Official Transcript of Proceedings

NUCLEAR REGULATORY COMMISSION

Title:	Advisory Committee on Nuclear Waste 135th Meeting
Docket Number:	(not applicable)
Location:	Rockville, Maryland
Date:	Wednesday, June 19, 2002
Work Order No.:	NRC-434 Pages 220-323

NEAL R. GROSS AND CO., INC.
Court Reporters and Transcribers
1323 Rhode Island Avenue, N.W.
Washington, D.C. 20005
(202) 234-4433

UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

+ + + + +

ADVISORY COMMITTEE ON NUCLEAR WASTE (ACNW)

135TH MEETING

+ + + + +

WEDNESDAY,

JUNE 19, 2002

+ + + + +

ROCKVILLE, MARYLAND

+ + + + +

The Advisory Committee met at 8:30 A.M. AT the Nuclear Regulatory Commission, Two White Flint North, Room T2B3, 11545 Rockville Pike, Dr. George M. Hornberger, Chairman, presiding.

COMMITTEE MEMBERS PRESENT:

GEORGE M. HORNBERGER, Chairman

RAYMOND G. WYMER, Vice Chairman

B. JOHN GARRICK, Member

MILTON N. LEVENSON, Member

ACNW STAFF PRESENT:

HOWARD J. LARSON, Special Assistant, ACRS/ACNW

SHER BAHADUR, Associate Director, ACRS/ACNW

ANDREW C. CAMPBELL

LYNN DEERING

TIMOTHY KOBETZ

MICHAEL LEE

RICHARD K. MAJOR

RICHARD P. SAVID

ALSO PRESENT:

TAE M. AHN

TAMARA BLOOMER

STEPHANIE P. BUSH-GODDARD

DAVID W. ESH

CAROL HANLON

BRET LESLIE

TIM McMARTIN

JACOB PHILIP

MERAJ RAHIMI

I-N-D-E-X

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

8:30 A.M.

CHAIRMAN HORNBERGER: The meeting will come to order. This is the second day of the 135th 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: Raymond Wymer, Vice Chairman; John Garrick and Milton Levenson.

Today, the Committee will (1) hear from the NRC staff on comments received on the Rulemaking Plan and Advanced Notice of Proposed Rulemaking: Entombment Options for Power Reactors, although there will be an amendment to that. We'll hear about that upon introduction. (2) Hearing presentations from the NRC and CNWRA staff on issues and activities related to the projected performance of waste packages in the proposed high-level waste repository at Yucca Mountain. (3) Discuss elements of a letter report on the Yucca Mountain Review Plan, Revision. (4) Continue its discussion of other proposed reports.

Howard J. 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 written comments or 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.

Okay, so as I had indicated just a moment ago our first topic is going to be the entombment option for decommissioning power reactors and the cognizant member of the ACNW for this topic is Ray Wymer, so I will turn the meeting over to Ray.

VICE CHAIRMAN WYMER: Thank you. The business of entombment of decommissioning power reactors is one that is a subject of discussion and concern to the ACNW for quite some time. We've written a letter on it and we have a commit from the staff to keep us updated and keep us current on the status and I understand that what we're going to hear this morning is just that. It's a current status report, where we stand and where we're going in the future and Stephanie Goddard-Bush is going to tell us all about that.

DR. BUSH-GODDARD: Good morning.

VICE CHAIRMAN WYMER: Bush-Goddard, sorry.

(Laughter.)

DR. BUSH-GODDARD: As Dr. Wymer said, my name is Stephanie Bush-Goddard and I will be giving you an update and next steps on entombment options for decommissioning power reactors.

(Slide change.)

DR. BUSH-GODDARD: I have five issues on the agenda today. I'll go over NRC papers and activities, a kind of background that led us into rulemaking. I'll go over the rulemaking options and the Advanced Notice of Proposed Rulemaking issues. Then I'll talk about some of the stakeholders' views and comments from the Advanced Notice of Proposed Rulemaking, and end with the staff recommendations.

(Slide change.)

DR. BUSH-GODDARD: So I'll begin with NRC papers and activities. To refresh your memory, in 1997, the Commission requested that the staff determine the viability of an entombed facility. As a result, SECY 98-099 was developed. The Office of Research provided the results of this study and the results was that entombment was a viable process. Also, in 1999, the Office of Research solicited stakeholders' views in a public workshop held here. And from that SECY 00-0129 was Workshop Findings and Recommendations. In that paper, there was a summary of views and issues that were raised in the workshop and a recommendation was that the staff should go into rulemaking. That resulted in the last SECY here and that paper was published or sent to the Commission in June of last year. There was a rulemaking plan and an Advanced Notice of Proposed Rulemaking.

The Advanced Notice of Proposed Rulemaking was published for a 75-day comment period. However, in the rulemaking plan and the Advanced Notice of Proposed Rulemaking, there were three options.

(Slide change.)

DR. BUSH-GODDARD: The first option was to do nothing, to maintain the status quo, to keep the 60-year decommissioning time frame in place and handle entombment on a case-by-case basis.

The second option was to extend the decommissioning deadline beyond the 60 years and to clarify the difference between engineered barriers and institutional controls in terms of their effectiveness in protecting the public.

And the third option was to create a new license type, to provide for an entombed facility which would be a new type of disposal license.

(Slide change.)

DR. BUSH-GODDARD: From the three options we also had five different issues that were also published in the ANPR and we requested stakeholder input. For example, we asked about whether the regulations were adequate and if not, what changes were needed.

We solicited about stakeholder views on types and capabilities of engineered barriers.

We solicited input on how to dispose of GTCC waste, whether we should remove it or entombment.

What were the views of the states and what were their roles?

Lastly, if any licensee planed to entomb their plant, when would they do it?

(Slide change.)

DR. BUSH-GODDARD: So from those issues we received 19 comments and I have listed there we had 6 states, 8 licensees, NEI, EPA, CRCPD Committee. We had a compact and a private citizen.

Overall, there was no clear consensus. There were many caveats suggested for all three options. Two commenters, New York State and Kansas favored Option 1, but most licensees favored Option 2 with some caveats and Washington State was the only commenter that advocated for Option 3.

(Slide change.)

DR. BUSH-GODDARD: So from the working group and management discussions, as well as looking at the NPR, we decided to defer the rulemaking and the reasoning behind that is that current regulations don't explicitly permit entombment, but they don't preclude it either. So entombed facilities could be addressed on a case-by-case basis. Also, if decommissioning takes longer than 60 years, then the GEIS may have to be revisited.

A third reasoning was that the roles of the Department of Energy and the states were unclear as they relate to GTCC. The states that commented noted that they have a regulatory role in this case and that entombing greater than Class C wastes in a reactor plant would adversely impact the low-level regional waste compacts.

Another reason was that although some licensees stated that they would like to have an entombment, as an option, the decision was not imminent by any means. And finally, given the fact that there's no immediate need to an entombed option, we looked at NRC priorities.

As you may know, we are working on Yucca Mountain and anticipate many more activities related to physical security and the control of radioactive materials.

Some of this will impact the regulatory framework for an entombed facility.

(Slide change.)

DR. BUSH-GODDARD: So finally, our next steps. Well, the staff is working on a SECY paper transmitting our recommendation which is to defer rulemaking to the Commission and this should be completed in October of this year. The Office of Research is currently looking at the structural capabilities of concrete. The study is scheduled to be completed in about three years. There's continual interaction with the stakeholders on an entombment option through conferences and forums and in the meantime we continue to look at what we need to create a performed-based regulatory framework.

Thank you.

VICE CHAIRMAN WYMER: Thank you, Stephanie. That brings us up to date pretty well. It seems just my offhand impression, this seems like a sensible course since there's no current plan by anybody that we know for entombment and most everybody is going other reactor operators and utilities are going to the 20-year extension for the licensing application and if anything does come up with respect to entombment it will be an individual case that can be handled on a case by case basis. Everything you've said seems very reasonable to me.

Let me ask for comments from here. George?

CHAIRMAN HORNBERGER: I don't have anything.

VICE CHAIRMAN WYMER: John?

MEMBER GARRICK: The only thing I would ask is was there anything particularly interesting that came out of the public comments that had a heavy influence on the actions you've taken?

DR. BUSH-GODDARD: I think the biggest thing was that there was no immediate need. We did have two questions in the ANPR that specifically said how many licensees would like to do entombment, when and when would they like to do it? There are a lot of different caveats. They said, you know, we would like -- we don't necessarily want to maybe do entombment, but we want that option. Or, it will depend on cost and you know, the availability of low level waste sites.

So the big issue, I think, that came out of the comments was that there was no immediate need.

MEMBER GARRICK: Is there much expression of interest at this point from the licensees in this approach in the entombment approach?

DR. BUSH-GODDARD: Well, we had eight licensees to comment and we also had the industry, NEI. I would say that it's not a high priority for them based on the number that commented.

MEMBER GARRICK: Okay, thank you.

VICE CHAIRMAN WYMER: Milt, do you have any questions or comments? How about the staff, does anybody around the table here want to -- Sher?

DR. BAHADUR: Stephanie, you mentioned that in the rulemaking options there were three options, either maintain the status quo, or amend the 50.82 or create a new license type.

Could you just tell us, maybe what were the pros and cons of each one of these options were?

DR. BUSH-GODDARD: Yes. The first one was to maintain the status quo. A big pro was that the status quo already permitted entombment. You have 60 years to decommission, but it is a regulation.

A con is that if you need to go beyond the 60 years, you might have to apply for an exemption, so that means regulating by exemption.

As far as Option 2 which was to amend the 60-year time frame, a pro for that would be you would not necessarily have to regulate by exemption, but a disadvantage of that is that you might have to revisit the GEIS. It's more resources than Option 1, of course, because you're amending a regulation. It could be more resources to the licensee, depending on how you look at than Option 1.

Option 3 was to develop maybe a new part or a new type of license. The pro for that was that it could possibly handle the disposal GTCC waste. The Commission requested that we look at disposal of GTCC waste in an entombed facility and the only way that we could do that under the -- develop that was that the facility had to be licensed because GTCC has to be in some type of licensed facility. So Option 3 was more a way of how we could dispose of GTCC, so that was the big pro for that.

However, the negative part of Option 3 was that it required a lot of staff resources to develop a new part. It was more expensive to the licensees than Option 1 and 2.

DR. BAHADUR: So in the public comments, of course, you had no clear consensus one way or the other, but I noticed that at least six people, six comments favored Option 2.

DR. BUSH-GODDARD: Yes.

DR. BAHADUR: Is there a reason why -- although it's not a priority from our point of view, also from the licensees, but did they mention any reason why they were favoring Option 2?

DR. BUSH-GODDARD: Yes. The majority of stakeholders that favored Option 2 were licensees and NEI. And Option 2 from their standpoint, they felt they do unnecessary burden. It was cheaper than Option 3, but it gave them a little bit more flexibility than Option 1.

I guess those were the big two issues. And also, come to think of it, they wanted the Department of Energy to take GTCC waste. They didn't really want to have to deal with it.

DR. BAHADUR: But that's true even if you go the status quo.

DR. BUSH-GODDARD: Yes.

DR. BAHADUR: Greater than Class C would be the DOE's responsibility.

