at least give examples of our thinking process, that there's things that have the potential

to affect the risk. And you'll see that as I go through.

But the question is, it's very hard in the base case to get any significant releases. It tends to have a lot of barriers, be it limited water, limited release, long-lived waste packages, limited transport in the saturated zone. You take all of those, you generally aren't going to see a large release.

But when you look at the system, what are the things that really have the potential to affect the risk if, for one reason or another -- it may be wrong or the uncertainties are a little greater or -- there's a couple things that go wrong.

And that -- qualitatively, that's the best I can do now. But as I go through the talk, you'll see the areas where, hopefully it becomes clearer, our thinking process. And that's what I want to try to get through today is that thinking process.

And, clearly, as even Dave Esh alluded to the model limitations and uncertainties, there's some aspects of our model -- we don't have certain processes. Well, how might -- you want to try to think, how might that affect, if it was included in there? And maybe you can do some offline analyses.

But I look on the TPA code and other performance assessment analyses, they assist your risk-informing. They do not do the risk-informing for you. You do have to use the gray matter between your ears. There's no substitute for that.

Yes?

VICE CHAIRMAN GARRICK: Tim, you spoke of how all of these factors enter into your forming your opinions about the risk significance of things like the agreements, the TSPA, your TPA, the offline analysis, EPRI's work, etcetera. And that all of this is taken into account when you assign priorities, I assume, or risk significance.

Does that also feed back into your own model to do improvements on the model?

MR. McCARTIN: Certainly. Certainly, yes. And, in fact, in doing some of this risk ranking, there were some things -- boy, we can't assess this with our model. Maybe that's an improvement you want to --

VICE CHAIRMAN GARRICK: Yes, that's what I was getting at, because there are some features of --

MR. McCARTIN: Absolutely.

VICE CHAIRMAN GARRICK: -- your model that

you don't --

MR. McCARTIN: Yes.

VICE CHAIRMAN GARRICK: -- you're not -- some issues with your model that you can't deal with.

MR. McCARTIN: Exactly.

VICE CHAIRMAN GARRICK: And --

MR. McCARTIN: Yes. And that's one of the parts that -- be aware, it was kind of odd in that the memo to the Commission represents our conclusions to the October report, basically, but we haven't finished the October report. So we sort of wrote the ending of our mystery novel before we wrote the novel.

There will be additional things like that, and that is an important feature. There are some things we may identify -- boy, this might be significant. We need to do a calculation like this to get a better sense of it, and it may require a modification of our code, or maybe an offline analyses.

Some of the analyses it's indicated we won't be able to do before October. We'd like to identify the ones, and in those prioritize, well, what should we work on first?

In terms of risk significance, many might say this slide doesn't say much. It's sort of the

"Goldilocks slide" -- too hard, too soft, just right. But it's high risk significance as a potential to have a significant effect on the risk estimate -- not too surprising. Medium risk, some effect. Low risk, little effect.

Think back to that other slide, though, where we looked at the potential to effect large number of waste packages. If you can't effect large number of waste packages, you can't get here. It's virtually impossible. So there are some ideas like that.

And although this slide, I'll say, is decidedly qualitative, as I walk through I want to give you an understanding of the thinking processes that we used to put things in the high, medium, or low risk significance area.

In October, for every one of the assertions that we have in the memo to the Commission, we are intending to have documented the quantitative analyses that we used to support each one of those assertions. Some of them may be dose calculations. Some of them could be barrier analyses or a subsystem analysis. We may point to some DOE analyses.

But the desire is to at least show and document a quantitative calculation or analysis for

each one of the assessments -- the assignments that we made. We're --

VICE CHAIRMAN GARRICK: But you've made no quantitative demarcations between these, like --

MR. McCARTIN: Not a does it have to be an effect of two orders of magnitude or --

VICE CHAIRMAN GARRICK: Well, you could say if it has a 50 percent change in the central tendency parameter for one or --

MR. McCARTIN: Certainly, in putting things in the high, medium, and low, in our discussions we talked about, gee, that's only going to affect the dose at most by a factor of five, or we talk to that.

And so generally I'd say you want it to -- a significant effect was if I had a -- if I was -- if my arm was twisted to say it had to be at least an order of magnitude or more -- at least. And as Dave indicated, there was somewhat of a sense if you were down at the micro rem range, an order of magnitude doesn't mean a lot there.

So as I go through, I think you'll get a sense of it. But we're hoping in October we'll have more of the analyses that people will more directly be able to see the quantitative sense of what was

intended.

But in the discussions everyone had quantitative analysis they could refer to and discuss when we went through it. It's just in terms of actually having it documented for the short time that we had to prepare that memo, it wasn't practical.

With that, I'm going to go -- that is a backdrop of how we began the exercise. I'm now going to go through a series of -- and I will admit, I did not count them, but I'll say seven to ten examples from the memo to give you our thinking as we went through it, which will I think hopefully explain some of the more qualitative words I used in the previous slides.

First, you'll notice that we have -- and in the memo, high, medium, and low. We did not always have low. I'm not sure we always had medium. We always had high. The desire was that we were complete in identifying the things that we understood were high, but we certainly did not try to identify all of the low items. That would have been an enormous list.

But what we do identify -- what are the high risk significant items? It might be -- we said, well, you know, people might have thought this was high; we have it as low or medium. As it was

instructive, we included some of those items that we thought would be useful. But neither medium or low were categories that we tried to be complete. We tried to be complete for the high.

I think we got a lot of processes. But, clearly, if you wanted to populate the low risk significance, you could end up with a very large list.

And for this particular slide -- this is flow paths in the unsaturated zone above the repository. You can see there, as Bob indicated, we have no high risk significant items. We have seepage into drifts, and one might say, well, gee, in our TPA code without seepage we have zero releases. Why shouldn't seepage be more important?

But part of this relates to how variable the seepage is, and how much uncertainty is there in that seepage? And it also is affecting -- the release of neptunium is primarily one of the big factors. It also affects water. But there's other things it's affecting, not necessarily a direct effect on the dose.

There's other things that have to happen for neptunium to be -- once again, there's a nuclide that in long-term doses is very important, but there are -- there's the waste package, there's the release

rate, there's solubility limits, and there's retardation in the alluvium. So it's very difficult for something that is a secondary effect to neptunium. You need so many other things, and that's part of the reason why it's not a high, it's a medium.

If I go to the quantity and chemistry of water contacting the waste package, there were a number of items that high risk significance -- what gets you into high risk significance for the waste package? We're looking for a process that could affect a large number of the waste containers. Okay?

And certainly the near-field chemistry, the brine chemistries, the temperatures at which these develop, all have a significant effect on a large number of waste containers. And so that's why these particular processes ended up in the high risk significant area.

In terms of degradation of engineered barriers, high risk significance, the passive film on the surface of the waste package is one of those processes that results in you having a very low corrosion rate for the waste package. Not surprising that that's high risk significance.

But as I mentioned before, you need to effect a large number of waste containers. You see

down at the bottom here we have juvenile failures as low risk significance. I might look at my TPA results. We have no failed containers, except for juvenile failures, in the first 10,000 years. The only releases we get are from juvenile failures.

One might say, well, gee, that's the only release you're getting. That should be high risk significance. Well, no. It's failing for -- in our particular code, on average 40 waste packages. You don't get high risk significance from a limited number of waste packages.

And even though that's the single -- for the nominal case, the single contributor for releases, it actually ended up low, because you really can't generate a large risk from a limited number of waste packages. And that's kind of the sense -- in looking at the processes, you're looking at things that can affect a large number of waste packages.

In terms of mechanical disruption of engineered barriers, earlier, Dr. Garrick, you asked the question, were there any things -- has anything changed? Here's one. Two years ago rock fall would have been low risk significance.

There's a lot of uncertainty in this, and that's another thing about -- I'd say, in general, the

high risk significant things tend to have a lot more uncertainty. But there's -- DOE has been looking at rock fall. There's been some separate analyses by the Center that suggest that we need to look at the potential for the degradation of the drifts, effecting a large number of waste packages.

VICE CHAIRMAN GARRICK: But on the rock fall, you're still talking about things that would enhance the onset of stress corrosion, for example, more than you are mechanical failure of --

MR. McCARTIN: No, this would be mechanical failure.

VICE CHAIRMAN GARRICK: This is --

MR. McCARTIN: It would be, yes, rupturing the waste package.

VICE CHAIRMAN GARRICK: I'm very surprised at that.

MR. McCARTIN: There is a lot of uncertainty, and I would be the first to admit on that one. But in terms of something we need to look at that has the potential for risk significance, because there's a possibility of a large number of failures of the waste package --

VICE CHAIRMAN GARRICK: I can certainly see how it would affect the corrosion model.

MR. McCARTIN: No, this is actual mechanical damage to the waste package, such that the --

CHAIRMAN HORNBERGER: So that --

MR. McCARTIN: -- would be breached.

CHAIRMAN HORNBERGER: So it depends upon the size of the blocks coming down --

MR. McCARTIN: Well, this is static load.

CHAIRMAN HORNBERGER: Oh, static load.

MR. McCARTIN: This is static. The dynamic actually still remains to be low risk significance in that. But this is as the drift degrades, and you get sort of a chimneying effect of the rock load builds up, and, like I said, there's a lot of uncertainty assumptions.

We're looking at it. For now, it's one that we believe needs closer attention. This is one of those that we expect to do further analyses. Right now we have it high because of the potential for effecting a large number of waste containers. As we do further analyses, as the Department looks at things further, it may change, but --

MEMBER LEVENSON: Tim, isn't really the thing we're sort of talking here is, that doesn't mean that it has a real significance. This is your list of

what has potential to have significance, is that right?

MR. McCARTIN: Yes, I think that's a -- yes. Some things have more uncertainty to them than others. This is one that I think you'll see we need to do further analyses to better understand the process. But for now, we put it as a high risk significance, yes.

MEMBER RYAN: Just to move your thought process along a little bit, if, for example, something on static loads, the uncertainty set is very high, if you reduce the uncertainty, it may actually change its risk significance category by that reduction.

MR. McCARTIN: Absolutely.

MEMBER RYAN: Similarly, if something becomes less certain, or you have another analysis that gives you some other insight, it may move from medium to high risk.

MR. McCARTIN: Yes.

MEMBER RYAN: So it's a very dynamic process.

MR. McCARTIN: Absolutely.

MEMBER RYAN: Okay.

MR. McCARTIN: Yes, yes. This is an evolving kind of effort. We look on it as a very

useful vehicle among the staff to have discussions in, well, what kinds of analyses can we do to better understand certain things? And that's a good example, I think, of one.

MEMBER RYAN: I think the key for me, Tim, is that it's a systematic way to do it, that you can --

MR. McCARTIN: Yes.

MEMBER RYAN: -- you know, if you want to lay out a line of reasoning, and somebody else wants to duplicate it, they can --

MR. McCARTIN: Right. and --

MEMBER RYAN: -- see how you got there. It's not a matter of conversation. It's a matter of analytical trends.

MR. McCARTIN: Right. And for the memo that went to the Commission, obviously we did not reference any analyses or provide any curves. That October report -- and I hate to get your expectations up too high, but I will set myself up that way. The desire is, for all of these we will have some analyses, some references to support why it's there.

And I think, once again, that's the process of continuing the discussions. I think it will be useful in potential exchanges with the

Department. Some of the analyses we'll point to are the Department's analyses.

CHAIRMAN HORNBERGER: So it struck several of us just looking at this particular slide that we would now also rate backfill as high risk significance?

MR. McCARTIN: If that remained there, and backfill would eliminate that process, it would be important. I mean, that would be one thing, if --

CHAIRMAN HORNBERGER: Backfill could create the process by creating large static loads on --

MR. McCARTIN: No, no, no. No, no. In that the reason the static load builds up, the rock -- the drift is degrading, filling up the void space that's there, because there is no backfill. If you had backfill, there wouldn't be as much void space. It goes away.

MEMBER RYAN: If you have backfill, don't you have a static load?

MR. McCARTIN: Not like -- to the extent of this. Yes. I mean, there's no suggestion -- I mean, be aware -- and I don't know if the Center wants to chime in on this one. But, in general, you're looking at a static load on the order of tens to 50

meters of rock above it to cause -- damage the waste package.

The waste package isn't going to cause any damage, and it just -- it's the nature of how -- not going into too much detail, but the bulking factor -- when rock falls, how much space does it take up? And it has to keep on taking up more space until it fills up that void space.

VICE CHAIRMAN GARRICK: But isn't it -- can't there be a cumulative effect on backfill that has the same phenomenon -- from the same phenomenon?

MR. McCARTIN: You don't have the -- well, it will -- it could degrade to an extent, but you don't have as much void space, because you've filled it up with backfill. You're starting with much lower -- a much lower empty space.

MEMBER LEVENSON: But you're not moving stuff in from outside someplace. And if it's a chimney effect, it just moves on up. The disintegration of the rock above it -- we're not talking about a dynamic load, so it isn't how far it falls.

MR. McCARTIN: Right. It's --

MEMBER LEVENSON: Even if you only had an inch at the top, the first big blocks of rock would

come loose and only settle an inch, and it still goes up and you get the same amount of disintegration.

MR. McCARTIN: Well, think of it this way, the -- let's say you have five cubic meters of void space above a waste package. And I'm just making up numbers. Don't hold me -- I'm just doing it off the top of my head.

And if a cubic meter of rock falls -- and it takes up five percent more space after it falls, so now you have 1.05 cubic meters of rock that has fallen on the waste package. But you also have created another -- a cubic meter hole. So you've only taken up .05 cubic meters of that potential five. You keep going up until you -- that void space is eliminated.

It adds up quite a bit. There is a lot of uncertainty, and it's being looked at to say the potential has -- there's a potential for effect on a large number of waste containers, and that's why it's there.

To be continued. I mean, the analyses are there. That's the benefit is the analyses -- you're identifying what your assumptions are, the analyses you're doing, and other people can weigh in on the basis.

And I don't know if the -- I mean, I'm not

the mining engineer expert on this, and I don't know if anyone here or at the Center wants to add anything. Raj?

THE CENTER: This is the Center. We don't have the staff here to add anything.

MR. McCARTIN: Okay.

MR. NATARAJA: Let me just -- this is Raj Nataraja. I would like to add a clarification here. The question of the static load has been examined only to the extent that has an effect on the drip shield. We have not yet done the analysis on the waste package. That's number one.

And, number two, we believe that if the -- the current design of the drip shields is such that -- at least the one that we analyzed is such that it would buckle under the anticipated static loading. And that will cause the load to be transferred onto the waste package.

We haven't come to that level yet, and we have not gone to the actual analysis of the impact on the waste package itself. It may or may not have an impact. That is something that we are going to continue to analyze.

The second point about the issue of backfill -- if you have backfill, the process of

degradation would not start at all, and that's how you would prevent the static load from impacting on the drip shield and not transferring the load further onto the waste package.

So the degradation process has to start, and then continue with time. It'll take hundreds of years, we believe maybe even a thousand years.

So as Tim pointed out, there are lots of assumptions and lots of uncertainties in the analyses. But the fundamental issue is that based on some of the analyses, DOE has already changed some of the designs for the drip shield and strengthened some of those components. So the new design is stronger, and, therefore, may not buckle under some of the anticipated loads.

So there's a lot more to be done. We have considered this as one of the topics that we would like to report to the committee on in one of the future meetings.

MR. McCARTIN: Although I will say, Raj, for this to get high risk significance there was an assumption that there would be damage to the waste package. I mean, if -- right, potential damage. Because if it was just the drip shield, that never would have been high.

VICE CHAIRMAN GARRICK: So that's an example of something that really has a large amount of uncertainty associated with it.

MR. McCARTIN: Yes. And it's relatively new, but it is changed from, say, a year ago.

In terms of radionuclide release rates and solubility limits, dissolution of the waste form is high risk significance. You'll see performance of zircaloy cladding. That's really in looking at DOE's TSPA. As you know, we don't take credit for cladding in ours, but looking at -- there is a potential there for the zircaloy in the DOE TSPA. And so that's an example of looking broader than our own performance assessment.

Also, you'll see down here criticality, probability, and consequences. Low risk significance.

If I look at radionuclide transport in the unsaturated zone, once again, there's no high risk significance. There is the potential for neptunium. Once again, neptunium shows up quite a bit, and that's -- in general, iodine technetium, they may get to receptor locations first.

But as you've seen in some of our analyses we've done previously, iodine and technetium are extremely inventory-limited. Actually, the neptunium

-- you'll see things come in risk significance -- not high, but medium -- because of its potential impact on neptunium. That generally larger doses, the potential for them to occur are really due to the neptunium and not due to iodine and technetium.

Also, the saturated zone -- once again, we're looking at the flow distance through the alluvium as medium risk significance. None for the high risk significance.

And I had these two slides here, both the unsaturated zone and the saturated zone flow system. And Bob was right that there's -- we have no high risk significance there. This is one of those areas -- and I'll go back to some of the comments the committee raised in terms of, are you doing realistic analysis? We struggle sometimes with the unsaturated zone and saturated zone not being high. And they don't appear significant in our analyses.

A question there that we're asking ourselves and thinking about -- I don't know if there's much we can do at this time, because of the complications. But is it due to the simplicity of our model that actually if we had a more sophisticated saturated zone model, would the saturated zone flow properties show up as more significant?

As you know, we have a simple pipe model. It's a pipe model that goes right to the group -- very, very simple. If we included more heterogeneity -- and as everyone knows, saturated zone modeling, you can get very sophisticated, very intensive, three-dimensional calculations.

But here's one of those situations where -- and this is where I think the discussions and the dialogue are useful is that the approach you have in your PA code is showing that it's not that significant. But actually, if you got more sophisticated in your analysis, it might have more significance. And it's just the depiction we have in our TPA code is very simple.

But you can get a sense of some of the discussions that you don't want to rely merely on your results. You have to think through looking at the abstraction you've used, etcetera, and there could be -- maybe we'll do some three-dimensional saturated zone modeling to get a better sense of how simplistic this is.

And I know, Dr. Hornberger, you brought up the last time -- we assume the pumping well intercepts all of the radionuclides. Well, it's pretty hard to do in reality. One might look at Superfund sites and

the pump and treat. It takes a lot of cycles to get contaminants out of the ground. We assume that we're 100 percent effective.

But there is -- now, the question is, what do you do, and how much resources do you want to spend in doing that? But those discussions -- it's all part of the thinking process in terms of identifying things and their significance.

Well, as I've talked about the transport in the saturated zone, retardation of neptunium in the alluvium, it's one of those things that we rarely see any doses in the first 10,000 years due to neptunium in our base case. It's all iodine technetium.

But when you look at what's going on, neptunium is one of those nuclides that has the potential to cause significant dose. The fact that we've -- it's delayed beyond 10,000 years. But if the solubility limit changed, if you had more containers failing, a little less retardation, what might happen -- it's one of those things, you are counting on things keeping neptunium beyond 10,000 years.

Not surprisingly, low risk significance things like iodine technetium that really have very little retardation are not risk significant.

Volcanic disruption of the waste packages

-- well, probability we had as high risk significance. Some might be surprised, the interaction of the conduit and the repository, some of the different scenarios possible for how many packages might be disruptive. It was only medium risk significance.

It might change, potentially not changing that much. It might be a lower probability, so we had medium risk significance. But the probability itself was the most important for this abstraction.

MEMBER LEVENSON: But, Tim, in this case, you're only looking at the probability. You haven't gone back and looked at whether the consequences might be off by a couple orders of magnitude, which would change it from what its significance really is. Because it doesn't get its significance from probability; it gets its significance from consequences.

MR. McCARTIN: Absolutely. And we are doing additional analyses with respect to the consequences, and that's absolutely correct. We're trying to refine some of those calculations.

And I didn't show it -- it's in a backup slide -- but we do have, in terms of how much ash is in an eruption, and the mass loading, how much of the radionuclides are resuspended in the dust levels, are

aspects of the consequence calculation that are high risk significance that, you're right, we are looking at some of those assumptions and modeling aspects. yes.

MEMBER LEVENSON: Do we have data -- you know, there's been a few hundred above-ground nuclear bombs detonated not very far from here. And there is -- these were all done under conditions where there was a lot of data collection.

Do we have data on how efficient resuspension really is as compared to what a computer says it might be?

MR. McCARTIN: Well, generally, we've looked more at analog volcanoes rather than -- the bomb blasts put up a limited amount of dust, I assume, although I'm not an expert on that. But I know Britt Hill at the Center went and they did some mass loading measurements at some -- was it -- and I don't if John Trapp -- was it Cerro Negro or -- Cerro Negro.

And so there has been some attempt to look at what we'll loosely call representative volcanoes to get a better sense.

MEMBER LEVENSON: Just out of curiosity, how do you measure resuspension of volcano ash, when you don't have a tracer like with the radioactive

materials? We're not talking --

MR. McCARTIN: Just the dust level. It would be the dust level, and then there's an assumption --

MEMBER LEVENSON: Yes, yes, yes. But if you --

MR. McCARTIN: There's assumption of how much of the radionuclides are entrained in the ash.

MEMBER LEVENSON: Yes. But from the TSPA, that original dose is not significant. The major significant contributor to dose arises just from resuspension, and that's why I raised the question.

MR. McCARTIN: Yes. The dust level --

MEMBER LEVENSON: The volcano is perfectly good for initial, but that does not appear to be the major dose. Major dose significance seems to come from resuspended material.

MR. McCARTIN: Absolutely. Yes. There is a couple of models we have in the TPA code for the dust level, and there's a decay with time to account for the dust level -- would be the highest the year of the event. But we do look for like an annual average, and it is sensitive to that value, and we are looking at dust levels for things and dust levels in the Nevada area, etcetera.

Yes?

MEMBER RYAN: Tim, is that one high risk because resuspension is so uncertain? Resuspension in the respirable range varies over orders of magnitude from any given, you know, dust loading on a particular area. So --

MR. McCARTIN: Sure. Well --

MEMBER RYAN: -- is that the driver, or is it something else?

MR. McCARTIN: Yes. The dust level is the -- as far as in all the calculations I've looked at is the primary driver for the dose. Now, there is a fair amount of uncertainty.

MEMBER RYAN: Four orders of magnitude.

MR. McCARTIN: Well, and also it -- remember, it's -- there's a change versus time. It's a time-dependent thing versus immediately after the event over time it changes and --

MEMBER RYAN: No, let's take the event out of it just for --

MR. McCARTIN: Okay.

MEMBER RYAN: -- the fun of it.

MR. McCARTIN: Yes.

MEMBER RYAN: And then look at what happens once you get the initial passage and the dust

settles out. Resuspension and inhalation of resuspension will vary four orders of magnitude based on how you assume things like, you know, water vapor and other --

MR. McCARTIN: Yes.

MEMBER RYAN: -- dust settling on top of the dust you're interested in, and all of those kinds of things.

MR. McCARTIN: Right.

MEMBER RYAN: I mean, there's a lot of variables there.

MR. McCARTIN: Yes. Yes. It's very uncertain. But I'll say, once again, the Center has been looking at representative volcanoes or ash deposits. I shouldn't say volcanoes. Ash deposits -- to try to get a sense of what the dust levels might be, but it is very uncertain. Absolutely. That's part of the significance.

MEMBER RYAN: And I have no argument with it being high risk until you resolve that uncertainty.

MR. McCARTIN: Yes.

MEMBER RYAN: But once you recognize it's the uncertainty that's driving the bus rather than the actual event itself, then you can turn your attention to, how do you reduce the uncertainty?

MR. McCARTIN: Right. And that's exactly what -- I'm sort of excited about this memo. Even though we wrote the conclusions today, as we tie the quantitative analysis, why did we say, say, mass loading? And we give you guys, and others, here's the model -- a brief explanation of the model and the TPA code, the parameter range, and you'll see the range of uncertainty, etcetera.

And that I think is a way to continue the dialogue in a more quantitative sense. I mean, I realize that today it's more qualitative, but the desire is for everything we've put down here we have a quantitative basis for what we've said.

And that is where I think the -- we can really make some progress on people saying, "Well, that doesn't make any sense at all." If you do this, this -- you know, or, yes, that looks about right. And I think the discussions with that October deliverable, where we can tie it and give you a sense of the uncertainty we have --

MEMBER RYAN: Sure.

MR. McCARTIN: -- over time with mass loading.

MEMBER RYAN: Well, I mean, to me -- I mean, it's my own view, but ultimately that leads to

confidence.

MR. McCARTIN: Sure.

VICE CHAIRMAN GARRICK: Tim, if it turned out that the probability of future igneous events was smaller than 10^{-8}, would it be on there?

MR. McCARTIN: No.

VICE CHAIRMAN GARRICK: So does that suggest that 10^{-8} is kind of your threshold for the likelihood of an event to be in the high risk category?

MR. McCARTIN: Well, it didn't -- as Mike indicated, it didn't get into that category. I mean, it's primarily because of the consequences, or, as Milt was saying, I mean, if it was -- if the probability was less than 10^{-8}, it's screened out.

VICE CHAIRMAN GARRICK: Yes, I know. That's why I'm --

MR. McCARTIN: Yes.

VICE CHAIRMAN GARRICK: -- raising the question. Yes.

MR. McCARTIN: But it's the -- yes, I mean, right now the probability is -- appears to be above 10^{-8}. And so it's an event that needs to be considered. When it occurs, the consequences are high enough. Even with probability weighting, it's on the

order of a millirem or so, and it needs to be factored into the analysis.

VICE CHAIRMAN GARRICK: Yes. Okay. I was just curious if this had any influence on helping you establish thresholds for high risk events.

MR. McCARTIN: No. No.

VICE CHAIRMAN GARRICK: Okay.

MR. McCARTIN: I can talk risk all day, of course. But the next three slides are just summaries of all of the ones, and I guess it -- I would prefer to skip these three. They're there for completeness of the high risk ones. And I can go through them quickly, but I guess I would prefer that -- just a summary and yield to Jim to get to the risk ranking, because I think I took as much -- you know, a fair amount of time, so --

VICE CHAIRMAN GARRICK: Okay. Very good. We may come back to you if he leaves us any time.

MEMBER RYAN: Just one --

MR. McCARTIN: Sure.

MEMBER RYAN: -- as you pointed out, for all of these summaries the devil is really in the analytical models that you use to support each one. So we'll be looking ahead to that.

MR. McCARTIN: Yes, absolutely. And we

certainly -- like I said, the desire is to have a quantitative basis for all of -- not just the high --

MEMBER RYAN: Right.

MR. McCARTIN: -- but the mediums and lows, yes.

MR. DANNA: Can everybody hear me?

Thanks. As Tim said, Tim discussed the risk insights baseline and its relationship to performance assessment and the quantitative analysis. What I'll do is I'll discuss the application of that baseline to the rating of the risk significance of the 293 agreements.

You'll recall that risk ranking the agreements was the focus of the first risk insights initiative. We presented the preliminary results of that first exercise to the committee in April of last year. That first exercise attempted to risk rank the agreements individually, without an integrated system-level understanding of the risk significant issues of the system.

While that was considered to be a successful communication exercise, it was recommended that we repeat the exercise with more of a quantitative basis.

So this second risk insights exercise was

initiated in October/November of 2002. The intent there was to first develop the risk insights baseline, which provided the system perspective for the quantitative basis, and then from that derive the risk ranking of individual agreements.

A little background on the Commission's SRM. During the waste arena briefing in March of this year, the issue of prioritizing the agreements was raised by the Commission, and specifically how that prioritization would be related to risk significance.

The Commission issued a staff requirements memorandum on March 19th, and in that SRM they requested that the staff provide to them the risk significance rank listing of the agreements based on the risk insights initiative.

In that SRM, the Commission also requested a ranking of the anticipated staff effort and anticipated technical difficulty for the agreements. And the Commission asked that these rankings be expressed in terms of low, medium, and high.

Now, to do this, we turned first to the risk insights baseline. We felt that the baseline provided the integrated system-level understanding of the risk significance of the various technical issues associated with the system. Essentially, as Tim

discussed, the baseline we feel is the synthesis of what we know based on our experience to date, primarily based on performance assessments and other supporting calculations.

We thought that by developing the baseline first we'd be able to create the story explaining what we know and why we have certain positions on what's important and what's not important.

We took this integrated approach, as was discussed earlier today, because the staff felt that the risk significance of individual agreements should not be evaluated in isolation without the system-level perspective. And also, that the risk significance of an agreement cannot always be evaluated with a quantitative risk calculation.

As Tim discussed, the performance assessment staff who participated in developing the risk insights took a first cut at rating the agreements. The agreements were grouped in technical areas, and individual staff members went through their areas of expertise and drew relationships from the risk insights baseline that Tim has summarized to the individual agreements.

These ratings were then reviewed by the engineering and geosciences staff, in much the same

way that the risk insights baseline itself was developed.

Now for the results. This process led to 41 of the agreements being rated as high risk significance, 92 were rated as medium risk significance, and 160 were rated as low risk significance.

Two things to keep in mind. One, this is a broad ranking of risk significance. It's described by ratings of high, medium, or low. As you mentioned earlier, there was no quantitative demarcation point between high and medium, medium and -- we didn't feel that we -- that that is something that's doable on an agreement-by-agreement basis, because of the nature of the agreements. But we, instead, related it back to the system perspective.

To fully understand the rankings for individual agreements, one would turn to the risk insights baseline for this integrated system perspective.

First, I'll discuss the high risk significant agreements, and then I'll discuss the medium and low risk significant agreements.

The high risk significant agreements are specifically related to high risk significant

insights. As with the risk insights, these agreements are related to features, events, and processes of the system that could affect a large number of waste packages.

They could significantly affect releases from the waste package or could significantly affect the transport of radionuclides. Those are the same three points that Tim mentioned in developing the set of high risk -- high significant insights.

Thirty-four of the 41 high risk significant agreements were related to the technical basis supporting DOE's understanding and representation of the post-closure repository in six technical areas. In the next slide I'll summarize those six areas.

The other seven of the high risk significant agreements are related to general post-closure performance assessment issues considerations, and preclosure safety analysis.