DR. BUSH-GODDARD: That's right, but I guess the problem they had with Option 1 was that they didn't feel that the majority of licensees could entomb within 60 years. That's why they wanted to really extend that time frame which was Option 2.

MR. LEE: Stephanie, on Slide 5 or Slide 6, your ANP or comment summary, you noted that you had 19 sets of comments, but I counted 9. Your tally under your second tick shows 9. What did the other 10 commenters have to say or if it's possible to kind of give you a sense for what they --

DR. BUSH-GODDARD: Okay, the other 10 did not come out with any preferred option. For example, the EPA, they basically said we don't have a preferred option to make sure that you coordinate with DOE to handle the GTCC. They asked us to look at if we were going to entomb to consider chemical contaminants as well as radioactive contaminants.

The private citizen that commented wanted to make sure that we keep active records and good institutional controls, issues like that.

The CRCPD Committee just really summarized a lot of the states' issues.

MR. LEE: Okay.

DR. BUSH-GODDARD: Things like that.

MR. LEE: Keying back on an observation you made earlier that the low volume of public comments, regarding the low volume of comments, it might be possible that there was just an indifference to the rulemaking proposal and that some organizations or utilities aren't in the position to formulate an opinion regarding the rulemaking proposal.

I mean that's another way to interpret the volume, if you will, of the public response.

MR. LARSON: Well, another thing is that there are license extension and license renewals, there have been a lot of them in the last few years since before this thing started years ago. I guess my question was I see they're going to do a research program on concrete and I don't know if the Committee has heard about it, whether what that involved.

MR. LEE: I see Jake Philip in the audience. Is that the Four Site?

VICE CHAIRMAN WYMER: I picked up on it somewhere.

MR. PHILIP: I'm Jake Philip with the Office of Research and one of the things we are looking with NIST, the National Institute of Standards and Technology is you know if you have a concrete structure and you want to entomb it, what you really need to look at, how does it perform a condition assessment of the structure? Right now, there's no such thing as a Commission assessment of a structure like a concrete containment building. So before you even entomb, you've got to know the quality of the structure. How good is it?

And then you've got to know if -- well, most of the ways to look at it is mostly observational. And we find from a flow and transport problem is actually the cracks in the concrete that would be the most important aspect as far as risk from an entombed facility.

So then we have to look at how the cracks form, are they all the way continuous. If it's continuous, that's the problem. However, we feel that in a concrete structure, as massive as a containment structure, it probably will not have cracks like that. But that's something we have to look for. And once we look for that, then the next question is are there some ways to look at other imperfections in the concrete, looking at the joints, looking at maybe segregation of the aggregates in the concrete and stuff like that, having many instances of some types of bad concrete.

So we were looking at some destructive or nondestructive ways, actually to basically get the baseline data on the containment structure before -- the entombed structure before we really go and entomb it. Of course, the next point is we have all that information as far as modeling of the concrete for flow and transport and stuff like that, but we don't have any experience on how well they perform or what time. So then can that be a modeling program? That's one of the things we look now -- a modeling program which could look at how the concrete structure performs and then verify some of the models that we have used in making the predictions.

DR. BAHADUR: Excuse me --

VICE CHAIRMAN WYMER: Somewhere in this presentation I put some of this flood of paper that we get -- I read something about that, about what he just said.

I want to make one observation here for whatever it's worth. There's -- it seems to me there's a problem with the greater than Class C waste in that we have two kinds which are very different in kind and they're both greater than Class C. One is the sealed sources which is well-defined situation. You have a sealed source. The other though is this trash that comes out of decommissioning reactor which is greater than Class C and it's certainly not sealed in any sense of the word. So it seems to me that some thought ought to be given to separating these two kinds of greater than Class C waste in how they're handled or in how they're regulated or something, since they are so very different, different in kind. That's just an off the top of my head observation.

Any other questions or comments from anybody? If not, thank you very much, Stephanie. We look forward to your next progress report, probably in October or some time following that.

DR. BUSH-GODDARD: I don't know. We'll keep the staff informed, I guess.

VICE CHAIRMAN WYMER: Thank you. Here's George.

CHAIRMAN HORNBERGER: Thank you, Ray. We have about an hour and 5 minutes before our scheduled next thing on the agenda. Do we want to take a break from recording? We're going to discuss -- so we can take a break for -- we'll pick up recording after our coffee break.

(Off the record.)

CHAIRMAN HORNBERGER: The meeting will come to order. Our next session is on the long-term behavior of waste packages and the ACNW Member leading this discussion again will be Ray Wymer. I'll turn the meeting over to Ray.

VICE CHAIRMAN WYMER: Thank you. We're

welcoming these presentations this afternoon. The waste package remains the central issue with respect to the repository performance and this morning and into this afternoon, we're going to hear presentations from David Esh and Tae Ahn and the first presenter will be David Esh who will be talking about performance assessment perspective on the behavior of engineered barriers and in particular, with the emphasis on waste packages and risks associated.

Dave?

DR. ESH: Thank you, Dr. Wymer. I'm David Esh. I'm a System Performance Analyst in the Environmental and Performance Assessment Branch and I'm here to talk about the PA perspective on the behavior of engineered barriers.

There are many contributors. The main contributors for this presentation were Dick Codell and Sitakanta Mohanty, but I could pretty much list everybody that contributed at some level to the PA work.

(Slide change.)

DR. ESH: My basic outline and the main points that I wanted to cover in this presentation are summarized here.

The overall repository risk with our

current knowledge, it's kind of a snapshot in time and then I'm going to talk about insights on system behavior and waste package as a barrier. Is it the salt barrier?

And then an issue that the Committee has raised in the past, conservatism and risk, I'm going to cover that with, I think, an insightful example and explain how that can be problematic and how we deal with it.

And then I'm also going to talk about the main focus of this presentation as our PA's perspective on the waste package key issues and that leads into Dr. Ahn's presentation where he'll cover those key issues in depth.

So I'm kind of giving you a step in from the top down working towards the waste package key issues and giving you some insights along the way.

Now our perspective comes from a lot of different things. One of the main things is our independent analyses that we do, both at the NRC and at the Center for Nuclear Waste Regulatory Analysis. And that independent analysis takes the form of a number of different things. The Total System Performance Assessment Code, TPA Code, which we're currently in development of version 5.0; uncertainty and sensitivity analysis. I believe our report is being worked on right now in that area that contains a lot of -- it's my sales pitch, a lot of useful information. And it also includes barrier evaluation and then other which can take any number of forms, simple calculations to all sorts of auxiliary analyses that we do. And our perspective is also a result of -- besides our independent work, the review of what the Department of Energy does and others, EPRI, the State of Nevada, all of that conditions are thinking and here's my gratuitous suck up. The comments of the Review Committees which I've listed, ACNW and NWTRB peer reviews.

Seriously, all of that -- sometimes you need other perspectives and those other perspectives can be very useful and so all of that conditions are thinking. But my main point here is that performance assessment is not just putting things into a code and getting things out. It's understanding why you got those results, how things are functioning, why they're functioning the way they are. That's our main objective. And so I hope you get from this presentation that that's one of the key things that we do in performance assessment is try to understand things and try to interpret things, not just generate results.

(Slide change.)

DR. ESH: So starting at the top, a summary of where we are right now is DOE results for the repository risk and also the failure of the packages and I'll summarize this verbally in the next slide, but what I want to emphasize is that we have various risks, depending on the time period and we have a nominal scenario and an igneous scenario and that the risks, while proportional to failures, failures might not be a good metric to think of in terms of risk and hopefully you'll see that in some of the slides going forward.

Certainly, the risks get larger as these packages failed, but it's not just failure that's important. There's other things to consider.

(Slide change.)

DR. ESH: The overall repository risk, our current understanding, the 10,000 year model risks are small and I'm careful here to say model risks. I think we have to understand that we're simulating this problem and that's the best that we're ever going to be able to do. And assuming, the caveat is assuming that our current model appropriately represent uncertainties.

The longer time risks are comparable to background radiation. Igneous model risks are larger than nominal risks, but small compared to the standard. So I look at this and I saw well, okay, if this is the case, what are we doing? Why are we continuing to look at this problem. I tried to summarize that in the next slide because we have some key uncertainties that we're evaluating. Some of them are subject -- represented in the agreements between NRC and DOE that we want to see the impact of those uncertainties on the timing and magnitude of the doses and the nominal scenario, the magnitude of the disruptive doses because the timing isn't very important and occurs early in the 10,000 year period and the capabilities are the barriers. So we have these uncertainties. We continue to do analysis because we want to evaluate the impact of those uncertainties going forward.

(Slide change.)

DR. ESH: Now that's kind of a snapshot of what we have right now, the way -- if you look at the way the repository system is working, that's the main overall result. But now let's go down into one layer down and we say this repository is made up of many things that we're you're all aware of and what I want to stress is not all of these things are created equal from a risk perspective. Some of them are more important, some of them are less important. That's expected in a system like this, complicated system with lots of parts.

And both NRC and DOE analyses -- I think there are some backup slides, suggest that waste package performance is a significant contributor to limiting future risk and we're here today to talk about the waste package and I think it's appropriate to spend significant amount of time talking about waste package issues in detail.

Within performance assessment and I think throughout the program, we complete simple calculations that we think can be particularly insightful. Sometimes we get caught up in building complicated models and doing complicated analysis and sometimes you can do some pretty simple things that you can learn a lot about how the repository system is working and why.

And so in this overall system, you've heard some opinion that the waste package is the only barrier, it's the only significant thing. Well, I'm trying to -- I asked that question and I try to answer it on the next slide, at least from one viewpoint.

(Slide change.)

DR. ESH: With any of these difficult problems, you can do different analyses and they may tell you different stories, but that's why it's important to do a variety of analyses. This is a very simple calculation where you just take the inventory of the iodine and technetium that's in a commercial spent nuclear fuel package, those are the readily transported species. Now let's just assume that the best you can do with the rest of the system is you can have some distributive failure, the waste form lasts some time, the cladding lasts some time, but it's only equivalent to about 500 years, a very short period of time.

You dilute that release in the regulatory defined water volume and you get a dose from a single package of about half a millirem a year, that's from a single package.

Now if you compare that to say the TPA 4.1 result which has approximately 40 initial failures, you have a dose of .02 millirem per year. Well, if you look at these two numbers and the fact that this is 40 failures and that's a single failure, the results are that the TPA 401 results are about a factor of a thousand lower. So if you're trying to argue that well, the waste package is the only thing that matters in this system, I would say I don't think so. I think there are a lot of other things that contribute. Sure, it plays a very important role, but there are a lot of other things that contribute -- if the other things weren't contributing, you couldn't have this disparity in numbers like you do here. And you can do various other comparisons, but they all come out pretty much the same way. So other components greatly influence the future risks, too.

So we have the repository behavior. We have the waste package within the repository and now we're getting into what are the mechanisms and the processes that affect the waste package and the tact that we took here was to look at risk and surface area. So okay, which corrosion mechanisms or processes may be more important than others? And why?