VICE CHAIRMAN GARRICK: So is that saying that the 34 -- the primary issue there is uncertainty? Because you didn't receive sufficient evidence from DOE to consider them going into another level? So is --

MR. DANNA: That's both the technical

basis and uncertainty that may be related with the technical basis. It would depend on the individual agreement. If the technical basis is not clear, or we don't necessarily agree with their technical basis, we would ask -- there may be an agreement to ask for more information.

If there's enough uncertainty, we may not disagree, but we may feel the level of uncertainty is great enough that it warrants additional information.

VICE CHAIRMAN GARRICK: Okay. So it's both an acceptability --

MR. DANNA: It's both.

VICE CHAIRMAN GARRICK: -- of the technical basis as well as an uncertainty.

MR. DANNA: That's right. As Dave pointed out, the agreements -- they vary greatly in their nature. They cover a lot of different pieces of information. Some get at the technical basis, but others resolve uncertainty issues.

VICE CHAIRMAN GARRICK: Thank you.

MR. DANNA: I mentioned that 34 of the high risk significant agreements were related or could be grouped into six post-closure issues. These are the six issues, and we've also included a number of agreements within each issue. And this should match

up pretty well with what Tim presented.

First, there's agreements related to corrosion of the drip shield and the waste package, including the chemistry of the water contacting the drip shield and the waste package. And there were 18 agreements in that area that we considered to be of high risk significance. Well, no surprise there.

The second would be the mechanical degradation of the drip shield and waste package due to long-term degradation of drifts. That was the issue that was discussed earlier regarding the rock fall. And there are actually six agreements that address that issue.

Third would be the effects of in-package chemistry and the dissolution of the waste form. This was that second point -- agreements or issues that could affect the release of radionuclides from the waste form. We identified four agreements directly related to that topic.

Number four, radionuclide transport in the saturated zone. There were two agreements related to that area. Probability of volcanic disruption of the repository, one agreement. And entrainment and transport of radionuclides in volcanic ash, there were three agreements.

Those are the 34 agreements we considered to be of high risk significance related to post-closure model abstractions.

The remaining seven -- of the remaining seven, six are related to general PA -- performance assessment issues, primarily evaluation of realism and conservatism, and the representation of uncertainty in their models. And they are broader issues; they are not related to any specific technical area.

And, finally, the last agreement that we considered to be of high risk significance was related to preclosure initiating events, specifically the consideration of aircraft crashes.

I'll just note that of those 41 high risk significant agreements, four are already completed, and six are in review.

VICE CHAIRMAN GARRICK: Are either of you prepared to go out on a limb and say which of the 41 you are most concerned about?

(Laughter.)

MR. DANNA: That's the high and higher, highest --

(Laughter.)

Tim, are you prepared to go out on a limb? No? I think at this point we had -- we felt we had

enough information to provide the information that the Commission was asking for in terms of high, medium, or low.

VICE CHAIRMAN GARRICK: Yes. I wasn't meaning the top one, but maybe the top three or four to give you a partial way out.

(Laughter.)

I'm in a position --

MR. McCARTIN: Not to duck things -- generally, I think we would look at the corrosion of the waste package, where there's 18 agreements. You know, as a group, that's probably the one that comes out the most significant.

MR. DANNA: Moving on to the medium and low risk significance agreements, these are generally related to information that's supportive of the high risk significant agreements. Let's say related maybe not primarily but secondary, or they may be related to less risk significant features, events, and processes. Or they are needed to provide baseline information for the repository system.

Ninety-two medium risk significant agreements, requested information expected to have some influence on risk estimates. Tim pointed that out in his presentation. They need to support high

risk significant agreements, as I mentioned -- and they may address the area of significant uncertainty.

The low risk significant agreements, of which there were 160, while they requested information that may have little effect on the risk estimates, we feel that they're still necessary to provide more routine baseline information of the site. And we want to emphasize here that even though this information may not be considered of high risk significance, we feel it's still necessary and fundamental to supporting an adequate understanding of the repository system.

We don't equate low risk significance with not being necessary. And I think DOE mentioned they do have every intent of providing information to address all of the agreements.

Now, I just want to, in the few remaining slides, discuss the next steps. The path forward for completing the risk insights initiative -- as you all know, we provided the risk insights baseline, the ranking of the agreements, to the Commission on June 5th. Andy mentioned that we consider this to be executive summary.

We're here today briefing you on our status and progress of this task, and we look forward

to your feedback, so that we can incorporate any areas that you have into the final report.

We hope to complete the final report by October, and this draft insight -- risk insights report would include the baseline, but also, more importantly, the documentation of the supporting quantitative information for the risk insights that Tim summarized.

We'll also include in that report the ranking of the agreements. And while we provided that to the Commission in June, we may find as we move towards October, we may have to make some minor modifications.

In parallel with completing this report, we intend to incorporate what we have found. We'll incorporate these risk insights into the -- our prelicensing issue resolution activities, specifically moving towards completion of the agreements.

How can we do this? We can do this in several ways. One, we can use the risk insights to guide the level of steadfast effort that should be expended in reviewing the particular agreements. We can also use it to guide our need for additional information requests from DOE. And, third, in terms of scheduling, receipt of agreements, and prioritizing

our reviews, we can use this to determine when multiple agreements come in where we should focus our resources.

Additionally, we think we can use the risk insights baseline to identify areas for discussion with DOE in terms of prelicensing interactions, technical exchanges, as I said, requests for additional information, but also looking at and evaluating their schedule for completing the agreements.

One of the concerns the Commission had was that the most important agreements, those of highest risk significance, would be bunched to the end, and we wouldn't have time to incorporate that. So while we don't have control over that process, we'll certainly look at how those agreements would be received over the next year and see how things might line up to avoid any kind of train wreck.

In a broader sense, we think the risk insights baseline is important, not just for this exercise of ranking the agreements, but we think it has a more fundamental importance throughout the prelicensing and licensing process. During prelicensing issue resolution, as I stated, it can guide us in our agreement closure activities, and in

requesting additional information, and in guiding exchanges with DOE.

But beyond prelicensing, we feel that this is a useful tool in communicating our understanding of the repository system -- what's important, what's not important, or what's less important, I should say -- communicating that both internally and externally.

And also, we think this is a first step in providing a useful basis for conducting the risk-informed license application review as described in the Yucca Mountain review plan.

Finally, in closing, first, we'd like to thank you for this opportunity to discuss our status and progress with you, and we look forward to your comments, to incorporate those into our October report.

And I want to reemphasize two important points. One is that the risk insights baseline is intended to be a reference point for both prelicensing and post-licensing activities. But also, that as analyses are conducted and new information becomes available, it's our intent to revisit and revise and update these insights, that this is not a static process but it's a dynamic set of insights that will change as technical information and quantitative

analysis become available.

And with that, thank you for your time this afternoon.

VICE CHAIRMAN GARRICK: Thank you.

Comments from the committee? George?

CHAIRMAN HORNBERGER: Tim used the metaphor that this is in some ways like writing your conclusion of your mystery novel before you write the novel. And, of course, that then leads to the question of whether or not this puts pressure on you to suppress any evidence that the butler was indeed innocent.

(Laughter.)

MR. DANNA: No. In fact, we -- that's why we emphasized -- we fully recognize this will evolve. And while we provided this to the Commission in June, I think in that letter we state that this may change. This is not the last word.

MR. McCARTIN: Yes. This was not intended to be a self-fulfilling promise. As we go through the analyses, if things change, they change. And we were careful to point out to the Commission that, you know, this is -- you've got a snapshot right today of what our thinking is. As it evolves, we would expect that if things change drastically we would go back to the

Commission and let them know, and let other stakeholders know that.

But it -- you know, the biggest thing, I mean, information continues to come in from DOE. We continue to -- as you know, the TPA 5.0 code is -- soon will be ready to use. We're going to get additional insights.

Some of the things -- and I guess I'll point to -- one of the items I didn't point out, but the failure mode of the degradation of the waste package is something we do not have in our TPA code. We have a model that when it starts to leak, they all leak the same. It doesn't matter whether it was a juvenile failure, which is a little stress corrosion crack on a weld, or a big corrosion hole, or a big rock going through it. They all leak the same.

And we thought, you know, we probably -- we're looking at revising that, that there should be -- gee, early on, if it's just juvenile failures, these little cracks, it should have a different water inflow mode than others. So there's things like that that are going to continue to come into the code, and we'll see how -- whether it's a big impact or not.

CHAIRMAN HORNBERGER: The other thing that I'm curious about is making a link to the

presentations we heard this morning. So, in fact, now what you've done is risk ranked the individual 293 agreements. How do you see this playing out with integrated or bundled -- or whatever the term we're going to use is -- agreements?

MR. DANNA: Well, I think -- not knowing too much about the bundling, but the bundling -- a particular bundle would include both high, medium, and low risk agreements, depending on the area. What I don't think we saw was the rank of individual agreements.

I think we took a different approach when we started from the big picture, identified what was important, and then bundled agreements or ranked agreements in that way.

VICE CHAIRMAN GARRICK: Milt?

MEMBER LEVENSON: Yes. As is sometimes the case, I get hung up on a word. I think we all understand --

VICE CHAIRMAN GARRICK: Usually it's "risk."

(Laughter.)

MEMBER LEVENSON: I think we all understand, and may have been the ones that originally encouraged this activity, to look at what are the

potential high, medium, and low risks, as a way to focus resources, to make sure what you look at.

What somehow has disappeared from all of the slides is that word that all of these are potential. This is a -- I mean, we don't understand that -- this is a public meeting and a public record. And I think we need to make it clear that, in fact, that's all they are.

If you delete the word "potential," and you say you know what is the high, medium, and low, then why are you asking for more information? I mean, the whole reason for doing the analysis and getting more information is to determine which of these, in reality, may be a high risk.

There may be some things that you had listed as a low risk that when you get the rest of the information and do the analysis you're going to move them up. And so I -- you know, it's not an important word for communication with us, because we understand and we know. But it seems to me that for the public record we really need to clarify that this is at a point in time, this is a potential rating to help guide priorities and focus.

VICE CHAIRMAN GARRICK: Thank you.

Mike?

MEMBER RYAN: My caution is along the same lines. First of all, I think it's very insightful and systematic in its nature, and that's very positive because, again, you can communicate from one analyst to another I think a lot more effectively when you have a tool that's useful.

But like Milt, you know, often we talk about projected doses, and we drop projected -- and we talk about doses as if they're actual and real. So I second the caution that we need to make sure we don't drop our modifiers.

And when we're -- you know, and I think in a good way getting excited about a particular issue and evaluating it, we have to recognize that it's not a guaranteed event or a happening. But it's just something to evaluate because of a potential that you continue to carry that forward. But other than that, it looks real good.

I guess maybe it's a question to you, John. Are we going to get another -- or to you, Tim. Are we going to get a chance to look at a draft of your report before it's turned in in October, or what's -- how does that play out in your view?

MR. McCARTIN: Well, I guess I hadn't really thought about it. But --

MEMBER RYAN: We're hearing your update, but like we agreed that the numerical details of -- of the assessment are probably what are really very interesting to us.

MR. McCARTIN: Sure. Yes.

MEMBER RYAN: So maybe it's looking at that part of it again. I don't know. I'm just asking, is that possible, or we should do that, or --

VICE CHAIRMAN GARRICK: I think that would be very good, if we could get access to it.

MR. CAMPBELL: As we develop this report, we'll look for the appropriate opportunity to where it has come together enough that it's useful to the committee to be able to see all of the elements there in the report. If we give it to you too early, obviously, then it's -- you're commenting on something that's in flux.

MEMBER RYAN: Right.

MR. CAMPBELL: But we'll look for an appropriate opportunity to provide that report to you.

MEMBER RYAN: And I guess I say that in responding to the question of, you know, getting our feedback is really looking at the report rather than just the final chapter, knowing the middle chapters are still in progress would be -- probably be a good

place for us to be.

MEMBER LEVENSON: And I'd like to add something to my comment. Tim, I hope you appreciate that the reason -- one of the reasons for my comment is I think this work is very good, and that people are going to be referring to it. And, therefore, it's more important that the public record make clear what it is.

MR. McCARTIN: Absolutely. The point is well taken. And it's a useful -- it comes at the right time, because, obviously, as -- as we're starting to write chapters or write sections and provide -- it's good to give that context. You're absolutely right. And these are potential estimates of risk significance, yes.

VICE CHAIRMAN GARRICK: Tim, there's one -- you spoke earlier about getting some feedback from the committee, and I think you've gotten some excellent ideas. And I have one that I may not articulate very well, but it is something that I think would bring a lot more credibility to the claim that these rankings are really risk-informed.

And as I read your summary document, your baseline risk summary document, the summaries were excellent. You outlined the issue, and then you

discussed the issue. But what was missing was that each issue was kind of discussed in a stand-alone isolated sense.

And I'm still struggling with the issue of linkage to the one thing that is the best supporting evidence you have of context -- namely, your risk assessment. And that is not really addressed in these summaries.

For example, if I look at a risk assessment as a structured set of scenarios, and I want to -- and I'm told that the degradation of the engineered barrier system is a high risk issue, then what I'm looking for in the structured set of scenarios is how often the degradation of the engineered barrier system appears as an event.

And that gives me some real evidence that these guys know what they're talking about, because it's very much tightly anchored to the one analysis that they did that is for the purpose of providing context.

And I think that if there's any way you could introduce more connections with your risk assessment, with your TPA, I think it would add a lot, especially now that you're in the domain of trying to importance rank, which I agree with all of the members

that this is -- this is very valuable work. This brings clarity and insight to the process that, you know, we haven't had before. But I do think there is something missing here.

MR. McCARTIN: Yes. Yes. That's a good comment, and it's -- as you know, I think for the past year or so we've been coming to you with some of work right on our cutting edge.

VICE CHAIRMAN GARRICK: Right.

MR. McCARTIN: Yes, it's something to think about, and --

VICE CHAIRMAN GARRICK: It all relates to the cross-cutting and integration that is -- goes on here, and that you eventually want to get out of your performance assessment.

MR. McCARTIN: Right. And you're right, that's -- it's something to think -- you're right. That tie to the linkage through is not there, and, yes, we need to work on that. Yes, that's useful.

VICE CHAIRMAN GARRICK: I think earlier in the day we had somebody in the audience that wanted to make a comment. And I think we'll ask them to announce their name and affiliation and give us their comment.

MR. MALSCH: Yes. Actually, I just had

two questions. I'm Marty Malsch. I'm with the law firm of Eagan, Fitzpatrick, and Malsch. We represent the State of Nevada on Yucca Mountain related matters.

I have two questions, one to the NRC staff and one to DOE. And the one to NRC staff is as follows. I can understand how a risk ranking of the KTIs would be useful in prioritizing staff resources. But lurking behind the scenes here, I infer also the concept that a risk ranking of the KTIs could dictate the contents of an eventual license application.

And so my question to the staff is: what staff interest in public health and safety is served if a risk ranking of the KTIs leads to an application which is less complete in terms of issue resolution than it might otherwise be?

And I ask that question because, although ordinarily it would make no difference whether a matter is resolved in the preapplication phase or afterwards, in this case, once an application is accepted for docketing, the staff review will be under a statutory time deadline, in which case if there are surprises and things which are -- were believed to be of a low significance turn out to be high significance, now they have to be resolved during a strict time deadline.