Well, the risk and surface area failed, the two main release mechanisms are diffusive or vective transport with the water. Diffusive releases are proportional to the surface area of the failures, directly. Advective releases are at least strongly correlated because you could say that they're also directly proportional, but it gets more complicated than that as the system state degrades, you run into shedding on the surfaces of the packages, so as you have initial fail package that might have one hole in it, the water that drips on the package can run into that hole and it's not just a direct surface area scaling that creates the results in the releases and dose. So it's a little more complicated, but it's at least strongly correlated with the surface area failed.

What I attempt to do in the upcoming slides are to look at well, does the type of failure have a strong influence on the risk or do you just need failure, any sort of failure, or are they all equal?

(Slide change.)

DR. ESH: And this figure on Slide 10 is some information extracted from the DOE TSPA-SR median value file. And I think what you'll see in this presentation and maybe you also see in the future, that we're going to be doing more work analyzing and reviewing DOE and explaining how their model is working, why it's working, what issues we identify and those sorts of things. We have a number of activities that are on-going along those lines, for instance, I think Tim McCartin is leading an activity to produce a comparison of TPA code results to DOE's TSPA model results and see how the various models compare and differ. I'm leading an effort to review DOE's TSPA-SR model and Goldsim to build up our capability and understanding of the Goldsim software and also to understand how their model is working and what it's doing.

This figure is basically -- the pink curve here is the crack area, so it's the total cumulative area from crack failures in a package. It starts at slightly less than 40,000 years. The blue curve is the cumulative patch failure area per package and the red curve is the technetium 99 dose.

Now what you see is that the cracks start earlier. They have a more gradual slope. The patches come in in this median value file at about slightly around 65,000 years. But if you look at the dose, it responds pretty directly. As soon as those patch failures start exceeding the crack failure area, the dose increases rapidly. And what this says is that at least at early times, the risk is proportional to surface area failed.

Now in DOE's model at about 65,000 years where there's only cracking existing for the median value file results, they have a dose of about .3 millirem for technetium from 20 cracks per package.

Now what I want to show is that okay, if the risk is proportional, the surface area failed, what else is important when you're trying to assess waste package failure?

And what we did was we looked at the diffusive risks from stress corrosion cracking, so right now in the TSPA-SR, the cracks only form in the end cap areas, the welded areas of the end caps and we did two models here. One, we did a conservative -- we should probably use pessimistic representation. Conservative is a difficult terminology, where we diffused through the end caps and what we did is we took the inventory of iodine technetium neptunium that's inside the package. We made it available for release. We put it at the opening of the crack. Diffused it through the end cap and then assumed a zero concentration boundary on the outside because of water flowing that could release it. If you did a model such as that, you'd get a result of about 300 millirem per year from 300 cracks and a thousand packages, fairly large number.

But our concern was well, okay, is your conservatism influencing, greatly influencing your conclusions here? And would it cause you to judge the importance of a corrosion mechanism different than maybe what you should? So what we did is we said well, the fuel inside of the package, especially for the state when you have a package, it's only cracked. You get a water film on the inside of the package, but otherwise there's no inflow, there's no influx, outflux of moisture into the system.

The fuel that fails inside the package, the radionuclides have to diffuse from that fuel to the point where the cracks are in the lid. And that water film is very thin, or at least the information that we were able to get out of the literature suggests that it will be very thin.

When you take into account the diffusion through the water film to get to the end caps and then model it the same on the outside, and take no performance benefit from the rest of the repository so you neglect the unsaturated zone, saturated zone processes, but you still dilute it in the regulatory defined water volume, that reduces the dose to a fraction of a millirem. So my conclusion is that you have to be really careful and I think the Committee said something along these lines in one of their letters. You have to be really careful when you're using conservatism and from a regulator's standpoint, we have to be careful when we interpret the results of highly conservative models.

I guess what I'm trying to stress is that we, within performance assessment do a lot of things like this to try to understand the implications of that conservatism.

Now it's up to the Department of Energy to choose, if they want to use a conservative model they can use a conservative model and we have to review that conservative model, but we should understand the implications of the use of that conservative model if it creates other sorts of problems. And that's what I wanted to highlight is what we attempt to do.

So the failure mechanisms, whether it's cracks or patches or pits or whatever, it can be influenced by what you're doing elsewhere in the model. In this case, if you're doing something very conservative for the transport, or release and/or transport, then you may be somewhat misled about the importance of failure versus type of failure and let's see -- so you need to be cautious, especially when you're employing conservatism in the mass transfer representations. The waste package failure mechanisms that result in numerous small openings or a few catastrophic failures are not likely to be risk significant and I'll go through those in a little more detail in upcoming slides.

From a PA standpoint, I'd say the staff are most concerned with mechanisms that may result in numerous, moderate to large openings that experience avective conditions. That's the real risk driver in this problem.

Now okay, based on what I said about failure types and how it affects risk, then performance assessment went through and we give our perspective on these issues that Dr. Ahn is going to cover in detail and these nine issues are subject areas where you could spend an hour or two hours on each one if you wanted to and so I want to try to give as much time for Tae and the Committee to evaluate these as you would like today.

(Slide change.)

DR. ESH: From a PA perspective, the environmental conditions, uniform corrosion, passivity, localized corrosion, materials aging, those are all things that together or in a synergism or by themselves could result in the numerous, reasonably sized openings. Now I say could here and what I think Tae is going to cover is that this could, should be a different sized font for each of these. It might be really big for one of them. It's more likely to occur and for some of the other ones it's less likely to occur.

And it's important to understand the consequence and identify the likelihood of this trans passivity localized corrosion phenomena.

I guess performance assessment also has some perspective on the environmental conditions because that is a particularly difficult area to evaluate the uncertainty. It comes from a lot of different sources and when you consider the chemical divide process, a small uncertainty upstream can be propagated into a big effect downstream. So it's really difficult to evaluate the uncertainty and the environmental conditions and I think for many of these -- or at least for some of these major corrosion mechanisms or processes, they're influenced strongly by environmental conditions and especially extreme environmental conditions. So it's important to do a strong job on the uncertainty evaluation for the environmental conditions.

Stress corrosion cracking is what I covered in Slide 11.

Now it looks like the frequency and the size of the openings are not likely to create a significant risk, and I use that term loosely, unless combined with conservative release modeling. If you do conservative release modeling, then you can conclude that the stress corrosion cracks are more important than what they are.

Now I would note that the advective releases are not expected for the cracks, based on their size and the capillarity argument. Basically, the size of the crack is so small it acts like a pore and the capillarity pressure wants to hold water in it and you don't get enough of a driving force to move any moisture -- to effectively flow moisture through that crack.

Now, there is an uncertainty in the pessimistic side that maybe these cracks grow once they form -- they continue to get bigger, and that would influence the release. There's uncertainties on the optimistic side that the cracks can arrest. Right now the cracks, once they begin growing, they continue to grow, but I guess that's observed that many times these cracks arrest and they don't propagate the whole way through the surface. And also, the cracks can plug with corrosion products.

So any of these things that we're doing a perspective on now have an uncertainties associated with them. I think that Tae is going to cover a lot of those uncertainties in greater detail. But this stress corrosion cracking we would say is somewhat of a lower risk significance.

Drip shield performance, if we were purely running a code and looking at results and not doing any thinking, we would probably say is a lower risk significance. I think there's a back up slide, or a couple back up slides, one that DOE did, barrier degradation or subsystem degradation, and you can look at the difference between the drip shield one and the waste package one and say well, waste package isn't doing anything. But if you think about it, the waste package may be preventing rockfall damage or other mechanical damage to the waste package. And it could also be preventing aggressive chemical conditions for the waste package that would lead to some of these failures that we would judge as more risk significant.

So from a thought standpoint, you might conclude that the drip shield serves more of a role than what you would get from a quantitative standpoint. Now you could argue that well, if you put those things in your model, you should be able to do analysis that the function of the rockfalls or the aggressive chemical conditions, the function of the drip shield preventing those should show up in your analysis. You should be able to do something, and I think that's probably true. You should be able to do something, that instead of just from a thought standpoint saying well, it could be important, from a more quantitative standpoint be able to show okay, here's why it would show up as important or more important.

Mechanical failure, our current analysis suggests that the combination and the likelihood and the consequences, or I should say DOE's analysis are a lower risk. The extent of the drift degradation and the resultant consequences need to be further analyzed however, so that rockfall is a lower risk significance, but the drift degradation could be anywhere from low to high depending on the extent and the likelihood. Now, in the TSPA-SR, they simulated very little drift degradation and in the TSPA-SR, if you just looked at those results, you would say it's a lower risk significance. But I guess there is a peer review panel that kind of expect significant drift degradation and also the NRC and CNWRA staff have a number of concerns about the uncertainty in that area.

Juvenile failures, you can look at the results on Slide 4 and 8 and you can see that the frequency is not high enough to create a significant risk. It's a lower risk significant item. And criticality is complicated, it's coupled to a lot of things, it's related to the geochemistry inside the package and water flow. But current analyses suggests the likelihood is not large enough to create a significant risk. So it's a lower risk significance item.

Now, the Committee, I think, always asks, maybe you don't want to hear about it, but you always ask about risk informing. And this is my stab at giving a little performance assessment perspective on it. We have 42 agreements related to model abstraction, which is how you build models, treat uncertainty, the confidence in those models. It's TSPAI sub-issue 3. Many of those deal with uncertainty. Well, about 30 percent of them pertain to uniform corrosion, passivity, localized corrosion, and environmental conditions, the things that, we feel, are more risk significant from an uncertainty standpoint. So I can only say we're consistent. Maybe you could argue we're not still not risk informed. But at least we're consistent.

So in summary, waste package is an important barrier, but it can do some simple things and even more quantitative things, results which are shown in the back up slides that you can conclude the performance of other system components limit risks. You need to be really careful with the conservatism, because that greatly influences your interpretation of the problem and the work that you do.

I think the PA results and additional analyses condition our thinking, but we do a lot of thinking outside of our analyses. And we do lots of different analyses to get different perspectives. Depending on your analyses, you can have different views and you want to be careful about the conclusions that you make.

And my last bullet is the assigned relative risk importance to CLST issues is based on current understanding, so that's my caveat that [nothing], we can be wrong, and we'll talk to you about it in the future, I'm sure, if we end up being wrong about one of these things. So that's it.

VICE CHAIRMAN WYMER: Thank you. I had one question, David, on Slide 8, which deals with waste packages of barrier and you take inventory of one particular fuel waste package and you somehow relate that what the results of TPA 4.1. I can't quite make the logical connection. Is TPA 4.1 give you a thousand-fold lower result for waste package because you simply don't dump the entire inventory?

DR. ESH: That's what I guess I was trying to say. There are a lot of things that cause that risk to be lower than you would get if the waste package was the only thing. Waste form, which results in distributed release; cladding, which results in distributed release; the solubility limits, which changes the magnitude of the release, which I guess you could say distributes it. And then the whole transport precesses through the UZ and the SC, that for readily transported species like the iodine technetium, might not have a huge influence from retardation. They still have dispersion and dilution during those transport processes.

There's a number of other things in this repository system that change those numbers. And that's what I wanted to say, is that if you're trying to make the argument, well, the waste package is the only thing, and that should be our complete emphasis, you're missing the story that this a system model and a lot of things contribute.

VICE CHAIRMAN WYMER: That's not exactly the message I got. The message I got was that don't take a simplistic approach.

DR. ESH: Also, I think the simplistic approaches can be used to -- I think they're useful when you're trying to get an unconfounded perspective about some of these simple processes. I think that's how we like to use them as they can go a long ways and they're pretty easy to understand.

VICE CHAIRMAN WYMER: Okay, any questions? Milton?

DR. LEVENSON: I just have one comment. I think if you sat in on any of the meetings of this Committee in the last year -- glad to see that your statement that be careful about the use of the word conservative, and don't overstate consequences, because it can mislead you badly about what's going on.

DR. ESH: You can imagine that if you did something really conservative on your model, and then you go away and forget about it. Or you say, well it's conservative, but you never look at it in more detail, it can be difficult to interpret your results than in a risk informed manner.

VICE CHAIRMAN WYMER: George.

CHAIRMAN HORNBERGER: Dave, in terms of CLST, currently is your view that the TSPA insights are similar, or essentially the same, as the TPA insights?

DR. ESH: For a large part, I think. I think, because we don't perceive that we have such a pessimistic release model, we may have a greater tendency to -- we still believe CLST is very important, and it's partly because it's a system model and it's one of the first things in a sequence of things that operates. So when you see your results, if it's preforming a big function that greatly influences your results.

I think we view the CLST as a very important issue. We also believe that NTPA, we have some work to do with representing some of these processes and uncertainties and that's ongoing in TPA 5.0. We don't distribute our failures, for instance, in the sense that DOE does. We distribute our failures from realization to realization, but we don't distribute them within a realization. But I think, as Dick Codell talk to you in the past, we've done a lot of off-line analysis to look at the implications of if you distribute your failures within a realization, package to package, patch to patch, and what are the influences of those processes.

So I think there are, Tae can talk to it in more detail, because he has a lot of the details even in back up slides, of what the TPA code is producing and you can compare that to what DOE's model is producing for various processes like uniform corrosion, for instance.

NTPA, we didn't have the stress corrosion cracking model, and I don't know if Chris Grossman is here, whether we're going to do it for TPA 5.0 or not, because it looks to us like only in special circumstances could you have a significant risk from it. In TPA 5.0 or in the TPA code, we originally had a diffusive release model, and then we took it out because it looked like we weren't getting any significant risks from the diffusive releases. Now we think we're going to put it back in just so we can have the flexibility to analyze these different cases if someone chooses to be conservative with release modeling for instance.

So I think in general, there aren't wide differences, but adding any sort of these phenomena with the detailed uncertainty is difficult in these models and it takes time. We try to do a lot of off-line analyses to look at the uncertainties rather than immediately, explicitly adding things into code. Whereas DOE may go right to the root of adding processes or phenomena directly into their performance assessment model.

CHAIRMAN HORNBERGER: Let's see. The second question. Do you think that the work that you're doing, the approach that you're taking, taking will lend itself to assisting in a potential license application in the situation and we'll be hypothetical, where DOE has some of these things in it that are what we might call, I think your term, overly pessimistic, instead of conservative. And it can color the interpretation.

Do you think that your approach will allow you to sort of disentangle it and still make some risk-informed judgments?

Or, do you think it will be buried in the TSPA?

DR. ESH: I think it can be useful. I can't say whether it will be useful. It will depend on the specifics of their performance assessment, going forward.

But I think it's something you have to attempt, at least. You have to try to unravel what the effects of, say, the conservatism is so that you can try to make those risk-informed judgments. I don't know.

CHAIRMAN HORNBERGER: Again, probably an

unfair question for you, perhaps. But do you think that in looking at the Yucca Mountain review plan that the acceptance criteria are such that you feel confident that you would be able to at least take the first steps to do the disentangling?

DR. ESH: Yes, I think -- I can't speak to the review plan directly. I think there's somebody probably here who could. But I can say that a lot of the work that we do, it would be difficult to like make an acceptance criteria or a review method to say okay, you do this or you do that. It's more of a philosophy of how do you handle this sort of problem and the sorts of issues that we are dealing with.

Maybe at a higher level, you should have some direct language that would speak to that, but it's really -- I mean their viewpoint is pretty extensive as it is and I think if you tried to put all of that in it directly it would be very cumbersome.

CHAIRMAN HORNBERGER: Thanks.

VICE CHAIRMAN WYMER: John?

MR. McCARTIN: Tim McCartin, NRC staff. In terms of the review plan, certainly the desire is that -- and we will understand DOE's performance assessment. As Dave indicated, how much detail you put in there, there's that sort of tug between too much detail and conveying a message without having to reach 50 pages.

But without question, we have to understand DOE's models and understand their assumptions. And I think we will.

One of the things Dave did very effectively here is, try to put a quantitative value on a potentially pessimistic model for release. And he had a good way to quantitatively give a sense of gee, we think this is pessimistic. How much effect does it have? Will we have to quantitatively put a number on how pessimistic this is? I think for the key models, yes. But all of them, some things, well, if we feel they supported, -- this is conservative, we won't necessarily try to quantify everything. That might be a daunting task. But we certainly would have to understand, whether the information supports it being conservative.

MEMBER GARRICK: Dave, it seems as though you're taking steps toward something that we've been interested in commenting on for a long time and that is begin to decompose this problem into some first principles that are comprehendible. And the idea of looking at an individual waste package and the inventory that you have to worry about in that waste package and the case, in your case here, technetium and iodine, but you could also add the only other things that we have to worry about such as the actinides, neptunium and plutonium.

I think this is very important that you kind of start out with something so basic as a waste package and what are the bad actors that we have to worry about, and then begin to put filters on those in terms of the waste package and then the natural setting that begin to communicate in a kind of a first principles way the activities and the barriers that this stuff goes through as a function of time and the effectiveness of each of those filters.

I just, I guess this is partly a compliment that this is the kind of the first time I began to see something that we've been alluding to for a long time to help the whole issue or risk communication of building a kind of a first principle's physics model. It would be very nice to see the same thing beyond the waste package in terms of the contribution from dispersion in different regions of the natural setting, the contribution of retardation and the effect of dilution and the effect of uptake to the point where we really go from rainfall, if you wish, to biological uptake.

So I think this kind of thought process is very effective. I think the thing that you could almost imagine a schematic here, based on a source and these multiple barriers and the idea of tracing through these barriers, this limited number of radionuclides that you have to worry about. It isn't as if you have to worry about 51 actinides and 250 fission products. We're only worried about three or four. So that's very positive and I would encourage you to continue to do this.

I think also it's very important to keep the focus on the whole notion of what is meant by risk. Risk is not conservative or non-conservative. Risk is risk. And so I think that when -- and I notice you're beginning to draw those kinds of distinctions. I think that the one thing that we want to always, it seems to me, start from is what we actually thing is the risk, rather than a conservative risk or a modified risk or a qualified risk of some sort. And go from there.

I think that the ability to begin to sort out where contribution is coming from in terms of performance is going to go a long ways toward reassuring everybody that there is performance role here for all facets of the repository and we need to

-- we need to quantify that role and we need not to get ourselves in the position where we're necessarily conveying that one barrier is all we really need or whatever, but lay it out in terms of well, this is what the contribution to performance is from the various barriers.

So I think this is good stuff. As long as we don't lose sight of characterizing it in a simple form as possible and as long as we don't lose sight of what we mean by risk. I encourage us to continue.

DR. ESH: I think we have a tendency to want to impress you with our complexity and sometimes it can be problematic from a communications standpoint and it can be problematic from a human intellect standpoint of interpreting exactly what did I get and why?

So one of the functions that we have to do in performance assessment is evaluate the reasonableness of DOE's performance assessment model and I believe an easy way to do that is to do these sorts of simple calculations and see how the simple calculations compare to that complex model or how they differ and then you can start extracting, excuse me, why they differ.

MEMBER GARRICK: Yes, and I think that you can get to a point where you can answer the kind of questions that Ray asked about the difference between the two values on Slide 8 very easily, that this is a direct result of barrier D and the phenomena associated with barrier D that contributes the most is dispersion.

DR. ESH: Sure.

MEMBER GARRICK: And once you get to a point that you can begin to present the information in those terms, then I think it really begins to be a powerful way to communicate.

VICE CHAIRMAN WYMER: Any questions from the staff?

MR. CAMPBELL: This whole use of a diffusion model by DOE actually goes beyond the stress corrosion cracks. They actually use it for the patches that they model developing from general corrosion on the waste package. And in fact, even at later time frames, it is the major release mechanism for TSPA-SR. Eighty seven percent of the waste packages never see advective flow, never see flowing water. They just simply see essentially humidity in a water film.

And throughout TSPA-SR, DOE says they're modeling the flow or attempting to address the flow of water over a film. And I think what you guys have shown is their model, in fact, grossly overestimates the potential release, that as a potential release mechanism. We identified that in our own analyses that we did for waste package in near-field environment and it's in this big long report that was issued a year ago. The international peer review identified this as a problem. I think DOE has identified this as a potential problem.

Do we have any indication that they're actually going to do something about this? And maybe come up with a more realistic model for their source term release?

DR. ESH: I don't know. I know we've talked to them about it a number of times and I can't say what their plans are. I think they're certainly evaluating it.

MR. CAMPBELL: Are there -- and a second apart of that question, are there potentially negative impacts on the concept of a multiple barriers approach if, for example, they stick to a very conservative release model?

DR. ESH: I think so. I think you could short change yourself if you're doing something very conservative that influences your perspective of how the overall system works.

For instance, if you had the -- say you had a failure mechanism that the end cap fell off the package and you had an opening. Diffusion doesn't occur through that whole geometic surface area. It occurs through the water films that will be contacting that circumference. So depending on what you do, you can get much different results. You just have to be careful about it.

Slide 22, by the way, is your test, if you want to look at that and try to explain what the three bumps are from.

So you can look at it and then talk to me. I'll tell you if you're right or not.

(Laughter.)

VICE CHAIRMAN WYMER: Are there any other comments, especially from over here on my right? Observations or questions?

Okay. Well, thank you, Dave.

MS. HANLON: Dr. Wymer?

VICE CHAIRMAN WYMER: That was Carol.

MS. HANLON: Hi, this is Carol Hanlon. I'd just like to respond to Andy. One of the things that we had noticed is that our models and our evaluations are higher and we are looking at that and calculating it and intend to correct it.

Abe was going to try and be here to today to speak to that point, but he's caught across town. But we are aware of those differences and looking to adjust them.

VICE CHAIRMAN WYMER: That was Carol Hanlon. Well, as we've seen the waste package is of importance and although not necessarily overriding importance, although it's front and center right now.

We're going to hear from Tae Ahn about the present status of issue resolution and risk assessment and waste package and drip shield performance.

DR. AHN: Thank you, Dr. Wymer. Dr. Esh introduced to you the importance of waste package risk domain. I would like to go over in detail all the failure modes of waste package and drip shields.

Many of the staff members of the NRC and the Center participated in the performance assessment of waste package and drip shield container and Container Life and Source Team, KTI is the lead KTI, led by Tammy Bloomer, Gustavo Gragnolino and Vijay Jain. And we also have participants from total System Performance Assessment Integration KTI, IDTME and Evaluation of Near-Field Environment KTI.

The purpose of this presentation is to go over the status of the issue of dilution of the oral agreement with Department of Energy and also some aspect of risk assessment in waste package and drip shield performance.