And so it would seem to me it would be in the staff's interest to have an application which is more complete than not. And so I wonder what staff interest would be served in that event if the KTI priority rankings are used to encourage DOE to file a less than complete license application.

That was my question to the staff.

My question to DOE is this: it occurred to me that if DOE is using its TSPA to risk rank questions about the essential validity of the TSPA, that is assuming some essential validity in the TSPA itself, and so that prompts my question whether using a TSPA to risk rank questions about the TSPA isn't engaging in some sort of circular reasoning.

Thank you.

VICE CHAIRMAN GARRICK: I don't know if anybody is here that wants to comment on behalf of the NRC. But if -- they are certainly free to do so, if they would like to.

MR. CAMPBELL: I'm going to take a stab at answering the -- actually, Janet is there, so I'm going to defer to Janet.

MS. SCHLUETER: Well, I'd like to make a couple of comments from a program perspective. And it addresses some of the EPRI comments earlier today, and

that is that our position on the importance of the agreements has not changed, regardless of the outcome of our risk exercises.

They're still important. We still believe that regardless of whether they're ranked low, medium, or high, they still need to be addressed prior to the license application. And doing so will help ensure that the license application is complete.

I think we all heard this morning that the Department of Energy intends to explicitly address all of those agreements as part of the grouping effort that will take place between now and license application. That's a new effort. We just received that letter last night. We haven't had the chance to digest that information. We will be doing so.

We intend to have public interactions with the Department of Energy to discuss that. The risk initiative is new. It's new on the part of the NRC. The DOE has just received the staff's response to the Commission. That's dated June 5th. There is learning on their side that needs to take place.

We need to have these discussions, so that we can identify areas of differences, if you will, in approach, so that we can better understand those, and have the transparency I think that we all need in

moving forward in addressing all of these agreements prior to LA.

So there's nothing in the NRC's approach. I mean, we still consider all of the importance to -- the agreements to be important and to be addressed prior to LA. It's just, as Tim and others have described, the low, medium, and high could have some bearing on the level of effort, the resources, the prioritization of when the work comes in, particularly if we find that we received several groups together that have a large number of agreements contained in them.

We'll certainly have to prioritize those review, and it may as well dictate the level of information that the Department of Energy chooses to provide to us. And the measuring stick is still: did they meet the intent of the original agreement? And that's the judgment that the NRC staff will be making.

VICE CHAIRMAN GARRICK: Thank you.

And it might be one of the reasons for talking about the process being a risk-informed one as opposed to a risk-based licensing process.

From DOE, April, did you want to say something?

MS. GIL: Yes. Dr. Garrick, if I could

just ask Bob Andrews to respond a bit about the circular reasoning using TSPA.

DR. ANDREWS: Yes. I think maybe it was misunderstood, but the TSPA analyses were not answering the question of the technical bases. We've tried to address the technical bases with additional information or corroborative-type information to support the technical bases.

The TSPA-type analyses were being used to evaluate the significance, you know, of that uncertainty and its potential significance to one particular performance measure -- that being dose -- not the underlying technical bases themselves. So that was being addressed by other means, if you will.

VICE CHAIRMAN GARRICK: Thank you.

Frank, did you want to make a comment?

DR. RAHN: Yes. Frank Rahn from EPRI.

I wanted to reprise a little bit my comments from earlier today. First of all, I wanted to compliment NRC for a fine presentation, and lots of progress appears to have been made in the last year or so in this area, which I find to be very encouraging. And I think it's very important work.

Some of my comments this morning is at EPRI we're trying to look at risk with what I call a

capital R, which means not only the subject at hand but the greater risk. And there was a discussion a few minutes earlier about "potential risks," which I think was well taken in terms of what we are looking at.

But also, when we look at risk with a capital R, we look at what I call real and present risks, which are things like physical security. And what's interesting to note is -- on one of the slides, things like airplane crashes were important to our understanding of the issue, and it was rated as a high risk significant issue.

So when you take into account the capital R risks, and that includes things -- we worry about things like fuel being stored above ground as it presently is, which as I indicated represents a clear and present danger as opposed to a potential risk, how do you balance that off?

And partly it is to move forward in an expeditious basis in terms of the licensing application. I'm not aware of any legal reason why all of the low risk significant issues have to be resolved prior to licensing to the LA itself, apart from the agreement that appears to exist or does exist between DOE and NRC on the issue.

So, again, I raise the issue whether or not from a total risk standpoint whether or not it makes sense, or at least we keep in the back of our mind whether or not it's a requirement that all of the low risk issues have to be resolved prior to the LA itself, or whether or not if there is sufficient confidence that they can be taken care of in the LA -- during the LA period prior to the actual license being issued, whether or not that would serve the greater public good and public safety.

VICE CHAIRMAN GARRICK: Thank you.

April?

MS. GIL: Dr. Garrick, I feel compelled to say something, primarily on the basis of what Mr. Rahn said this morning. I just wanted to reiterate that DOE has plans in place to explicitly address every single KTI agreement on a schedule that supports the December '04 license application submittal.

Now, a few of the agreements are scheduled for completion after 12/04. However, we promise to give the NRC a path forward for resolution to address these items prior to LA submittal. And I think I mentioned earlier, I take the KTI agreements very seriously and personally, because my name is on a lot of the letters in which the KTI agreements were made.

And I consider those to be commitments between the Department and the NRC.

And I think for the purposes of public perception it's very important that we maintain those commitments, and that the Department maintain its promises to address every single one.

We've just submitted a revised KTI schedule to NRC. They just got it yesterday. They've recently completed their risk significance ranking results, which we've been looking through with significant interest. Both agencies are going to have to take time to evaluate the approaches and see how they affect what it is we're planning on doing.

The NRC's risk insight baseline is going to be very helpful to DOE. And I really appreciate the work that both Tim and Jim have done on that. I think it's very helpful to us. As I mentioned, we looked at it with quite a bit of interest.

We're going to use it to refine our approach and assist us to concentrate on what's important. But remember, to us all of the KTI agreements are important, and we will address every single one.

Thank you.

VICE CHAIRMAN GARRICK: Thank you.

MR. CAMPBELL: John, can I just --

VICE CHAIRMAN GARRICK: Yes. Andy Campbell?

MR. CAMPBELL: -- add one more thing? It's important to keep in mind that all of the agreements that were made were based upon, if you will, somewhat of an integrated approach by the various KTIs to identify key issues. The agreements weren't just made out of thin air. They actually represent a large amount, over many years of staff work.

And those agreements, at that time they were put together, it was felt that those were important to having a high quality license application in the door. This risk ranking doesn't nullify those agreements, but what it does is it tries to put all 293 into some context in terms of importance.

But it was never our intent to remove from the board a large number of agreements simply by calling them low. It's just they're lower in importance than mediums and highs. And that's, I think, where we view all 293 agreements. They are important, but they have differing levels of importance.

VICE CHAIRMAN GARRICK: Thank you.

It certainly has to be a confidence builder to have the analysis evolve in such a way that you have high confidence that the most important things are being ferreted out, and that you can allocate your resources accordingly.

It seems that that's the logical thing to do, and that you're developing some basis for doing just that -- and without neglecting any of the items, any of the 293, or 294 I saw once today, items.

All right. Any other questions, comments, or what have you? You have been an excellent set of briefers. We are right on schedule. And we got through pretty much what we wanted to, and we appreciate it a great deal. And we look forward to hearing more about this later.

Okay. Mr. Chairman?

CHAIRMAN HORNBERGER: Thank you, John.

We are going to take a five-minute break. We will no longer be on the record. We won't need the recorder. This will give people who want a chance to not hang around and listen to us talk about our reports a chance to leave. So a five-minute break.

(Whereupon, at 4:17 p.m., the proceedings in the foregoing matter went off the record.)

CERTIFICATE

This is to certify that the attached proceedings before the United States Nuclear Regulatory Commission in the matter of:

Name of Proceeding: Advisory Committee on Nuclear Waste 143rd Meeting

Docket Number: n/a

Location: Rockville, MD

were held as herein appears, and that this is the original transcript thereof for the file of the United States Nuclear Regulatory Commission taken by me and, thereafter reduced to typewriting by me or under the direction of the court reporting company, and that the transcript is a true and accurate record of the foregoing proceedings.

Rebecca Davis

Rebecca Davis
Official Reporter
Neal R. Gross & Co., Inc.

UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON NUCLEAR WASTE
WASHINGTON, D.C. 20555-0001

June 5, 2003

AGENDA
143rd ACNW MEETING
JUNE 24-25, 2003

TUESDAY, JUNE 24, 2003, CONFERENCE ROOM 2B3, TWO WHITE FLINT NORTH, ROCKVILLE, MARYLAND

1)	10:30 - 10:40 A.M.	Opening Statement (Open) (GMH/JTL) The Chairman will open the meeting with brief opening remarks, outline the topics to be discussed, and indicate items of interest.
2)	10:40 - 12:00 Noon	DOE Strategy for Resolving Key Technical Issue (KTI) Agreements (Open) (BJG/MPL) The Committee will be briefed by DOE representatives on their approach to grouping and resolving all KTI Agreements for the Yucca Mountain Project, including status and path forward.
	12:00 - 1:00 P.M.	***LUNCH***
3)	1:00 - 2:30 P.M.	Use of Risk Information as Basis for DOE/NRC Agreement Closure (Open) (BJG/RKM) The Committee will hear presentations by and hold discussions with representatives of the NRC Office of Nuclear Materials Safety and Safeguards (NMSS) and DOE representatives on the use of risk information as the basis for closure of technical agreements for the Yucca Mountain Project.
	2:30 - 2:45 P.M.	***BREAK***
4)	2:45 - 4:15 P.M.	NRC Staff Report on the Risk Significance Ranking of the 293 KTI Agreements (Open) (BJG/NMC) The Committee will hear an update by the NRC/NMSS staff on how the 293 KTI agreements were ranked into high, medium, and low risk significance.
5)	4:15 - 6:00 P.M.	Preparation of ACNW Report (Open) The Committee will discuss a proposed report on the following topic: 5.1) Status of KTI Agreement Resolution for the Proposed Yucca Mountain High Level Waste Repository (BJG/NMC) (Tentative)

WEDNESDAY, JUNE 25, 2003, CONFERENCE ROOM 2B3, TWO WHITE FLINT NORTH, ROCKVILLE, MARYLAND

6)	8:30 - 8:35 A.M.	Opening Statement (Open) (GMH/RKM) The Chairman will make opening remarks regarding the conduct of today's sessions.
7)	8:35 - 10:30 A.M.	Spent Fuel Characterization Project (Open) (ML/RKM) The Committee will hear presentations by and hold discussions with representatives of the NRC Office of Nuclear Regulatory Research (RES) on a project involving spent fuel loaded in 1985 in a dry cask and opened and inspected in 1999.
	10:30 - 10:45 A.M.	***BREAK***
8)	10:45 - 11:45 A.M.	Update on Waste Management Related Research (Open) (MTR/RPS) The Committee will receive an update from the NRC/RES staff on the status of the radionuclide transport research as well as other waste-related research activities.
	11:45 - 1:00 P.M.	***LUNCH***
9)	1:00 - 1:30 P.M.	Plans for Performance Confirmation Working Group (Open) (MTR/NMC) The Committee will discuss the final agenda, and plans for the Performance Confirmation Working Group scheduled for the next (144th) meeting.
10)	1:30 - 2:00 P.M.	2003-04 ACNW Research Report (Open) (MTR/RPS) An outline and potential plan for the next ACNW Research Report will be discussed.
11)	2:00 - 2:15 P.M.	Election of Officers (Open) (GMH/JTL) Members will nominate and elect members to the positions of Chairman and Vice Chairman for the period July 1, 2003 through June 30, 2004.
	2:15 - 2:30 P.M.	***BREAK***
12) (BREAK as needed)	2:30 - 5:45 P.M.	Preparation of ACNW Reports (Open) The Committee will continue its discussion of proposed reports: 12.1) Status of KTI Agreement Resolution for the Proposed High Level Waste Repository at Yucca Mountain (BJG/NMC) (Tentative) 12.2) Spent Fuel Characterization Project (ML/RKM) (Tentative)

13)	5:45 - 6:00 P.M.	Miscellaneous (Open) The Committee will discuss matters related to the conduct of Committee activities and matters and specific issues that were not completed during previous meetings, as time and availability of information permit.
	6:00 P.M.	Adjourn 143rd Meeting

NOTE:

- Presentation time should not exceed 50 percent of the total time allocated for a specific item. The remaining 50 percent of the time is reserved for discussion.

- Thirty-Five (35) copies of the presentation materials should be provided to the ACNW.

- ACNW meeting schedules are subject to change. Presentations may be canceled or rescheduled to another day. If such a change would result in significantinconvenience or hardship, be sure to verify the schedule with Mr. Howard Larson at 301-415-6805 between 8:00 a.m. and 4:00 p.m. prior to the meeting.