I would like to focus in two areas. The current status of safety demonstration and the status of technical basis. The safety demonstration is based on the best abstracted models based on the current knowledge in the medical manner and on the other end, the technical basis is the evidences and the data base to support the based current models.

The content includes basically environmental conditions and the various failure mode of the waste package and drip shield.

I will go over one by one as overall perspectives. The environmental conditions, we have issues of variations of chemistry in the repository as well as a simulated corrosion test solution. Also, it includes a chemistry from -- chemistry of the simulated repository solution. So we have three different chemistry we've discussed the variation among themselves.

The other area is temperature effect. Currently, the repository may go up to 106 degrees C in the high temperature operation. The normal (unintelligible due to accent, hereinafter, UDTA) corrosion practices needed to be extended to a higher temperature about 100 degrees C.

Also, we have issues of coupled processes, thermal, hydrological, chemical and a couple of processes. In addition to that, we have mechanical processes involved. I will go over briefly that.

Also, this assessment involves various sciences. People are worried about very aggressive chemical conditions of very low probability. I will address those aspects as well.

The first failure mode of the waste package materials is uniform corrosion, which means waste package should corrode very uniformly and the probability of occurrence of uniform corrosion, uniform penetration is very high, like close to one.

Next failure mode is localized corrosion which is fast localized penetration such as peeling, crevice corrosion. This failure mode has lower probability of occurrence under the current Yucca Mountain conditions.

The next failure mode is stress corrosion cracking. This is a discrete failure compared with uniform corrosion, producing cracks assisted by both stress as well as chemistry. It has a lower probability occurrence.

In the drip shields performance, we have all failure modes addressed in the waste package uniform penetration of higher probability of occurrence, a discrete failure of low probability of occurrence. I will go over more detail later.

Next failure mode is materials aging because we are talking about a time period of 10,000-year period, the microstructure or distribution of a chemistry may be altered which may lead to localized corrosion as addressed previously.

This material aging is considered to be a low probability occurrence because still the temperature is low enough compared with normal engineering practice where the material engineer aging is of a concern such as a temperature 1000 degrees C.

Next, the failure mode is a mechanical failure which is a discrete failure or a uniform deformation. One example is rockfall or degradation of drift which is considered to be a low probability of occurrence.

Juvenile failure, even with the quality assurance and the good design, still, we need to allow certain percentage of waste package to fail initially. Current data shows it has a low probability occurrence.

The last one is criticality. Currently, DOE has taken an approach to assess the criticality using the probability screening. In other words, based on very low probability of waste package failure, criticality is considered to be screened out. Therefore, we need to address the criticality issue here with respect to waste package performance.

I will go over each failure mode and environmental conditions one by one. The first is environmental conditions. We have one CLST agreement, 18 ENFE agreement and four TSPAI agreement with DOE. DOE needs to resolve all those agreements of [UDTA].

What we know about these environmental conditions, DOE tested the repository -- simulated repository chemistry at various temperatures up to -- above the boiling point and also they established a long-term test at the facility LTTF with various chemistry.

Currently, it appears that there is a consistency between the chemistry modeling and test, experimental test chemistry.

(Slide change.)

DR. AHN: Next slide shows a tabulated form. The first column is the ions of our interest with respect to corrosion. We analyzed all ions involved. However, I picked up only chloride, fluoride, carbonate, nitrate and sulfate which are influenced in the corrosion property.

Chloride is responsible for localized corrosion. Fluoride is similarly. Carbonate determines the pH of the solution. Nitrate and sulfate are more like inhibitors to prevent the corrosion.

The second column is evaporated synthetic J-13 well water as temperature goes up to temperature of 100 degrees C, dripping water will evaporate leaving the concentrated chemistry on the surface of waste package.

The third column is evaporated synthetic pore water to extend the analysis from the J-13 to pore water and the third column stand out J-13 well water at the higher temperature at 60 degrees and 90 degrees and the rest of the three columns are chemistries used in the DOE's long-term testing facilities. One is simulated or concentrated water, simulated acidified water and simulated saturated water.

As you see here, for instance, the chloride, there are variations, but at least the test of conditions pick up the range of chemistry expected from the operated testings.

Likewise, fluoride carbonate and nitrate, sulfate were captured in the actual testings. Nonetheless, there are gaps there, variations there. DOE is giving effort to include other combination of chemistry in their potential static or short-term testing to have a whole range of chemistry.

Likewise, at the center, we do have confirmatory research, varying the chemistry by taking away or adding up chemistry from the pure solutions.

(Slide change.)

DR. AHN: This slide shows the temperature profile for two depository operating mode. Left one is low-temperature operating mode. As you see, the scale of time up to a million years. The maximum temperature you could see is only slightly above 80 degrees C.

On the other hand, in the higher temperature mode, you see the temperature can go up to 170 degrees C. In the normal practice of aqueous corrosion they really do not go temperature of 100 degrees C. unless under the pressurized condition. We do not have pressurized conditions. Nonetheless, we are concerned about [UDTA] corrosion above 100 degrees

C, due to the so-called Deliquesense[UDTA] relative humidity.

In the presence of mixed salt, deposited under waste package and drip shield, the effective boiling point may go up because of the low vapor pressures, pressure in the presence of salt as well as capillary effect.

This is based conditions of temperature profile. DOE has chosen currently to go with high temperature mode. Therefore, we will discuss more extensively the waste package and drip shield behavior at temperature created in 100 degrees C.

Environmental conditions data. What kind of testing was done, especially at temperature 100 degree C. DOE has limited data in autoclaves and with humid chambers above 100 degrees C. and up to 150 degrees C. Some long-term current data from Germany tests of rock salts are available for Alloy C-4 and titanium 7 up to 200 degrees C over a decade because there are reposited rock salt . It's a more aggressive condition with respect to the Yucca Mountain repository. But the method of -- not very desirable, are not much incorporation of electro chemistry. Nonetheless, they are long term field data are very valuable. We are analyzing data.

Lately, the EPRI used some of these data for their performance assessment in Phase 6. Likewise, our center effort is to add assessing the high temperature affecting autoclave above 100 degrees C. as well.

As I mentioned, we needed in this area, environmental condition is more characterization of above the [UDTA] boiling point, also, in solution chemistry as well as corrosion performance both.

There are a number of issues. I cannot go over all details with you today. I have about 40 back up slides.

(Laughter.)

I will not go over. I haven't made any copies for you, but if you like to, I can go -- for instance, how coupled processes affect the performance, how mixed salt affected the corrosion, what kind of chemical speciation at different temperature in turn effect the corrosion behavior; heavy metal impurity effect as raised by State of Nevada, for instance another one is aerosol chemistry.

In the presence of drip shield, you can see in any pure water on the surface of waste package because there will be no water drip. Then we don't have to worry about low pressure corrosion as stress corrosion cracking. Nonetheless, if aerosol will be observed on the pure water and the surface waste package, we still need to consider the low pressure corrosion and the stress corrosion cracking in the presence of the drip shield. And the low pH and hydrogen peroxide condition. This is very aggressive condition. People are concerned with it. A low pH may be obtained from a radiolysis. Hydrogen peroxide and maybe obtained through radiolysis or from the structure and material in the drip to may dissolved to release ferric ions. Under this combined condition, waste packaging may be subjected to localized corrosion or lately the State of Nevada presented low pH conditions from the condensed water, but we need to discuss a lot about the subsequent offering with the geological material or [UDTA] or the waste package.

Also, the State of Nevada present a concern about geometric radio integrative result. Nitrate and sulfate may act as inhibitors. However, if the salt deposit differentially, in other words, at some point [UDTA] floride other point [UDTA] nitrate then at certain point the surface may see a worsening of the conditions. We need to take a look at that condition as well.

Another area is a comparability of waste package with internal structure, inside waste package. For instance, nitrate is a benefit for a waste package performance. It's detrimental to internal structure, so we need to take a look at that.

We have many uncertainties here. Also from our a PA perspective, how those uncertainties propagate need to be considered as well.

If you have questions, I may go to the back up slides later.

The first failure mode is uniform corrosion. We have eight CLS7 and four TSPAI agreements with DOE in this area. I give you [UDTA] and I leave other topics for future discussion, unless you have questions, then I can go back to the back up slide.

The data shows the passive layer formed on the uniform corrosion. Seems to have integrity for a long period of time, based on current knowledge. Currently available data suggests that waste package of life time gradient of 10,000 years.

(Slide change.)

DR. AHN: Next slide shows this is fraction of penetration of waste package surface as a function of time. These data are from Department of Energy. These group of curves are from the data for various conditions. One single higher curve from the short-term test like six months and one year. DOE is currently planning to use 5-year data which is lower than 6 months or 2-year data. As you see for any case, within 10,000 years, no container failure is shown here.

The inference of analog studies suggests long-term passivity and consistent with model for [UDTA]. Lately the center issued very extensive review in the validation of analog studies. We do not have eject analogs with respect to materials and environment. If we could analyze interpret the observations made in the analogs with respect to current corrosion theory, then we may predict the future of material as well, In other words, validate more than the corrosion theory, is the main purpose of the study of analogs.

They covered not just the nickel [UDTA] for instance, not just nickel-based analog but other iron-based, other artifact meteorite, Indian pila or whatever is necessary to validate the modern corrosion theory. The theory analyzed [UDTA] as well to see similar perspective.

However, we still need more work. For instance, MIC, microbial induced-corrosion, DOE's assessment have two sources, one from expert elicitation. There will be no MIC in the Yucca Mountain repository. In LTCTF at 60 degrees C. there wasn't any significant MIC means. Microbes, as opposed to alive at 60 degree C, but MIC attack means there appears to be no significant MIC.

Under the list of concerns, nitrate, an inhibitor may be consumed quickly by microbe in order to have better rationale, how this affects the performance. [UDTA] Center [UDTA] shows microbes in stuff from the Pena Blanca uranium deposit mine survived a temperature of 100 degrees C. We need to consider these kind of concerns.

Other issues in uniform corrosion included the effect of aggressive chemistry on the uniform code and rate, effect of temperature, especially above the groundwater boiling point. Some of these are already assessed by DOE, EPRI and the foreign country along with the Center. We reviewed all those data and analysis.

Also, there is a concern of sulfur segregation. That means sulphur can accumulate at interface within corrosion that exists in the passive filament metal that will lead to falling off of the passive film. It's a well-observed phenomenon in industry. This can be mitigated by proper design, DOE is conducting right now an accelerated testing.

Also, we have a concern about long-term corrosion potential rise observed in one of the tank DOE ATCTF. There is trying to interpret that is an artifact due to the release of ions from the tank itself. We'd like to see their basis for that.

(Slide change.)

DR. AHN: Now, next topic subject is localized corrosion. We have four CLST agreements in this area. Data based includes first LTCTF did not see any localized corrosion up to 95 degrees C. Lower risk significant is considered as Dave mentioned. This statement is somewhat consistent with NRC TPA exercises as well as EPRI analysis.

Other data available in localized corrosion is higher temperature effects in aggressive solution, tests performed by the Center, aggressive solution of pure sodium chloride at temperature close to 90 degrees C., Alloy C-22 was the subject of localized corrosion.