U.S. Department of Energy
Office of Civilian Radioactive Waste Management

YUCCA MOUNTAIN PROJECT

DOE's Approach to Resolution of Key Technical Issue Agreements

Presented to:
Advisory Committee on Nuclear Waste

Presented by:
April V. Gil, Division Director
Regulatory Interactions and Strategy
Office of Repository Development
Office of Civilian Radioactive Waste Management
U.S. Department of Energy

June 24, 2003
Rockville, Maryland

DOE's Approach to Key Technical Issue Resolution

- **Background**
  - **Key Technical Issue Agreements**
    - **Were established over an 18 month period in a series of interactions ending September 2001**
    - **Were key to NRC's sufficiency finding**
    - **Have been an effective way to focus program resources and interactions**

Key Technical Issue Agreement Summary - NRC Key Technical Issue Agreement Summary - NRC Status

Reflects activity thru June 17, 2003

KTI ID	Agreements Reached	Documentation Received for Agreement	Documentation Partly Received for Agreement	Documentation Not Received for Agreement	Need Additional Information	Agreements Complete
CLST	58	1	3	23	11	20
ENFE	41	3	7	17	2	12
GEN	1	0	1	0	0	0
IA	22	0	0	7	3	12
PRE	9	1	0	6	1	1
RDTME	23	1	2	20	0	0
RT	29	1	3	16	4	5
SDS	10	1	4	0	1	4
TEF	15	0	3	4	1	7
TSPAI	58	0	3	37	11	7
USFIC	27	0	1	12	4	10
Total =	293	8	27	142	38	78

Note: Reflects current DOE activity but may not reflect recent NRC changes not yet received or processed

DOE's Approach to Key Technical Issue Resolution

- Introduction
  - Revisions to resolution strategy were needed
    - Program replanning due to Continuing Resolution
    - Availability of Yucca Mountain Review Plan (Draft Final)
  - Increases in understanding due to communications with NRC staff
    - Developing responses to original Key Technical Issue agreements
    - Receipt of Additional Information Needs from NRC staff
    - Clarification of NRC staff expectations
    - Discussions at technical exchanges
  - Previous approach focused primarily on responses to individual agreements
    - Addressing each agreement in isolation was not as effective as an integrated approach

DOE's Approach to Key Technical Issue Resolution

- **Revised approach reflects a total postclosure system view**
  - **Key Technical Issues will be addressed according to their relationship to the system**
  - **Consistent with the Yucca Mountain Review Plan (Draft Final) and the Safety Analysis Report**
  - **A more integrated, systematic approach to address Key Technical Issue agreements**

DOE's Approach to Key Technical Issue Resolution

(Continued)

- **DOE will explicitly address every Key Technical Issue agreement**
  - **Goal is effective resolution of Key Technical Issue agreements**
  - **Revised schedule for submittal has been provided to NRC**
  - **Some Key Technical Issue agreements will be handled separately and/or individually, for example preclosure, criticality, and design**
- **Coordination with NRC staff for their review is critical**
  - **Regulatory interactions will be held to assist NRC's review of DOE's proposals and products**
  - **Current schedule of interactions will be updated as needed to reflect this approach**

DOE's Approach to Key Technical Issue Resolution

(Continued

- **Presentations:**
  - **Robert Andrews, Bechtel SAIC Company, LLC**
    - **Development of the Integrated Technical Basis for the Key Technical Issue Agreement Responses**
  - **Tim Gunter, DOE**
    - **Key Technical Issue Grouping Strategy**

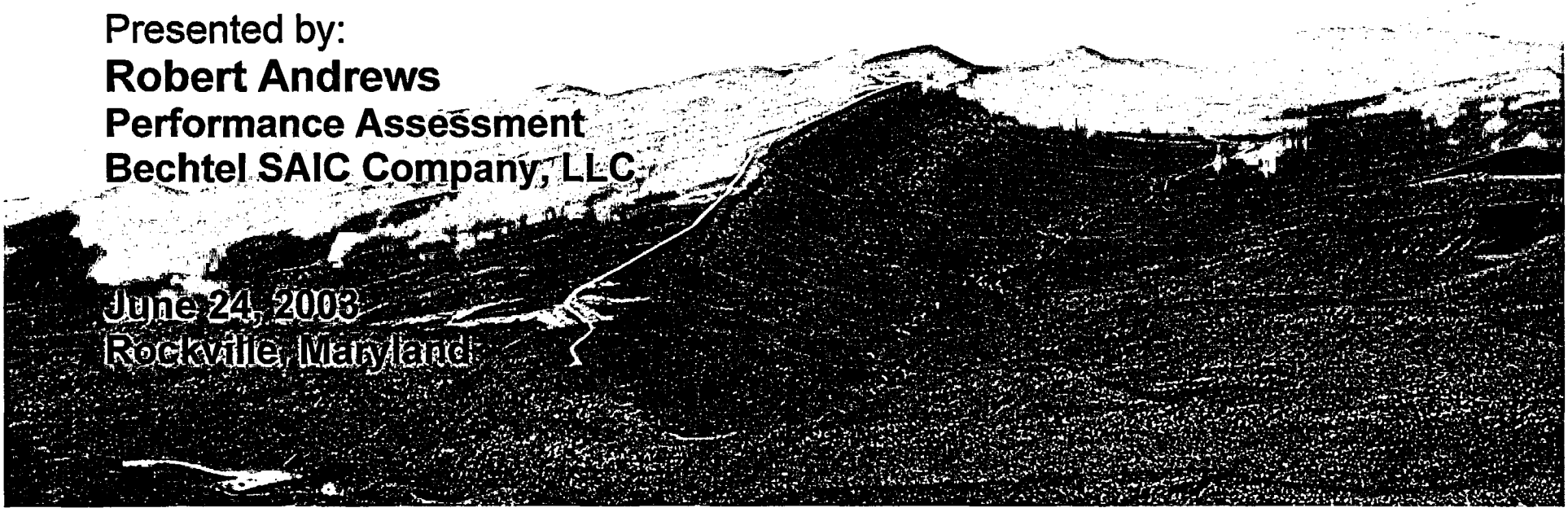
U.S. Department of Energy
Office of Civilian Radioactive Waste Management

YUCCA MOUNTAIN PROJECT

Use of Risk Information to Address Key Technical Issue Agreements

Presented to:
Advisory Committee on Nuclear Waste

Presented by:
Robert Andrews
Performance Assessment
Bechtel SAIC Company, LLC



June 24, 2003
Rockville, Maryland

OUTLINE

- DOE approach to addressing Key Technical Issue agreements
- DOE approach to using risk information to address Key Technical Issue agreements
- Implementation of risk approach to address Key Technical Issue agreements
- Example of implementation of risk approach
- Summary of NRC concerns with use of risk approach to address Key Technical Issue agreements
- DOE's planned path forward on use of risk information to address Key Technical Issue agreements

DOE Approach to Resolving Key Technical Issue Agreements

- Alternative approaches have been followed to address Key Technical Issue agreements
- The majority of Key Technical Issue agreements are being addressed with additional scientific/engineering information consistent with the original agreement
- For some agreements, DOE has used risk information as an alternative means of addressing the agreement
- To date, 8 agreements have been submitted using this approach
- The following summarizes this approach as presented to NRC staff May 15, 2003

DOE Approach to Using Risk Information

- **Basis in 10 CFR Part 63**
  - **"DOE must demonstrate … reasonable expectation of compliance … based upon the mean of the distribution of projected doses…" (10 CFR 63.303)**
  - **"Reasonable expectation … focuses performance assessments and analyses on the full range of defensible and reasonable parameter distributions rather than only upon extreme physical situations and parameter values." (10 CFR 63.304)**

DOE Approach to Using Risk Information
(Continued)

- **Goal**
  - Focus resources on those Key Technical Issue agreements for which unresolved technical issues could impact the repository's ability to meet postclosure compliance standards
  - Identify those agreements for which uncertainty associated with the technical issue will not affect compliance with the standards
  - Document the technical basis for closing agreements that does not affect compliance with the standards, using appropriate modeling studies that are available now

DOE Approach to Using Risk Information
(Continued)

- DOE has proposed to address Key Technical Issue agreements with results of model sensitivity analyses in lieu of specific new technical information if and when
  - Information requested in the agreement is shown to have limited significance to risk based on importance to repository performance or waste isolation (i.e., mean annual dose or radionuclide concentrations in groundwater during the 10,000-year regulatory period); or

DOE Approach to Using Risk Information
(Continued)

- Information requested in the agreement is not needed to support the technical basis for the treatment of uncertainty regarding the relevant processes that will be included in the Total System Performance Assessment for the License Application (i.e., current treatment of uncertainty is defensible); and
- Information requested in the agreement is not needed to support the description of barrier capability that will be included in the License Application

DOE Approach to Using Risk Information

(Continued)

- **Two broad types of agreements for which risk information is believed to be an appropriate approach**
  - **Agreement calls for additional technical work to reduce uncertainty from that currently included in the Total System Performance Assessment, and DOE can document that performance is insensitive to the current treatment of uncertainty**
  - **Agreement calls for additional technical work to defend current treatment of uncertainty (i.e., NRC staff believes DOE's treatment of uncertainty is not supported by available information); and DOE can document that performance is insensitive to a broader range of uncertainty that the NRC staff agrees is consistent with available information or is conservatively bounding**

Risk Information Implementation

- To date, 8 Key Technical Issue agreements have been addressed using the risk information approach
- These have included agreements related to the climate and infiltration models (5), unsaturated zone flow and transport models (2), and drip shield degradation (1)
- NRC staff have identified Additional Information Needs for each of these responses
- One additional response using a combined technical basis and risk information approach was closed based on technical information

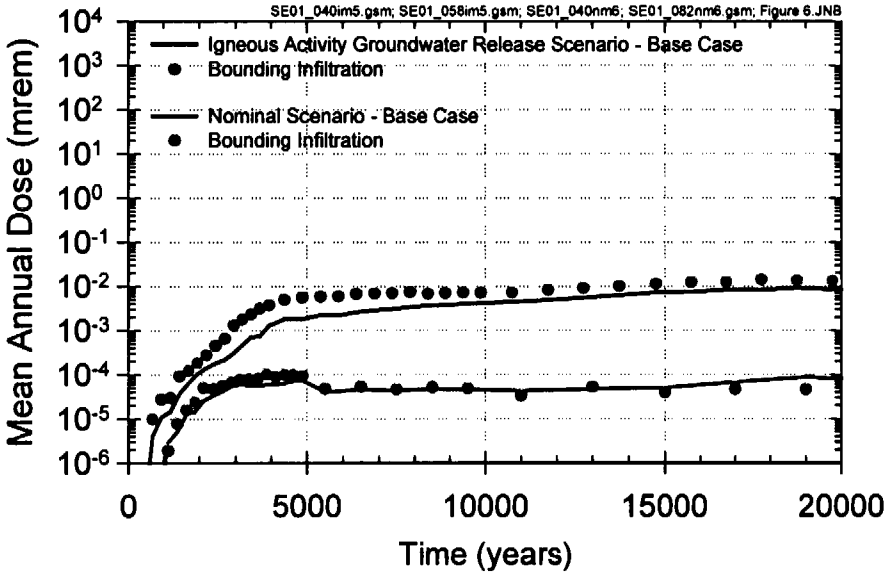
Risk Information Implementation - Approach

- Technical basis information includes other lines of evidence to support the model or parameter uncertainty that formed the basis of the Key Technical Issue agreement
- Risk-informed basis includes Total System Performance Assessment sensitivity analysis techniques, such as
  - Extreme value one-off analyses
    - Show that mean performance is insensitive to the assumption of extreme values for possible conditions associated with the component related to the issue
  - Neutralizations
    - Show that mean performance is insensitive to the presence or absence of the entire component related to the issue
  - Combined effect analyses
    - Show that mean performance is insensitive to the assumption of extreme values occurring simultaneously in multiple components for which DOE proposes to use risk information to resolve agreements

Risk Information Example - Total System Performance Assessment and Integration 3.18

- Total System Performance Assessment and Integration (TSPAI) 3.18 - provide basis that water-balance plug flow model adequately represents non-linear flow processes represented by Richards' equation
- Issue - Richards' equation would allow a more realistic evolution of water distribution in the soil column
- DOE letter dated January 21, 2003 addressed TSPAI 3.18
- Technical basis for proposed resolution included
  - Alternative representations of infiltration including comparisons with heat and moisture transport, a variety of environmental tracers, and regional water budget information
- Risk-informed basis for proposed resolution included
  - Total System Performance Assessment sensitivity analyses which included two extreme value one-off analyses and a neutralization analysis

Risk Implementation Example - Effect of Increased Net Infiltration Rates



- Net infiltration rate averages 4.7 mm/yr for present-day climate (range from 0 to 250 mm/yr depending on soil/rock properties and precipitation/evaporation rates) and increases to about 12.5 mm/yr with climate changes within 10,000 years
- The one-off sensitivity analysis used a bounding unsaturated zone flow field associated with infiltration rate of ~ 150 mm/yr (the glacial maximum climate infiltration rate)
- This infiltration rate increase affects unsaturated zone flow and transport
- The changes in dose projections are small
- Separate analyses of the effects of increased seepage were conducted and yielded similar results

Example - Additional Information Needed to Complete Total System Performance Assessment and Integration 3.18

- NRC response, dated April 30, 2003, indicated a need for additional technical information
- Additional information to complete TSPAI 3.18 based upon technical merit include:
  - Technical basis that non-linear flow processes have been adequately represented, or
  - Technical basis that water balance plug flow model is not underpredicting net infiltration rate in comparison to Richards' equation
- Additional information to complete TSPAI 3.18 based upon low risk significance include:
  - Combined effects of uncertainties for all Key Technical Issue agreements that are to be addressed using low risk significance
  - Additional description of changes made to the model for the sensitivity analyses
  - Additional description of uncertainties in the performance analyses (e.g., 5th and 95th percentiles of the dose estimates)

NRC Concerns with Implementation of Risk Information Approach

- Rationale behind the sensitivity analysis requires technical basis commensurate with risk significance
- Documentation of the analysis is insufficient to discern exactly what model modifications were implemented
- Results require explicit evaluation of range of results rather than focussing on mean dose response
- Confirmatory analyses are required with a fully qualified model
- Combined effects of multiple barrier sensitivity analyses are desired

DOE's Proposed Path Forward

- **DOE will continue to provide documentation to the NRC for agreements identified as candidates for risk informed resolution**
  - **Explanation of the technical basis for the conclusion that overall performance is not sensitive to the information requested**
  - **Explanation of the technical basis for the conclusion that the requested information is not needed for demonstrations of barrier capability**
  - **Sensitivity analysis results demonstrating that overall performance is not sensitive to the information requested**
    - **Additional information about analyses (e.g., traceable documentation of models and inputs, displays of uncertainty in results) will be provided**

DOE's Proposed Path Forward
(Continued)

- DOE does not propose to update the combined effects analysis
  - NRC's concerns primarily relate to components for which the DOE does not propose to use risk-informed approaches
- Full probabilistic Total System Performance Assessment for the License Application will provide information on combined effects of uncertainties
  - Focus "on the full range of defensible and reasonable parameter distributions rather than only upon extreme physical situations and parameter values." (10 CFR 63.304(4))

Backup Slides - Additional Detail on Risk Informed Implementation Approach

Implementation (Backup)

- **Risk-informed analyses are not meant to be realistic projections of performance**
  - **All use an unrealistic assumption that the particular combination of conditions has a probability of one of occurring**
  - **Some assume physically impossible conditions (i.e., neutralizations)**
  - **Some assume highly unlikely conditions (i.e., extreme value cases)**
    - **Extreme values may be within the range of uncertainty supported by available information, and therefore have a quantifiable probability (e.g, 95th percentile)**
    - **Extreme values may be outside the range of physically reasonable uncertainty, and therefore should have a probability of zero**

Implementation (Backup)

(Continued)

- The probability of extreme values occurring in multiple components simultaneously (i.e., the combined effects analysis) is very small
  - For example, the probability of the 95 percentile performance occurring in 9 independent model components simultaneously is $(0.05)^9 = 2 \times 10^{-12}$
  - For overall risk (mean dose) associated with this example to exceed the standard, calculated doses to the reasonably maximally exposed individual would have to be on the order of 10^{12} mrem/yr
    - This hypothetical dose is greater than what can be calculated assuming the entire radionuclide inventory of the repository could be dissolved in 3000 acre-ft of water in a single year

Implementation (Backup)

(Continued)