Also, if you have improper micro structure from welding, the material will be subjected to localized corrosion. Nonetheless, the Center added up inhibitors such as nitrate and sulphate to pure sodium chloride and saw the dramatic increase of resistance to the alloy localized corrosion. There is some data of German tests. German repository is deducing, nonetheless, under the radiation conditions, we think the oxidized environment formed comparable with our repository.

At 100 radical hour, they did not see any localized corrosion for C-4. C-4 is a slightly less corrosion resistant to alloy 22. And DOE tested localized corrosion on heavy metal, low pH, high temperature conditions and the State of Nevada did under very aggressive conditions. Also lately, DOE's waste package panel considered the limited appropriation of local corrosion [UDTA] due to the limited supply of the oxidants. There is some evidence of localized corrosion as well, for instance pitting observed in ion artifact had a high chloride concentration which means, demonstrating a validity of localized modern corrosion theory.

Still, we need to learn more about in the localized corrosion. We suggest to fill in there a temperature above 100 degrees C in a wide range of ground water concentration, including the aggressive solutions.

Another area of work did include a simple solution by adding more different species or taking away different species. Also, we'd like to see a better basis for DOE's critical potential for localized corrosion and NRC is taking the conservative side, but DOE's critical potential really does not tell a good electrochemical basis and we would like to see that.

(Slide change.)

DR. AHN: Next failure mode is stress corrosion cracking. We have two CLST agreements in this area. Again the data from DOE, the LTCTF results showed no SCC even on the double U-bend specimens. Double U-bend specimens means SCC tendency under aggressive conditions due to the aggressive solution including U-bend. You don't see any SCC indications.

As they showed here, the risk of curve, they assumed the SCC appears to be lower risk significant.

Other data available is DOE and GE showed the SCC under controlled conditions where they applied the potential with a very high straining. In the natural environment we may not have such conditions, however, the chemical fluctuations at some point may reach such conditions, therefore, we need to see more extensive data to make sure the repository will never reach such conditions.

Center did some conservative evaluations in severe environment and of magnesium chloride in 1110 C and so the SCC. DOE has also a different approach to mitigate SCC by applying laser peening, the compressive stress to mitigate the stress corrosion and cracking.

Also, DOE is proposing to design the waste package to mitigate the rockfall stress in the elastic regime. This is a difficult task, so we'd like to see how that task is implemented. DOE also improved the cracked measurement to sensitivity, less than one micron so that they can predict the crack behavior for 10,000 year properly.

The State of Nevada have heavy metal, low pH, high temperature condition testing. Some of DOE analogy produced very well. It's another concern. But again, those tests were done in a very severe environment for the purpose of extrapolating to really positive conditions. And the German tests also are available. Some of them are used by EPRI PA lately. I guess tests again is valuable because they did test up to 200 C.

Work needed: we'd like to suggest to fill in data at temperature above 100 degrees C and a wider range of groundwater concentrations including the aggressive solutions. Other work needed area includes heavy metal impurity effect and the fluoride effects, DOE has a concern about this and pursuing to conduct tests.

(Slide change.)

DR. AHN: Next issue is a drip shield performance. Drip shield performance includes all the failure mechanisms of waste package itself, but I put together here. We have four CLST agreements and all our waste package agreements are relevant here.

The risk factor associated with drip shield includes uniform corrosion, hydride embrittlement which are not in the waste package performance; and stress corrosion cracking. Overall, risk is lower significant as Dave mentioned earlier. However, drip shield may mitigate the impact of rockfall.

What kind of data do we have? We have low corrosion uniform corrosion rates from LTCTF. There was a concern of fluoride-enhanced fast corrosion. In the DOE's LTCTF, DOE did not see fluoride-enhanced fast corrosion. Primarily due to the [UDTA] effect, such as the effect of nitrate and sulfate.

There appears to be that the fluoride

effects a lower risk, however, the Center did a test under more controlled system and pure sodium chloride solution, added a fluoride and added sulfate, nitrate gradually. They still saw the [UDTA] of uniform corrosion rate with the fluoride additions. So we need to clarify better why LTCTF did not see the fluoride effect, if fluoride uniform corrosion rate is increased a couple order of magnitude, the drip shield life will be reduced a couple of order of magnitude as well, like 100,000 years. So it's important to clarify that.

No drip shield localized corrosion was observed in LTCTF, also in German repository up to 200 degrees C, under radiation condition. Although lately DOE saw stress corrosion cracking under the slowest hydrogen condition at 110 degrees C in [UDTA] solution, DOE raised a panel caution about this observation, probably we would like to see how this observation affected the overall risk of association [UDTA] of failure as well as waste package failure.

(Slide change.)

DR. AHN: Work needed -- we would like to suggest to confirm the lower risk significant with respect to hydride embrittlement. Hydride embrittlement is unique failure phenomenon in titanium compared with C-22 because the hydrogen entry from the corrosion will not be fast. Also, the amount of hydrogen to form the hydrogen is a very large amount, the risk is considered to be of low significance. However, as I discussed, if fluoride accelerated the corrosion rate, then a hydrogen uptake will increase, so this is related concern. We need to see better rationale for that, including the height.

Also, critical hydrogen concentration to initiate the embrittlement is under debate by now. We have all literature from DOE and EPRI to establish our basis right now. Currently, this is an agreement with Department of Energy.

Again, it is difficult to obtain the rockfall stress in the elastic regime, so we'd like to see how DOE implements the proper design to avoid the larger stress applied.

(Slide change.)

DR. AHN: This is DOE's risk assessment drip shield, associated with drip shield performance. Here, the dose rate of millirem per year, this is time. As you see here for base case, degraded drip shield, enhanced drip shield. All cases show the dose rate is very low after 10,000 years.

(Slide change.)

DR. AHN: Our next topic is thermal aging. We have six CLST agreements. We consider thermally driven long range ordering and the precipitations are unlikely under the repository conditions. This type of solid state base transformation may lead to localized corrosion and stress corrosion cracking. We do not think this is a likely phenomenon under repository condition, mainly due to a low temperature.

DOE is trying to collect some analog observation of the stability of basis from [UDTA]. Again, we have specific agreements with DOE suggesting the measurement of factor to time for transformation at high temperature around 800 to 900 degrees C. They measured the transformation temperature under accelerated conditions, like at 800, 900 degrees C, extrapolated. If the measurement here are not accurate, the extrapolation consequently would not be accurate, so we'd like to see more accurate measurement here.

Other work needed include better initial sample characterizations. Again, they had to factor extrapolation of the aging in a long-term period and cooling rate effect. DOE is conducting right now the mark up testing to see this type of phenomena.

(Slide change.)

DR. AHN: Mechanical failure included many more [UDTA]. We have 7 CLST agreements and 5 RDTME agreements and 2 TSPAI agreements. It is of concern right now as Dave mentioned. A current notion based on current understanding is low risk significant mainly due to the probability to occur. Even without waste package you expect a low dose. Then if you multiply the probability, you could expect a lower--. There is a sequence of events associated with drip collapse like drip collapse probability, rockfall probability, rock size distribution and so forth. It's all probabilistic. Nonetheless, we would like to suggest to evaluate drift degradation better, make sure there will not be high risk phenomena there. Other areas we would like to see better rationales: impact of loading from discrete rock blocks, static loads from rockfall, inducing the crib of a waste package of drip shield. Seismic ground motion. Again, it is probabilistic, but DOE needs to incorporate that. The corrosion process, as time goes on, the thickness of container and drip shield will be reduced, therefore, stress will be reduced as well.

Another area is whether the drip degradation at some point at the property of water seepage and temperature will change and temperature may rise. Something like emplacement of backfill with the rocks. For instance, this is earlier DOE's analysis of backfill. We then without backfill mainly temperature will rise. The windows did not change much. We like to have a better assessment associated with drip degradation. This kind of curve will be valuable interpretation of the risk associated drip degradation.

(Slide change.)

DR. AHN: Next topic is juvenile failure. Again, we do not have any agreement with DOE on juvenile failure per se, however, we have agreement in the criticality with DOE which deals with juvenile failure.

What is the source of the juvenile failure? Those include detection limit of flaw size, initial flaw size; human error, stress corrosion cracking. Here, [UDTA] means only a period like 10 years, 15 years, {UDTA] subsequently. Improper materials in welds, especially filler material; improper heat treatment; surface contamination; thermal output outside the expected range during the welding. All those will lead to juvenile failure. Right now DOE considered less than one waste package failure, but we are considering more than that, about

30 waste packages initially.

Work needed in this area is detection limits. Current technology such as ultrasonics or x-ray has a certain limit of detecting the flaw size. We have better bases for that.

Also, all data bases used were from performance of steels, not specified in C-22. We have better rationale why those data are C-22 or titanium drip shield.

Last one is -- this is closed welding with remote control. All commercial data base are not from remote control, so they need to consider how this remote control or automatic control affect the juvenile failure rate. Otherwise, the control may reduce the juvenile failure rate or remote control may increase the juvenile failure rate. We'd like to see the [UDTA] for that. On a conservative basis, the NRC's component reevaluation uses about [UDTA] higher juvenile failure rate right now.

(Slide change.)

DR. AHN: Last one is criticality. We have seven CLST agreements. Criticality may be discussed separately in another meeting. The reason I have brought this one here is that criticality is planned to be screened out based on the long-term waste package lifetime.

Screening, based on low waste package of probability is the key to the current criticality assessment.

Preliminary NRC's confirmative consequence assessment showed similar lower risk with steady-state and transient criticality.

We'd like to see though a better based for probability screening. They have already changed the position a few times. So in the beginning its entire waste package, 100 percent waste package integrity. Later on they change the probability of water infusion into failure container is a loss, assuming waste package failures. So we've like to see a good justification for all those scenarios.

(Slide change.)

DR. AHN: In conclusion, DOE assessed the environmental conditions of waste package and drip shield extensively at temperature below the groundwater boiling point. It is suggested that DOE fill in data at temperatures above the groundwater boiling point. Especially, aggressive chemical conditions need to be better characterized.

The uniform corrosion rates of waste package are extremely low. Analog evidence and models provide an insight of long-term passivity. Again, it is suggested that DOE fill in data at higher temperatures and under aggressive chemicals condition. For example, uniform corrosion rate under crevice environments, these are to be characterized. We have one agreement with DOE in this area.

No localized corrosion and SCC were observed in DOE's LTCTF at temperatures below the groundwater boiling point. It is suggested DOE fill in data at higher temperatures and under aggressive chemical conditions. The assumed localized corrosion appears to be a lower risk significant. Actually, in my back up slide, we did a risk assessment using NRC's code assuming a stress corrosion cracking, assuming a localized corrosion and so forth. We did not see a significant effect there.

(Slide change.)

DR. AHN: The risk associated with drip shield failure is lower significant. It is suggested that DOE provide again proper design to mitigate inelastic rockfall effects which may cause the drip shield failure.

The current assessment of rockfall effects is suggested to include drift degradation, creep, impact, and corrosion processes. As Dave mentioned earlier, this is an area we need to clarify for them.

Although the juvenile failure may be lower risk significant, better data bases are suggested for a detection limit of flaw size, remote control and materials specific performance.

The last one is the criticality, is lower risk significant. Nonetheless, it is suggested that DOE obtain a better basis for the probability screening.