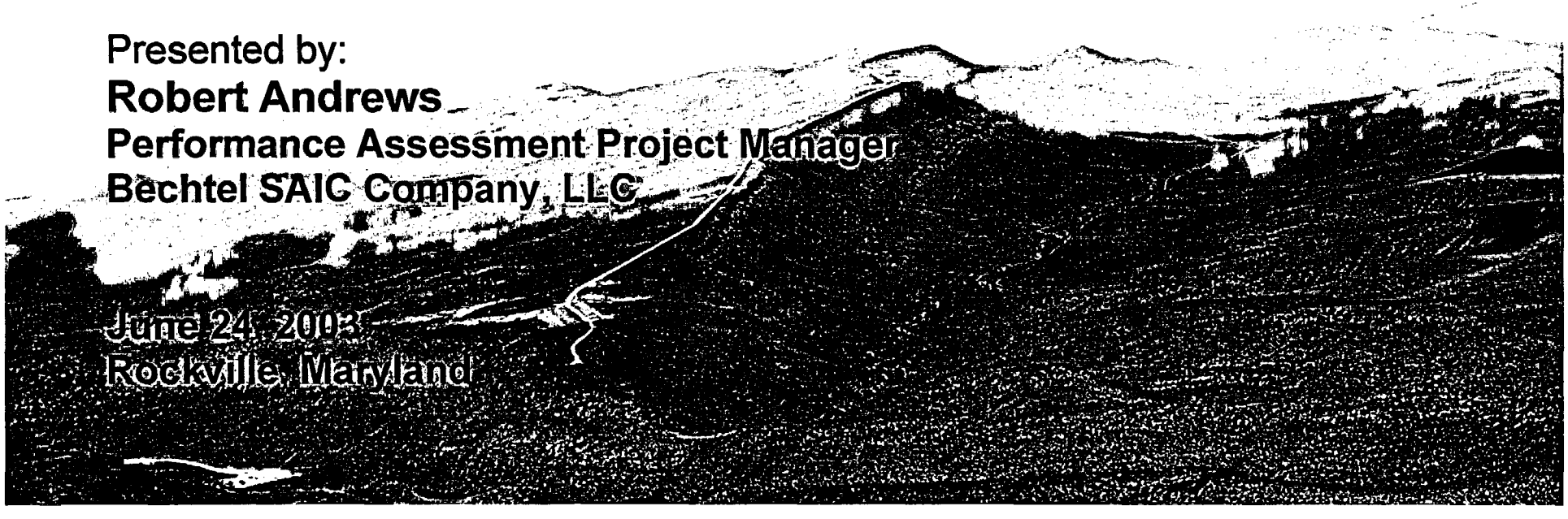
- Results are presented as information to be considered in evaluating the status of the agreements, and are not appropriate for comparison to regulatory limits
- DOE has identified, to date, approximately 10 Key Technical Issue agreements for which it proposes using risk information in lieu of additional technical work
  - List may change as work progresses
- DOE does not propose to use extreme-value sensitivity analyses to resolve agreements specific to waste package performance

U.S. Department of Energy
Office of Civilian Radioactive Waste Management

YUCCA MOUNTAIN PROJECT

Development of the Integrated Technical Basis for the Key Technical Issue Agreement Responses

Presented to:
Advisory Committee on Nuclear Waste



Presented by:
Robert Andrews
Performance Assessment Project Manager
Bechtel SAIC Company, LLC

June 24, 2003
Rockville, Maryland

Outline

- Previous approach to developing Key Technical Issue agreement responses
- Revised approach to developing Key Technical Issue agreement responses
- Organization of Integrated Technical Basis and Key Technical Issue response groups
- Correlation of Key Technical Issue response groups with Yucca Mountain Review Plan (Draft Final) model abstraction groups
- Example of a Key Technical Issue response group
- Conclusions

Previous Approach to Developing Key Technical Issue Responses

- Perform scientific/engineering activities related to Key Technical Issue agreements (design, testing, model refinement, analyses)
- Document results of scientific/engineering activities in technical products
  - Products have multiple procedural and technical requirements to be fulfilled in addition to addressing the Key Technical Issue agreements and Yucca Mountain Review Plan (Draft Final) acceptance criteria
- Abstract results from technical products into Key Technical Issue-specific letter reports
- Develop technical basis for Safety Analysis Report
- Document technical basis consistent with Yucca Mountain Review Plan (Draft Final)

Disadvantages of Previous Approach

- Key Technical Issue agreement responses completed prior to documentation of technical basis
- Key Technical Issue agreements described without full context of technical basis

Revised Approach to Developing Key Technical Issue Responses

- Develop the technical basis describing the barriers and basis for barrier performance
- Organize technical basis to be consistent with abstraction groups of the Yucca Mountain Review Plan (Draft Final)
- Address Key Technical Issue agreements using scientific/engineering activities presented in the context of the technical basis
  - i.e., consistent with the intent of the original Key Technical Issue agreement

Advantages of Revised Approach

- Integration of technical basis helps identify potential gaps that can be addressed
- Placing Key Technical Issue agreements in context of integrated technical basis allows more transparent discussion of bases of information requested
  - Relevance generally is related to process, model, parameter, data or testing uncertainty
- Early communication of technical basis to NRC

Possible Methods Considered to Organize Development of Technical Basis

- Time
- Space
- State variables
  - Temperature, pressure, chemistry, stress, hydrology (flux and saturation), radionuclide concentration
- Barrier
  - Sequential barriers identified by following the path of water and radionuclides through the system
- Process
- Scale

Integrated Technical Basis Key Technical Issue Response Groups

(and Related Process Model Groups)

I. Climate and Infiltration

II. Unsaturated zone flow

III. Water Seeping into Drifts
- Water seeping into drifts
- Thermal effects on water flow

IV. Mechanical degradation and seismic effects

V. In-Drift chemical environment
- Thermal effects on water flow and chemistry
- Evaporation effects on in-drift water flow and chemistry
- Chemistry modification by dust and deliquescence

VI. Waste package and drip shield corrosion
- Degradation of the Drip Shield
- Degradation of the Waste Package

VII. In-package environment, waste form degradation and solubility
- Water and chemistry evolution in the waste package
- Degradation of waste form
- Mobilization of radionuclides

VIII. Colloids
- Mobilization of radionuclides
- Transport to edge of waste package
- Transport to invert
- Transport to rock
- Unsaturated zone transport
- Saturated zone flow and transport

IX. Engineered Barrier System Transport
- Thermal effects on water flow and chemistry
- Transport to edge of waste package
- Transport to invert
- Transport to rock

X. Unsaturated zone transport
- Thermal effects on transport
- Unsaturated zone transport

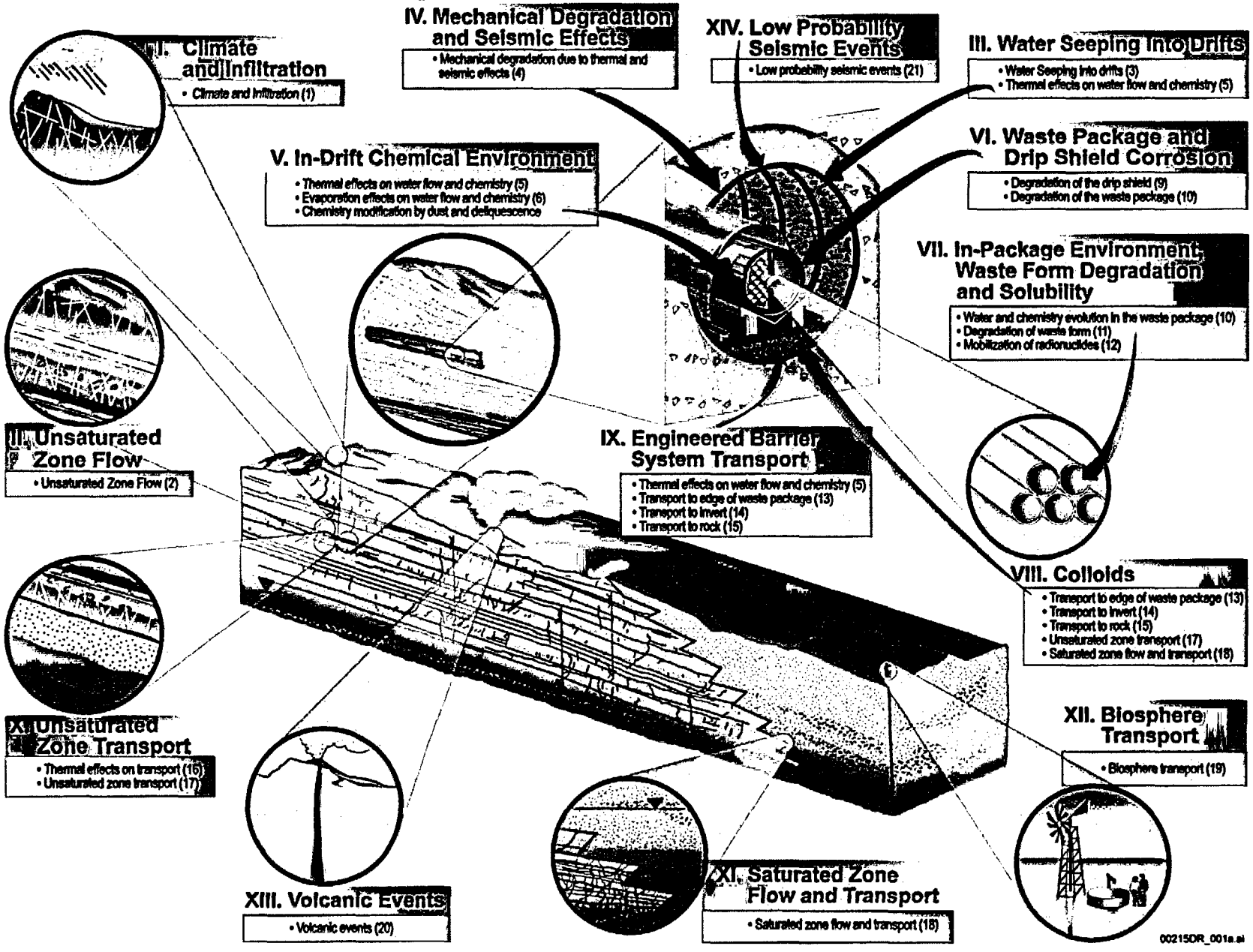
XI. Saturated zone flow and transport

XII. Biosphere transport

XIII. Volcanic events

XIV. Low probability seismic events

Integrated Technical Basis Key Technical Issue Response Groups (and Related Process Model Groups)



Correlation of Key Technical Issues with Integrated Key Technical Issue Response Groups

Key Technical Issue	Key Technical Issue Response Group(s)
Unsaturated and Saturated Flow under Isothermal Conditions (USFIC)	I. Climate and infiltration II. Unsaturated zone flow III. Water seeping into drifts
Thermal Effects on Flow (TEF)	II. Unsaturated zone flow III. Water seeping into drifts IV. Mechanical degradation and seismic effects VII. In-Package environment, waste form degradation and solubility
Repository Design and Thermal Mechanical Effects (RDTME)	IV. Mechanical degradation and seismic effects
Evolution of the Near Field Environment (ENFE)	III. Water seeping into drifts IV. Mechanical degradation and seismic effects V. In-Drift chemical environment VI. Waste package and drip shield corrosion VII. In-Package environment, waste form degradation and solubility IX. Engineered barrier system transport
Container Life and Source Term (CLST)	IV. Mechanical degradation and seismic effects V. In-Drift chemical environment VI. Waste package and drip shield corrosion VII. In-Package environment, waste form degradation and solubility
Radionuclide Transport (RT)	VIII. Colloids IX. Engineered barrier system transport X. Unsaturated zone transport XI. Saturated zone flow and transport XII. Biosphere transport
Igneous Activity (IA)	XII. Biosphere transport XIII. Volcanic events
Structural Deformation and Seismicity (SDS)	IV. Mechanical degradation and seismic effects XIV. Low probability seismic effects
Total System Performance Assessment and Integration (TSPAI)	All including features, events, and processes
Preclosure (PRE)	N/A
General (GEN)	All

Correlation of Integrated Key Technical Issue Responses and Yucca Mountain Review Plan (Draft Final) Abstraction Groups

Yucca Mountain Review Plan Abstraction Group	Integrated Key Technical Issue Response Groups (Number of Remaining FY03 KTIs)
1. Degradation of Engineered Barriers	VI. Waste package and drip shield corrosion (8)
2. Mechanical Disruption of Engineered Barriers	IV. Mechanical degradation and seismic effects XIV. Low probability seismic effects
3. Quantity and Chemistry of Water Contacting Waste Packages and Waste Forms	III. Water seeping into drifts (3) V. In-Drift chemical environments (14) VII. In-package environment
4. Radionuclide Release Rates and Solubility Limits	VII. Waste form degradation and solubility VIII. Colloids (8) IX. Engineered barrier system transport
5. Climate and Infiltration	I. Climate and infiltration
6. Flow Paths in the Unsaturated Zone	II. Unsaturated zone flow
7. Radionuclide Transport in the Unsaturated Zone	X. Unsaturated zone transport
8. Flow Paths in the Saturated Zone	XI. Saturated zone flow and transport (18)
9. Radionuclide Transport in the Saturated Zone	XI. Saturated zone flow and transport (see above)
10. Volcanic disruption of Waste Packages	XIII. Volcanic disruptive events (3)
11. Airborne Transport of Radionuclides	XIII. Volcanic disruptive events (see above)
12. Concentration of Radionuclides in Ground Water	XI. Saturated zone flow and transport (see above)
13. Redistribution of Radionuclides in Soil	XII. Biosphere transport (see below)
14. Biosphere Characteristics	XII. Biosphere transport (6)

Example Integrated Key Technical Issue Response - In-Drift Chemical Environment

- **CLST 1.01** Bases for evolution of brine water chemistry
- **ENFE 1.05** Uncertainty in the thermal-hydrologic-chemical model
- **ENFE 2.04** Uncertainty in trace elements and fluoride
- **ENFE 2.05** Data and model uncertainty for in-drift geochemical environment
- **ENFE 2.06** Uncertainty in local chemistry on drip shield and waste package considering chemical divide phenomenon
- **ENFE 2.09** Provide an update to the *In-Drift Precipitate Salts Analysis*
- **ENFE 2.10** Range of bulk chemical compositions that could affect degradation of drip shield and waste package
- **ENFE 2.11** Additional basis for treatment of precipitation-dissolution kinetics
- **ENFE 2.13** Effect of dust on the chemical environment on the drip shield and waste package
- **ENFE 2.14** Analysis of laboratory solutions that have interacted with introduced materials
- **ENFE 2.15** Additional information to constrain the low relative humidity salts model
- **ENFE 2.17** Data uncertainty to calibrate and support model predictions
- **TSPAI 3.12** Corrosion testing in a credible range of environments
- **TSPAI 3.13** Compare environments predicted in models to corrosion testing environments

NOTE: CLST - Container Life and Source Term
ENFE - Evolution of the Near Field Environment
TSPAI - Total System Performance Assessment and Integration

Conclusions

- Revised approach places Key Technical Issue agreement responses in the context of the technical basis for the License Application
  - This mapping is similar to the Yucca Mountain Review Plan (Draft Final) abstraction groups which are based on the Integrated Issue Resolution Status Report groups
- Revised approach consolidates like agreement items regardless of the Key Technical Issue category

Backup

Technical Basis Process Groups

1. Climate and infiltration
2. Unsaturated zone flow
3. Water seeping into drifts
4. Mechanical degradation due to thermal and seismic effects
5. Thermal effects on water flow and chemistry
6. Evaporation effects on in-drift water flow and chemistry
7. Chemistry modification by dust and deliquescence
8. Degradation of the drip shield
9. Degradation of the waste package
10. Water and chemistry evolution in the waste package
11. Degradation of waste form
12. Mobilization of radionuclides
13. Transport to edge of waste package
14. Transport to invert
15. Transport to rock
16. Thermal effects on transport
17. Unsaturated zone transport
18. Saturated zone flow and transport
19. Biosphere transport
20. Volcanic events
21. Low probability seismic events