Thank you.

VICE CHAIRMAN WYMER: Thank you very much. I had a couple of questions.

DR. AHN: Yes.

VICE CHAIRMAN WYMER: There's a lot of additional work in this area, ranges somewhere between very large and huge and I wondered what sort of screening criteria are you planning to use or would you suggest with respect to the -- which are more -- which of these things are more important to carry out and on what time schedule based on a risk-informed way of evaluating?

DR. AHN: Yes. I didn't catch your question quite clearly.

VICE CHAIRMAN WYMER: There's a lot to do. How do you decide what to do first?

DR. AHN: They started with researching well water. Then later on pore water was introduced. However, because of the high temperature at the repository, they tested the chemical chemistry of the evaporated solutions which was shown in the beginning. And in the meantime, they simulated evaporated solution for corrosion testings in all the time to use in LTCTF. There is some consistency there with [UDTA]. Nonetheless, there are variations. Again, those -- with those solutions you do not see localized corrosion in SCC and SCTF up to 90 degrees C. And in terms of risk, there is no localized corrosion there and no cracks formed there, so risk was assessed based on uniform corrosion rate with those solutions.

For instance, in the Center's assessment was based on pure sodium chloride solution to raise the issues concerned on the aggressive conditions. So we did some risk assessment varying the chloride concentration from the J-13 to LTCTF concentration up to the [UDTA] limit. We saw some localized corrosion within 10,000 years, but still risk was very low. So in addition, DOE is doing testings in a combination of various chemical species. I don't think anybody can do a long-term testing for all permutations, but based on current corrosion theory, they selected LTCTF chemistry as well as combination of key component in short-term testings.

VICE CHAIRMAN WYMER: I probably haven't phrased my question clearly enough. There's a lot yet to be done. DOE will come in with a license application and some of these questions you'll want the answers to in order to evaluate their license application. Some of the questions can wait while the licensing process is underway.

How will you decide what information DOE has to have at the time of their license application and how will you decide what is, which of -- and part of that, how are you to say which of these is most important and therefore should be done before the license application?

DR. AHN: I don't think I can answer your question on the basis of quantity, but I presented to you DOE has evidence of no stress corrosion cracking or localized corrosion from ATCTF. I have brought high temperature test results from Germany or Center, so what I would like to present today, the current status, what we know to close the old agreement by LA. The final decision will be made by Licensing Board whether there is sufficient information to the safety case.

All we needed to do is bring about all the DOE's evidence, international committee evidence, Center's evaluation to the Licensing Board.

VICE CHAIRMAN WYMER: Okay, another question. I'm sure you remember a while back the consultants from Nevada made a big to do about the effects of mercury and lead.

DR. AHN: Yes, I addressed that.

VICE CHAIRMAN WYMER: And corrosions.

DR. AHN: Yes, high heavy metal impurity factor.

VICE CHAIRMAN WYMER: Where does that stand right now?

DR. AHN: Right now, Ron is here. As I understand correctly for localized corrosion, the heavy impurity effect was observed under very severe condition. The aim of the testing of the State of Nevada was to accelerate that.

However, in the stress corrosion cracking, as I understand correctly, the State of Nevada [UDTA] produced the early observation.

VICE CHAIRMAN WYMER: I see. One final question before I turn the rest of the Committee loose on you. With respect to criticality, that probably is a nonstarter for commercial fuel in a repository.

DR. AHN: Yes.

VICE CHAIRMAN WYMER: But there will be DOE spent fuel in there, some of which is very high enrichment stuff. Have you analyzed that?

DR. AHN: Yes. Right now they are focused -- Meraj is here, focusing on the -- moderator that water cannot get in, but you're right, actually, there's a concern about graphite, degrees of [UDTA] variant DOE fuel. Meraj will make a comment on that further.

MR. RAHIMI: Meraj Rahimi, NRC staff. I guess to answer -- provide a short answer. I mean DOE has submitted to us a topical report which outlines an entire methodology for analyzing looking at the potential for criticality. And your question about high enriched DOE-owned SNF, that's also the methodology applies to that waste form. Basically, DOE's approach is that probability of water getting into the waste package is low, so you need the water to get into the waste package, corrode the internal component that could [UDTA] controlled system for it to go -- to have the potential for criticality. So right now, DOE's approach is approaching from the probability point of view.

VICE CHAIRMAN WYMER: That's considered to be a low probability by DOE also.

MR. RAHIMI: That's right. At this point, they said because of the long waste package life, the probability and of course, we are, the staff, is doing independent analysis. We're approaching from the consequence side of it.

VICE CHAIRMAN WYMER: Thank you.

MEMBER LEVENSON: But doesn't DOE also intend for all of the research reactor fuel which was highly enriched to dilute it before burying it, before sending it to the repository?

I think there's a program at Savannah River to dilute that so that the highly enriched research reactor fuel does not go into the repository as such.

VICE CHAIRMAN WYMER: Well, I was in a little study group a while back that looked specifically at this issue and they dilute some of it, that's true, but there are some very high enriched stuff that they're just going to package up and stick in there.

John?

MEMBER GARRICK: How much influence on what you do is the peer-review work that's been going on with respect to especially the waste package issues?

DR. AHN: I don't know what you mean "influence".

MEMBER GARRICK: Well, the peer-review study, for example, has suggested that certain materials not be used in the drip shield.

DR. AHN: Yes, I mentioned that.

MEMBER GARRICK: Yes. And I'm just curious, how much of what they have found correlates with the work that you're doing?

DR. AHN: Actually, I tried to put together not just DOE's Centers including peer-reviews' comments and NWTRB comment, TSPA International Review Committees. I put together all and one example is stress corrosion cracking of drip shield.

MEMBER GARRICK: Right.

DR. AHN: Which was raised by peer review group.

MEMBER GARRICK: Right.

DR. AHN: I mentioned that. I don't think anything new arrived there. I copied lots of those comments.

MEMBER GARRICK: Given the views of the peer- review group and this information about the drip shield, I would -- are questions beginning to be raised about the basic design and the basic need of the drip shield? In other words, do we need to spend that billion dollars?

DR. AHN: Well, again, our mission is not the cost analysis.

MEMBER GARRICK: I know it isn't, but it is performance. Your mission is to deal with the issue of performance and our interest is in the effectiveness of these various barriers with respect to safety and based on some of the material that you presented today and some of the material that's in the peer-review report, there's serious questions about the effectiveness of the drip shield.

DR. AHN: Yes, I agree.

MEMBER GARRICK: When do we get to a point that there's serious consideration of an alternative?

DR. AHN: Yes.

MEMBER GARRICK: Or different type of design or even an abandonment of the drip shield?

DR. AHN: Right, there are a couple of functions of drip shield that we are considering right now. It's a rock shield, one component.

MEMBER GARRICK: Yes.

DR. AHN: The other one is water drip --

MEMBER GARRICK: Water.

DR. AHN: If the aerosols are really benign, then the drip shields will play a very important role because it prevents the water drip not deposit in the salt and waste package, but if aerosol does, drip shield may be do anything. Again, there is a role of rock shielding there.

MS. BLOOMER: Hi. Can I take a stab at this? This is Tammy Bloomer. I'm the CLST Team Lead currently.

MEMBER GARRICK: Yes.

MS. BLOOMER: While DOE currently has the drip shield as part of what they're putting forward to us, they have indicated that they are not sure whether the drip shield will be there. We will continue to evaluate it while they have it there, so that we're up on top of it. They may propose another material which at that point we would take a look at, but -- or they may remove it all together and then we will have them reevaluate what that effect has on they've determined how the waste package reacts.

We are under the understanding that they may pull it out. If they do, that's what we're going to ask them to do and we have, as well, evaluated what the waste package may and may not do without the drip shield based on the projected length of the drip shield as we have it now.

DR. AHN: There was also in the very beginning another motivation for putting titanium there.

MEMBER GARRICK: Yes.

DR. AHN: They chose entirely two different materials, C-22 and titanium in case liquid-based alloy [UDTA] work, then titanium will prevent the water intrusion. That's the original intent as well.

MEMBER GARRICK: Right, right.

VICE CHAIRMAN WYMER: George?

CHAIRMAN HORNBERGER: Yes. John asked my questions, but just as one quick follow-up, to phrase it a different way, if the drip shield were to go away, are you comfortable with the agreements that you have in place now to provide enough information on effects, potential effects of rockfall and things like that?

DR. AHN: Most of them, most of them, yes.

MEMBER GARRICK: Milt?

MEMBER LEVENSON: Yes. I have a rather basic question and that is in almost all cases, you've identified additional necessary information. How much of those additional necessary information arise from a risk perspective as opposed to just filling out the scientific information because, for instance, Slides 19 and 22 show that the performance is the same whether you have a base case, an enhanced drip shield or a degraded drip shield. If that's really the case, why do we need to collect more data of the drip shield? How much of this is scientific interest as opposed to risk --

DR. AHN: Right. In the very beginning -- second slide.

Here I mentioned the objectives, the status of safety demonstration, status of technical basis. Safety demonstration was obtained based on the best models with the current understanding of science. That does not mean we do not have uncertainties. Therefore, we need to discuss basis. I don't think -- you see, safety demonstration shows those figures. Still, we have good technical basis for that because those demonstrations were made on the best judgment with the current knowledge.

How much basis do we need? I don't now. Tim McCartin may address that issue. We have discussed that among ourselves several times.

DR. ESH: Well, this is Dave Esh. I have

a perspective on that. It's a good comment. I mean your curves are showing that if you degree or enhance that barrier it doesn't influence the system behavior that much, but you have to be careful because that's purely using the model that you developed and most of these uncertainties that they're talking about, you'd first have to evaluate whether that degradation or enhancement captured those uncertainties that Tae has talked about would be the first thing and I would say for the most part it probably didn't because if -- I don't know if this is true or not, but if the drip shield is preventing significant rockfall or drip collapse damage to the packages, that sequence of events isn't built into the model. So if you take out the drip shield completely, and you never change your rockfall model, you're not going to see an effect from that process.

The same thing would apply say if the drip shield was preventing aggressive chemical conditions that would result in localized corrosion of stress corrosion cracking much greater than considered now at early times. If those things aren't built into your model so that when you take out that barrier or degrade it, you're not going to see the effect in your model.

So your comment is a good one. I think to fully answer it, they would need to do some more work, not necessarily experimental work related to the drip shield, but more analysis, PA type work to be competent.

MEMBER LEVENSON: If I can summarize your answer, it's that you're not using risk insights to decide what additional information to get?

DR. ESH: Well, I think we do, but you have to be cautious. Yes, but that's an example of where you have to be cautious.

CHAIRMAN HORNBERGER: But I think you answered a different question. I think what -- Milt's question is why acquire more information on the drip shield itself, not on the waste package, not on an analysis of what happens if you take the drip shield out, but why require more information on corrosion of the drip shield if, in fact, it doesn't matter?

DR. ESH: But I think that question of whether it matters or not is influenced by the other things that you've put in the model. So those three curves that are close to each other, the degraded, enhanced and the base case, they may be much different, they may have a bigger spread between them, if you've added other things into the model that that barrier is influencing.

DR. AHN: Before Tim comments, let me add one more thing. In this safety there was [UDTA]. We incorporated uncertainties here quantitatively, if we know where; for instance, distribution of uniform corrosion rate, distribution of critical potential. We factored uncertainties here. What technical basis means supporting those observations, how much. He may address that issue.

MR. McCARTIN: Tim McCartin, NRC staff. I think Dave's correct in what he's saying. We have a very complex code and sometimes you do the calculations and you see something that lines up and gee, there's no effect here and the initial reaction is you don't need to do anything more. We are constantly looking at the risk impact of these things and making sure the code results are truly depicting a good representation of risk. That's one part of it.

The other part of it though and this gets to NRC's review of what DOE is doing and the rule looks at the capabilities of barriers and if the Department is coming and they have a drip shield that provides a capability for let's say no water will get on the waste package for say 5,000 years, that's a significant capability. We'll look at the -- what they've claimed and whether there's sufficient information to support that claim. Because ultimately, we have to decide whether what they're saying is supported. Now whether that's risk significant or not, it may have a limited effect on dose with a waste package that lasts a very long time. But I would argue from a multiple barrier standpoint, if the drip shield can keep water off the waste package for 5,000 years, that's a capability and if they're going to take credit for that, it needs to be supported. So yes, we try to be as risk informed as we can. There are certain things that if you look strictly at dose and that's important, strictly at dose, may not be as risk-informed, but I think you do need to look at what is the capability of each of the barriers and in that sense the drip shield does provide something that does need to be supported.

MEMBER GARRICK: But the capability should be looked at in the context of the dose to the critical group. That should be the starting point --

MR. McCARTIN: Yes and no because I think the dose calculation can be very misleading sometimes in that regard and I would just point to that there have been claims that it's not a geologic repository. It's completely engineered and I think there are aspects that dose calculation, it's very easy to jump to the dose number. Sometimes it isn't necessarily as informative as other things and I'll point to there are certain nuclides that never get out. You never see a dose value from those nuclides.

One might argue, well, there's no risk contribution. Well, if you look at it, well, gee, the geology is causing delays later than a million years, potentially. And it's hard to get to that and I guess Dr. Garrick, you might say well, that is part of the risk and somehow you need to pull that out and I would agree, but it gets very difficult if you just look at the dose and I think the multiple barrier requirement is --

CHAIRMAN HORNBERGER: But again, not to -- to go your example, the example you just used, Tim, given this calculation that you describe of retardation of nuclides that never appear for a million years, would you turn around and still ask the Department of Energy to provide more information on the performance of zeolites or the saturated zone because we just want to make sure that that barrier really is contributing in the way you think. It's a way of asking for more information, not evaluating the barrier.

MR. McCARTIN: Well, correct. But the question would be is if the Department has say retardation factors for americium and plutonium --

CHAIRMAN HORNBERGER: They're not the ones.

MR. McCARTIN: They would need to be supported, but so I think we would ask for the support for what they're claiming.

CHAIRMAN HORNBERGER: But your example was for radionuclides that never appear.

MR. McCARTIN: Right, well, those were --

CHAIRMAN HORNBERGER: Would you ask for more information on those?

MR. McCARTIN: We wouldn't ask for more. We would ask for the information to support what they're claiming.

The other problem with the dose thing, the drip shield is a prime example. If it keeps water off the waste package and if that was the only thing, if it's redundant with the waste package, one might argue it has no risk contribution and when you do the dose calculation, it's very difficult to show that. That's the part, at least I like in the rule that you have to talk to the capability of each of the barriers. And somehow that capability should be point to some ability to potentially affect risk.

MEMBER GARRICK: Yes, but again, what we've tried to stress is that the capability of the barriers is not in an abstract concept. It's the capability with respect to something.

MR. McCARTIN: Yes.

MEMBER GARRICK: We need to keep that in focus.

MEMBER LEVENSON: Let me expand, Tim, a little bit maybe my question because I understand what you're saying and generically I agree, but if I look at this and every single thing in here has a long list of more additional information, it seems to me the second question to ask is how many of those items of information are important to assess that particular issue? Is that really necessary to assess the corrosion or is it just to fill out the scientific background? An awful lot of information here that doesn't exist on anything else we do routinely. This is a pretty complete package. It's a shopping list.

MR. McCARTIN: Well, we certainly would like to think that all the agreements are tied to something that has a contribution to performance. And something that's necessary.

Having said that, there's no question that this is a continual process of reevaluating whether some of the information is still necessary and it does evolve, but certainly when these things were requested, there was a sense that they had an effect. Could we be wrong in some areas? Absolutely. And that's --

MEMBER LEVENSON: Well, you have many, many more risk insights, both from your own work and DOE work and I think the question of when you're talking about Ray poses a question, there's no way all of this information is going to be accumulated.

And so to set priorities, I don't know how you do it other than risk insights, not necessarily just the computer TPA or TSPA, but other risk insights. It seems to me you have to introduce risk insights into this.

DR. AHN: Yes. Let me add one thing. Tim mentioned multiple barrier requirement and in case of other concern we may consider those lists.

As I mentioned to you, the safety demonstration is based on the current observation. I stressed for each subject what evidence we had to demonstrate the case, but there are more technical bases, how much do we need should be determined by the Licensing Board during the licensing period.

What we are trying to do is to put together all those bases, evidences to support the current safety demonstrations.

VICE CHAIRMAN WYMER: Andy, what would you like to ask?

MR. CAMPBELL: So is it the opinion of the staff that all the information requested for and all the agreements is necessary prior to licensing or is there an attempt to reevaluate the information requests in some of the agreements in light of your risk analyses?

DR. AHN: We do. We interact with DOE more like weekly to pursue the closure of the oral agreement, going into detailed aspect of oral agreement. We are seeking a way to close all agreements by considering what are important factors of risk analysis.

MR. LESLIE: This is Brett Leslie from the NRC staff and I would kind of like to address two things that were actually in Andy's question. It's two-fold, which is performance confirmation or you know, is there information in the agreements that we expect to come after an initial license application?

This is going to be a point of discussion at the upcoming technical exchange for the Fiscal Year

2003 agreements. I think we've gone through a thought exercise inside NRC and at the Center, looking at the their agreements and saying yes, look at the scope of what these things are saying, long term testing. Do we expect them to turn off the switches and shut down their experiments at the time of license application? That wasn't our intent. But regardless of what is requested in those agreements, there must be sufficient information at the time of initial license application on the particular area to make a decision.

So I think all the information we've requested, we believe is needed prior to license application in the agreements. Maybe not all the information because we anticipate performance confirmation testing.

The second one was really -- is the staff using risk information to tell DOE what they don't need to do? Okay. That's -- we -- management, NRC management is constantly telling DOE to use risk information, to make a case and say yes, we don't need to supply this information. We've been waiting for quite some time for the first analysis from DOE with that approach. We're ready to talk about it, but DOE has to come up and say here's the information or here's the reason why we don't need to do it. It's not our purview to say well, just trust us and you don't need to do it. So part of that using the risk information and part of using, doing the risk insights analysis and doing some of these off-line calculations is so that when DOE comes in and say okay, for this agreement here's some additional sensitivity or calculations for why this information isn't really needed. We're in the position to say okay, yes, or no, have you considered this uncertainty when you've done your sensitivity analysis.

VICE CHAIRMAN WYMER: Thank you. That gets at my question very squarely.

MEMBER LEVENSON: But Brett, I have a little problem with that because generally the things that are in the agreements are because NRC asked for it and DOE submitted and agreed to submit it, to provide it. Now if the person who asked for it by subsequent risk insights and analysis decides it really wasn't required in the first place, I think you have an obligation to go back and say we really shouldn't have asked for that.

MS. BLOOMER: In fact, we have done that on occasion. We take a look at -- as Tae mentioned, we take a look at all of the agreements and we discus them with DOE at regular intervals in the CLST team.

We have come to conclusions about some agreements that we feel are no longer necessary and therefore, we said this is now under a status of closed. And we've gone ahead and closed agreements, based on the fact that either DOE has provided us information or said that you know, this information probably isn't needed and we've agreed because we've done more testing that said you know, this information isn't needed.

If you look at the fluorine that people are talking about and how all of a sudden that that's an issue with the drip shield, if nobody asked about that question to begin with, everybody would assume the drip shield was going to last for the amount of time that DOE said it was going to last and that would have been the end of it.

We want technical basis to justify what they say. These issues that we've put in front of them have all been risk significant in the fact that we asked them the questions and we didn't just ask irrelevant questions. We've done testing. We've read about testing. We've found results that indicate this may not be the whole truth. Give us some background to help us see the whole truth and from that, these agreements have fallen out. When we find some other data that says we don't need that agreement any more or we don't need all that data for that agreement any more, we discuss with DOE and we come to some understanding and we have done that as recently as today.

VICE CHAIRMAN WYMER: Thank you. That's very clear.

Are there other questions or comments? Mike?

MR. LEE: Yes, hi. I just want to take exception with a statement you made regarding the Licensing Board and none of us here, I think, can certainly speak to what the Licensing Board may or may not do, but in the first instance, DOE is obliged to demonstrate compliance with NRC's regulations and in doing so provide sufficient technical basis for that demonstration.

The staff and any potential licensing review would use its own independent judgment and render an appraisal or assessment as to whether or not there's sufficient information there, given uncertainties and state of knowledge to judge whether or not the regulations have been complied with.

The Licensing Board will take all of that information and then render its own independent decision, but I don't think they're going to be the arbiter as to whether or not DOE needs to provide more information or that there are technical cases --

DR. AHN: No, I didn't mean that. It's just where there's insufficient information.

MR. LEE: The first line of defense in all of this is the staff and they'll prepare a safety evaluation report which will evaluate DOE's compliance demonstrations and that, in turn will be use --

DR. AHN: Yes. Before that time, as Terry mentioned, we are going with DOE weekly to close most agreements.

MR. LEE: I understand that.

VICE CHAIRMAN WYMER: Are there other questions or comments?

MR. LEE: You might ask San Antonio.

VICE CHAIRMAN WYMER: Might ask what?

MR. LEE: San Antonio.

VICE CHAIRMAN WYMER: Hello, San Antonio, do you have any questions or comments?

UNIDENTIFIED SPEAKER: No, we don't have any questions.

VICE CHAIRMAN WYMER: Okay, thank you. I know you have prepared an excellent and very detailed comprehensive set of back up slides.

DR. AHN: Thank you very much.

(Laughter.)

VICE CHAIRMAN WYMER: Which I'd like to have a set of, if I may. If there's no more questions or comments, thank you for a very stimulating discussion.

CHAIRMAN HORNBERGER: Okay, so we are scheduled to have lunch from 1 to 2. We can definitely have it early.

Are there things that we need to discuss before we break for lunch? Or that you want to discuss.

I think we will not need the recorder after we close for lunch, we won't need the recorder any more.

Any follow-up discussion you want to have on what we just heard?

VICE CHAIRMAN WYMER: I don't think so. I think we do have to talk about writing a letter on this issue of waste package performance, but that's another, sort of another time.

CHAIRMAN HORNBERGER: Okay. Okay, nothing -- anything else that we need to discuss? Okay, we're going to break until 2 o'clock. Adjourned.

(Whereupon, at 12:25 p.m., the meeting was concluded.)