Mapping of Process and State Variables at Different Scales - Nominal Performance

Scale	Key Processes	Key State Variables
Repository scale	1. Climate and infiltration 2. Unsaturated zone flow	Water flux, saturation
Drift scale	3. Seepage 4. Mechanical degradation 5. Chemistry and thermal effects	Water flux, saturation, temperature, stress, chemistry
Waste package scale	6. Chemistry evolution in drifts 7. Effects of dust 8. Drip shield degradation 9. Waste package degradation	Water flux, temperature, stress, chemistry
Waste form scale	10. Water and chemistry evolution in the waste package 11. Degradation of waste form 12. Mobilization of radionuclides 13. Transport to edge of waste package	Water flux, temperature, chemistry, radionuclide concentration
Drift scale	14. Transport to invert 15. Transport to rock 16. Thermal effects on transport	Water flux, saturation, temperature, chemistry, radionuclide concentration
Repository scale	17. Unsaturated zone transport	Water flux, chemistry, radionuclide concentration
Site scale	18. Saturated zone flow and transport 19. Biosphere transport	Water flux, chemistry, radionuclide concentration

Correlation of Technical Basis Process Groups to Yucca Mountain Review Plan (Draft Final) Abstraction Groups

Yucca Mountain Review Plan Abstraction Group	Technical Basis Process Groupings
1. Degradation of Engineered Barriers	8. Degradation and corrosion of drip shield 9. Degradation and corrosion of waste package
2. Mechanical Disruption of Engineered Barriers	4. Mechanical degradation due to thermal and seismic 21. Low probability seismic events
3. Quantity and Chemistry of Water Contacting Waste Packages and Waste Forms	3. Water seeping into drifts 5. Thermal effects on water flow and chemistry 6. Evaporation effects on in-drift water flow and chemistry 7. Chemistry modification by dust and deliquescence 10. Water and chemistry evolution in the waste package
4. Radionuclide Release Rates and Solubility Limits	11. Degradation of waste form 12. Mobilization of radionuclides into solution 13. Transport from waste form to edge of waste package 14. Transport to invert 15. Transport to rock
5. Climate and Infiltration	1. Climate and infiltration
6. Flow Paths in the Unsaturated Zone	2. Unsaturated zone flow
7. Radionuclide Transport in the Unsaturated Zone	16. Thermal effects on unsaturated zone transport 17. Unsaturated zone transport
8. Flow Paths in the Saturated Zone	18. Saturated zone flow and transport
9. Radionuclide Transport in the Saturated Zone	18. Saturated zone flow and transport
10. Volcanic disruption of Waste Packages	20. Volcanic events
11. Airborne Transport of Radionuclides	20. Volcanic events
12. Concentration of Radionuclides in Ground Water	18. Saturated zone flow and transport
13. Redistribution of Radionuclides in Soil	19. Biosphere transport
14. Biosphere Characteristics	19. Biosphere transport

U.S. Department of Energy
Office of Civilian Radioactive Waste Management

YUCCA MOUNTAIN PROJECT

Key Technical Issue Grouping Strategy

Presented to:
Advisory Committee on Nuclear Waste

Presented by:
Timothy Gunter
Office of Repository Development
Office of Civilian Radioactive Waste Management
U.S. Department of Energy

June 24, 2003
Rockville, Maryland

Key Technical Issue Group Response Approach

- **Objective**
  - **Explicitly and transparently address each Key Technical Issue agreement and Additional Information Needs in a context that reflects:**
    - **Total system postclosure view**
    - **Expected technical basis for the License Application**
    - **NRC guidance in Yucca Mountain Review Plan (Draft Final)**

Key Technical Issue Group Response Approach

(Continued)

- 194 Key Technical Issues and Additional Information Needs mapped to logical groupings for which a technical basis description will be prepared
  - Technical basis document planned in 2 Phases
    - Fall 2003
    - Late Winter/Spring 2004
  - Grouped Key Technical Issue deliveries begin Fall 2003 and continue through 2004
- 13 Key Technical Issues not associated with postclosure processes scheduled individually
  - Delivered in parallel with grouped Key Technical Issues and Additional Information Needs through mid-2004

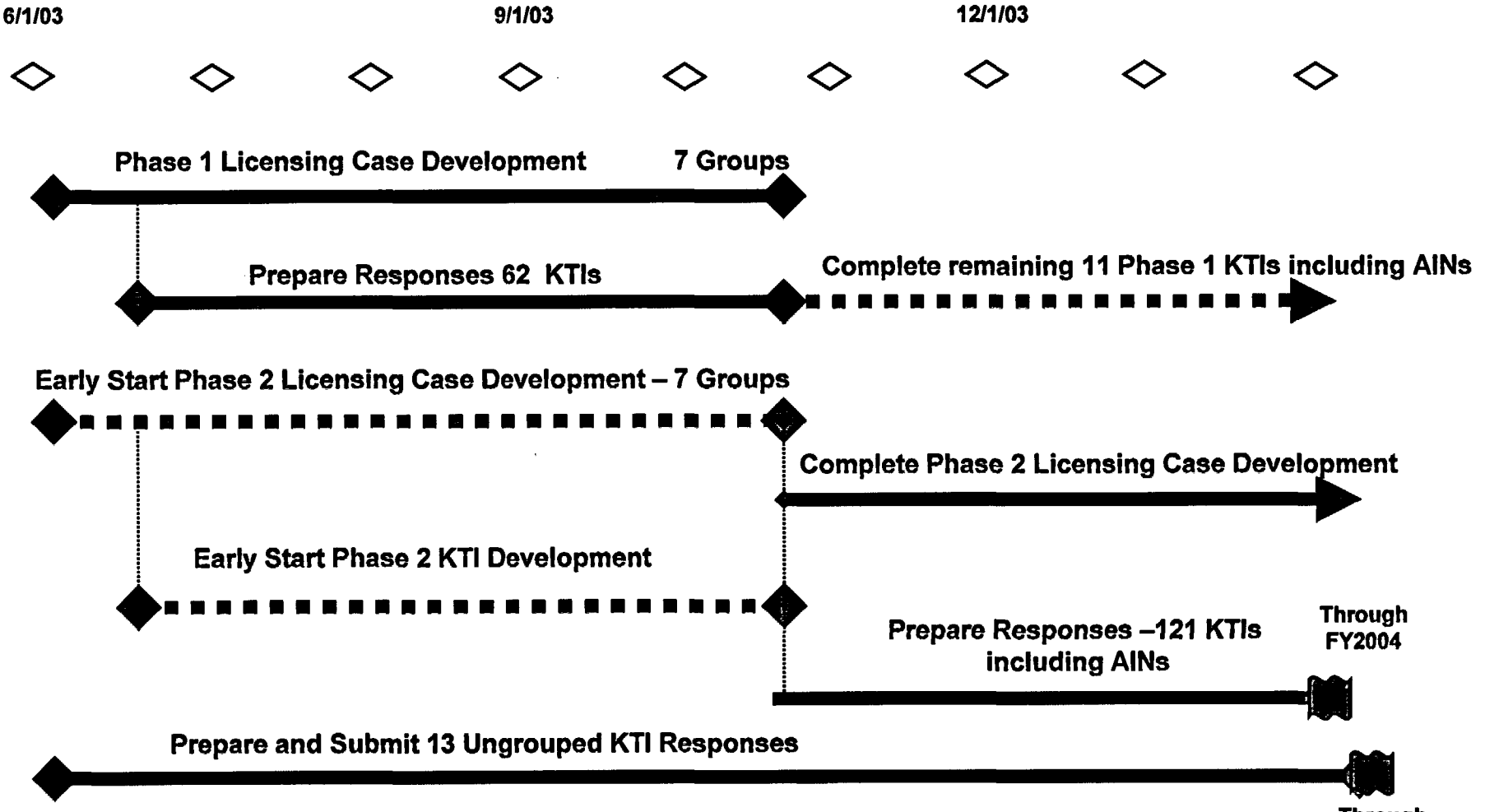
Key Technical Issue Group Response Approach

(Continued)

- DOE will provide the technical basis descriptions for each group topic
- Individual Key Technical Issue agreements and Additional Information Needs responses will be discretely addressed by DOE letters to NRC
- Where possible, the Key Technical Issue agreements and Additional Information Needs responses will also be explicitly addressed in the technical basis descriptions
- Where more detail is required by the response that would be appropriate in the technical basis description, the response will provide its contextual relationship

Key Technical Issue Group Response Approach

(Continued)



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Risk-Informed Issue Resolution

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U.S. Nuclear Regulatory Commission

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143rd ACNW Meeting **June 25, 2003**

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"The NRC encourages the use of risk assessments and sensitivity analyses to help identify data, models, and barriers that are most important to repository performance and to focus available resources on those items."

Schlueter to Ziegler, January 27, 2003

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Overview and Background

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Overview of Risk-Informed Agreement Resolution:

- Status as of 9/21/02 had 31 proposed agreements (termed Bin 3 by DOE).
- Nine of those agreements have been received by the NRC.
- Agreements cover multiple areas of the TSPA.
- Quantitative analysis must address the system-nature of the TSPA model.

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Overview of DOE Analysis:

- DOE has performed sensitivity analysis using the TSPA model.
- Uncertainty associated with an agreement item is evaluated.
  - An analysis is typically performed where the behavior of a model is set to a (very?) pessimistic state (compared to the base case).
  - DOE concludes if the absolute change in dose rate results in less than 1.0 mrem/yr, then the agreement is not important to meeting the performance objectives.

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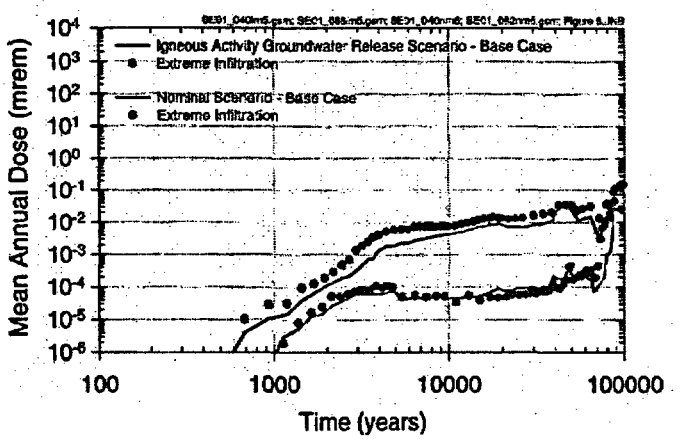
Overview of DOE Analysis:



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Risk-Informed Agreements:

- Originally proposed risk-informed (bin 3) agreements covered:
  - infiltration
  - seepage
  - unsaturated zone flow and transport
  - drip shield performance
  - in-drift chemistry
  - in-package chemistry
  - cladding performance
  - THC effects on seepage
  - THM effects on permeability

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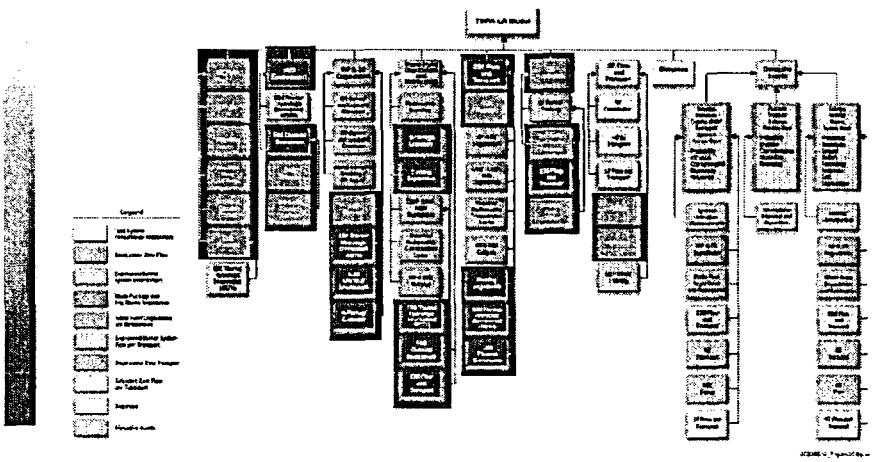

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Elements of Risk-informed Issue Resolution

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- Technical bases for quantitative analyses.
- Adequate documentation of the analyses.
- Consideration and representation of uncertainties.
- Understanding and explanation of the quantitative results.
- Confirmatory analyses with qualified TSPA model.

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Technical Basis for Quantitative Analysis

- Amount of technical basis for the analysis should be commensurate with the uncertainty, risk-significance, and pessimism introduced into the analysis.
- The treatment of model and parameter uncertainty is the focus of the risk-informed agreement resolution process.
- The NRC expects a reasoned argument why the analysis appropriately represents the uncertainty or is sufficiently bounding.

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Technical Basis for Quantitative Analysis-Example

- TSPAI 3.19 – "DOE will provide justification for the use of its evapotranspiration model, and defend the use of the analog site temperature data (UZ1.3.1). …."
  - The agreement addresses infiltration rates. The infiltration rate in TSPA-FEIS base case model averaged 12 mm/yr over the next 10,000 years.
  - What is an appropriate range in infiltration rate to address TSPAI 3.19?
- In response to agreement USFIC.3.02, DOE provided an appropriate justification for the distribution of infiltration rates used in the sensitivity analysis.

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Adequate Documentation of the Analysis

- Provide enough information to allow for adequate understanding of the analysis without recourse to the author.
- Some models and assumptions within the TSPA may not be integrated such that changes in one model would be automatically reflected in other associated models.

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Consideration and Representation of Uncertainties

- Analysis should appropriately consider and represent uncertainties.
  - Have related potential effects been considered?
  - If not directly included in the analysis, related potential effects should be discussed in at least a qualitative manner.
- TSPA is a system model designed to integrate abstractions (process models) and to address uncertainties. The combined effect of uncertainties should be quantitatively assessed.

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Understanding and Explanation of the Quantitative Results

- Quantitative results should be explained, in particular when results may be counter-intuitive.
- Demonstration of understanding of the model and results is essential to developing confidence in the conclusions.
- Simple physical arguments and presentation of intermediate outputs can enhance confidence in the results.

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Combined Effect of Uncertainty

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Insights from NRC Performance Assessment (PA):

- Stochastic performance assessment used to evaluate impact of uncertainty on performance (risk) for the repository system.
- For the TPA4.1j base case, 10% of the realizations represent 95% of the peak mean dose.
- Usually, propagation of uncertainty (combined effects) drives the risk in a PA model.

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Analysis of TPA 4.1J High Realizations

Parameter name	Highest Realization	2nd Realization	3rd Realization	4th Realization	5th Realization	mean
WPFlowMF	84	82	91	86	90	87
SbArWt%	70	92	79	32	85	72
WP-Def%	91	64	88	74	32	70
PSFDM1	81	67	87	94	98	85
InitRSFP	63	56	50	98	70	67
DSFailTI	53	64	27	55	37	47

Percentiles of Sampled Parameter Uncertainty Ranges

- The highest realization contributed 16% to the mean.
- It is not necessary for key parameters to be at the extremes in order to have a meaningful contribution to risk.
- Propagation of uncertainty significantly influences the risk.

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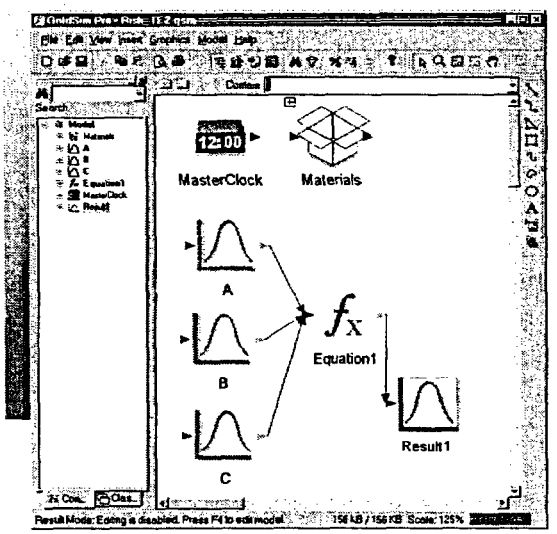
Hypothetical Uncertainty Evaluation Example:



Base Case:

$A_b = N[\mu=5, \sigma=1]$

$B_b = N[\mu=5, \sigma=1]$

$C_b = U[-1,1]$

Equation1 = $(A*B)^C$

Result:

Mean(Equation1)=3.84

Limit = 15.0

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Hypothetical Uncertainty Evaluation Example:

- Agreements (unrepresented uncertainty) associated with A_b, B_b, C_b
- To evaluate uncertainty1, uncertainty2, uncertainty3 (e.g., agreement1, agreement2, agreement3), three analyses:

  1) $A_b=A_n= N[\mu=6, \sigma=1.5]$, B_b and C_b unchanged
  2) $B_b=B_n= N[\mu=6, \sigma=1.5]$, A_b and C_b unchanged
  3) $C_b=C_n= U[-1.5,1.5]$, A_b and B_b unchanged

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- From this sort of local sensitivity analysis, one might conclude that none of the individual uncertainties are important to meeting the limit

  Result1: Mean(Equation1) = 4.35
  Result2: Mean(Equation1) = 4.35
  Result3: Mean(Equation1) = 13.0

- However, a combined effect analysis that probabilistically represents all three uncertainties gives a result that the combined effect of the uncertainties is important to meeting the hypothetical limit

  Result: Mean(Equation1) = 20.3

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Conclusions: NRC Perspective on Combined Effects

- Extremely pessimistic analyses for individual uncertainties are not required by the NRC.
- NRC agrees that the margin between the analysis results and the performance objective can be considered when risk-informing.
- However, the potential combined effect (propagation of uncertainty) on risk of the Bin 3 agreements can be important.
- Technical analysis should appropriately consider the system-nature of the performance assessment model (e.g., the combined effect of uncertainty).

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Conclusions:

- Risk-informed issue resolution can be done in lieu of original agreement when uncertainties are considered appropriately.
- The technical analyses must appropriately consider the system-nature of the performance assessment model (e.g., the combined effect of uncertainty).
- Confidence in the supporting analyses and resulting conclusions is an essential aspect to risk-informed issue resolution.

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Summary of May 15, 2003 Technical Exchange :

- DOE in agreement with NRC additional information needs except for the combined effect of uncertainty analysis.
- DOE likely reducing the number of agreements addressed with risk information (e.g., from 31 to ~20).
- DOE will no longer address agreements associated with the environmental conditions for corrosion of the waste package using risk information.
- DOE believes the reduced set of ~20 agreements can be completed via risk arguments with improved documentation and explanation of the existing sensitivity studies.
- DOE will perform analyses with the final, fully-qualified TSPA model that supports conclusions made with preliminary models, and if unsuccessful develop and alternative approach.

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Status of the HLW Risk Insights Initiative

143th Meeting of
Advisory Committee on Nuclear Waste
June 24-25, 2003

Tim McCartin 302-415-7285 tjm3@nrc.gov
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Division of Waste Management
U.S. Nuclear Regulatory Commission

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Outline of Presentation

- Risk Insights Baseline
- Risk Ranking Pre-licensing Agreements
- Next Steps:
  - Continuation of Risk Insights Initiative
  - Application of Risk Insights Baseline

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Risk Insights Baseline

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Risk Insights Baseline

- Documents an integrated system-level basis for supporting risk-informed HLW program activities
- Promotes consistency in risk-informed activities among staff
- Enhances communication of risk significance of system components

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Process for Developing Risk Insights Baseline

- Insights based on experience with total system performance assessments, subsystem analyses, auxiliary calculations, and review of performance assessments
- Initial draft developed by performance assessment staff
- Insights reviewed by engineering and geosciences staff
- Insights continue to evolve

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Considerations for Risk Significance

- Potential effects on:
  - Large number of waste packages
  - Release of radionuclides from the waste form
  - Transport of radionuclides through geosphere
- Multiple barriers
- Model limitations and uncertainties

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Risk Significance

- High Risk Significance
  - potential for significant effect on risk estimate
  - generally significant uncertainty
- Medium Risk Significance
  - some effect on the risk estimate
- Low Risk Significance
  - little effect on risk estimate

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Risk Insights for Model Abstraction: "Flow Paths in the Unsaturated Zone" (above repository)

- High Risk Significance:
  - None
- Medium Risk Significance:
  - Seepage into drifts
    - Determines quantity of water contacting drip shields and waste packages
    - Affects release/transport of lower-solubility radionuclides (Np-237)
- Low Risk Significance:
  - Short-term variation in precipitation

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Risk Insights for Model Abstraction: "Quantity and Chemistry of Water Contacting Waste Packages and Waste Form"

- High Risk Significance:
  - Near-field water chemistry contacting the drip shield and waste package
  - Temperature at which specific brine chemistries develop on waste package
- Medium Risk Significance:
  - Effect of quantity and chemistry of water on radionuclide solubility limits

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Risk Insights for Model Abstraction: "Degradation of Engineered Barriers"

- High Risk Significance:
  - Passive film on surface of waste package
- Medium Risk Significance:
  - Effect of failure mode on water inflow
  - Effect of drip shield integrity on quantity and chemistry of water on waste package
  - Stress corrosion cracking
- Low Risk Significance:
  - Juvenile failures

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Risk Insights for Model Abstraction:
"Mechanical Disruption of Engineered Barriers"

- High Risk Significance:
  - Rock fall creating large static loads
- Medium Risk Significance:
  - Ability of the drip shield to minimize effect of rock fall on waste package
- Low Risk Significance:
  - Dynamic effect of rock fall on drip shield and waste package

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Risk Insights for Model Abstraction:
"Radionuclide Release Rates and Solubility Limits"

- High Risk Significance:
  - Dissolution rate of the waste form
- Medium Risk Significance:
  - Performance of zircaloy cladding
  - Solubility limit of Np-237
  - Diffusional release modes
  - Formation of colloids in waste package
- Low Risk Significance:
  - Effect of invert
  - Criticality (probability and consequences)

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Risk Insights for Model Abstraction:
"Radionuclide Transport in the Unsaturated Zone"

- High Risk Significance:
  - None
- Medium Risk Significance:
  - Retardation of Np-237 in Calico Hills non-welded vitric (CHnv) unit
  - Matrix diffusion in the unsaturated units where flow is primarily through fractures
  - Transport of colloids through CHnv unit

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Risk Insights for Model Abstraction:
"Flow paths in the Saturated Zone"

- High Risk Significance:
  - None
- Medium Risk Significance:
  - Flow distance through the alluvium
- Low Risk Significance:
  - Hydrologic properties of the saturated zone tuffaceous rock and alluvium

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Risk Insights for Model Abstraction:
"Radionuclide Transport in the Saturated Zone"

- High Risk Significance:
  - Retardation of Np-237 in the alluvium
- Medium Risk Significance:
  - Matrix diffusion
  - Transport of colloids
- Low Risk Significance:
  - Sorption properties of low-sorbing radionuclides, such as I-129 and Tc-99

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Risk Insights for Model Abstraction:
"Volcanic Disruption of Waste Packages"

- High Risk Significance:
  - Number, age and location of past igneous features as an indicator of the probability of future igneous events
- Medium Risk Significance:
  - Modeling of interaction of volcanic conduit and repository

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Summary of High-Risk-Significant Insights

- **Quantity and Chemistry of Water Contacting Waste Packages and Waste Form**
  - evolution of near-field water chemistry
  - specific brine chemistries and temperature
- **Degradation of Waste Package**
  - passive film
- **Mechanical Disruption of Engineered Barriers**
  - accumulation of rock fall

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Summary of High-Risk-Significant Insights (cont.)

- **Radionuclide Release Rate and Solubility Limits**
  - dissolution rate (water chemistry and temperature)
- **Radionuclide Transport in Saturated Zone**
  - retardation in the alluvium (Np-237)
- **Volcanic Disruption of Waste Packages**
  - probability

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Summary of High-Risk-Significant Insights (cont.)

- **Airborne Transport of Radionuclides**
  - concentration of radionuclides in ash
  - resuspension of volcanic ash
- **Performance Assessment Methodology**
  - scenario screening
  - model abstraction and representation of uncertainty
  - model confidence building
- **Preclosure Safety Analysis**
  - hazards and initiating events

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Applying the Risk Insights Baseline: Rating the Agreements

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Applying the Risk Insights Baseline: Rating the Agreements

- In response to Commission SRM (March 2003, staff used the Risk Insights Baseline to rate the risk significance (H, M, L) of the 293 NRC-DOE pre-licensing agreements
- The SRM also requested a rating of the anticipated staff effort and technical difficulty of the agreements

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Applying the Risk Insights Baseline: Rating the Agreements

- Staff used the Risk Insights Baseline to provide a system-level perspective on the agreement-rating process
- Performance assessment staff rated the risk significance (H, M, L) of individual agreements based on the Risk Insights Baseline (supported by quantitative analyses)

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Applying the Risk Insights Baseline: Rating the Agreements

- Results of risk-significance ranking:
  - 41 high-risk significant agreements
  - 92 medium-risk significant agreements
  - 160 low-risk significant agreements

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Applying the Risk Insights Baseline: Rating the Agreements

- Generally, high-risk significance agreements are associated with features, events, and processes that could:
  - Affect a large number of waste packages
  - Significantly affect the releases from the waste package
  - Significantly affect the transport of radionuclides
- Of the 41 agreements rated as high:
  - 34 provide the technical basis supporting DOE's understanding and representation of the proposed repository in six areas
  - 7 are related to post-closure performance assessment and pre-closure safety analysis

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Applying the Risk Insights Baseline: Rating the Agreements

- 34 of the 41 high-risk significance agreements related to post-closure model abstractions:
  - Corrosion of the drip shield and waste package, including chemistry of contacting water (18 agreements)
  - Mechanical degradation of the drip shield and waste package, due to long-term degradation of drifts (6 agreements)
  - Effects of in-package chemistry on dissolution of the waste form (4 agreements)
  - Radionuclide transport in the saturated zone (2 agreements)
  - Probability of volcanic disruption of the repository (1 agreement)
  - Entrainment and transport of radionuclides in volcanic ash (3 agreements)

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Applying the Risk Insights Baseline: Rating the Agreements

- 7 of the 41 high-risk significance agreements related to general post-closure performance assessment review and pre-closure repository safety:
  - Confidence in performance assessment methodology (6 agreements)
  - Consideration of aircraft crashes during pre-closure phase (1 agreement)

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Applying the Risk Insights Baseline: Rating the Agreements

- Agreements rated as medium- or low-risk significance provide information that is:
  - secondary or supportive of the high-risk-significant agreements; or
  - related to less risk significant features, events, and processes; or
  - needed to provide baseline information representative of the proposed repository

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Applying the Risk Insights Baseline: Rating the Agreements

- 92 medium-risk significance agreements:
  - requested information is expected to have some influence on risk estimates
  - needed to support higher-risk significant agreements
  - may involve consideration of significant uncertainty
- 160 low-risk significance agreements:
  - requested information is expected to have little effect on risk estimates
  - necessary to provide more-routine baseline information of the site

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Next Steps

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Completing the Risk Insights Initiative

- Risk Insights Baseline and ranking of agreements provided to Commission as SRM response on June 5
- ACNW briefing June 24
- Complete revised draft Risk Insights Report by October
  - Risk Insights Baseline
  - Documentation of supporting quantitative analyses
  - Ranking of agreements
- Incorporate risk insights into pre-licensing issue resolution activities
  - Completing the agreements
  - Identifying areas for discussion with DOE

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Application of Risk Insights Baseline

- Baseline can help prioritize pre-licensing activities, focus staff resources, and support risk-informed project management and decision-making
- During pre-licensing issue resolution:
  - Assessing the appropriate level of staff review of DOE agreement submittals, and need for pre-licensing interactions
  - Evaluating DOE's proposed approach for using risk information to complete agreements
- Beyond pre-licensing issue resolution:
  - Communicating staff's understanding of repository system
  - Supporting risk-informed LA review per the YMRP

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Conclusion

- Status of our progress in developing risk insights
- Risk insights baseline is used to support risk-informed regulatory program
- Development of risk insights baseline is an ongoing activity that will continue to evolve

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Backup Slides

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Risk Insights for Model Abstraction: "Climate and Infiltration"

- High Risk Significance:
  - None
- Medium Risk Significance:
  - Shallow infiltration affects release of Np-237
    - Effect of soil thickness
- Low Risk Significance:
  - Long-term climatic change

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Risk Insights for Model Abstraction: "Flow Paths in the Unsaturated Zone" (below repository)

- High Risk Significance:
  - None
- Medium Risk Significance:
  - Areal extent and thickness of CHnv unit

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Risk Insights for Model Abstraction: "Concentration of Radionuclides in Ground Water"

- High Risk Significance:
  - None
- Medium Risk Significance:
  - None
- Low Risk Significance:
  - Modeling of radionuclide concentrations in ground water in accessible environment

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Risk Insights for Model Abstraction: "Redistribution of Radionuclides in Soil"

- High Risk Significance:
  - None
- Medium Risk Significance:
  - None
- Low Risk Significance:
  - Leaching and other mobilization processes related to radionuclides in soil

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Risk Insights for Model Abstraction: "Airborne Transport of Radionuclides"

- High Risk Significance:
  - Volume of ash released during event
  - Assumptions regarding the amount of fine ash particles resuspended in air
- Medium Risk Significance:
  - Wind speed and direction
  - Remobilization of contaminated ash

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Risk Insights for Model Abstraction: "Biosphere Characteristics"

- High Risk Significance:
  - None
- Medium Risk Significance:
  - None
- Low Risk Significance:
  - Biosphere modeling assumptions, parameter values and uncertainties

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Risk Insights for Performance Assessment Methodology

- High Risk Significance:
  - Scenario analysis
  - Model abstraction and representation of uncertainty
  - Model confidence building
- Medium Risk Significance:
  - None
- Low Risk Significance:
  - Description of capabilities of barriers

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Risk Insights for Pre-Closure Repository Safety

- High Risk Significance
  - Risk associated with aircraft crashes
    - Based on limited considerations
- Medium Risk Significance
  - Microstructural and compositional variations in waste package base metal and weld filler

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