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BEFORE THE
UNITED STATES NUCLEAR REGULATORY COMMISSION

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123RD MEETING OF THE ADVISORY COMMITTEE ON NUCLEAR WASTE

NOVEMBER 28, 2000

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TR08

P R O C E E D I N G S

MR. GARRICK: Good morning. The meeting will now come to order. This is the second day of the 123rd meeting of the Advisory Committee on Nuclear Waste.

My name is John Garrick of the ACNW. Other members of the Committee include George Hornberger, Ray Wymer and Milton Levenson. ACNW consultants are Drs. Jim Clark and Rod Ewing. They're also in attendance with us today. The entire meeting will be open to the public.

Today we're going to hear a presentation by center staff, and on the Yucca Mountain TPA, Total Performance Assessment Code and External Review.

We're going to hear a presentation by NRC staff and the center on capability of NRC staff to evaluate risk significance of information submitted by DOE for postclosure.

We're going to discuss in here a presentation by the center staff on preclosure safety analysis, or at least on the preclosure safety analysis tool. Review alloy C-22 studies by DOE and the center. Hear a briefing and discuss the draft plan for research, supporting the nuclear waste safety area.

And we're continue our discussion and work on proposed ACNW reports. That's a pretty loaded agenda.

Andy Campbell is the designated federal

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1 official for the initial portion of today's meeting. This
2 meeting is being conducted in accordance with the
3 provisions of the Federal Advisory Committee Act.

4 The Committee has received no written
5 statements from members of the public regarding today's
6 session. And should anyone wish to address the Committee,
7 please make your wishes known to one of the Committee
8 staff.

9 If you make a statement, it's requested that
10 each speaker use one of the microphones, identify
11 themselves, and speak clearly in a volume so that it can
12 be readily heard.

13 All right. I think without any delay, since we
14 gave a rather comprehensive introductory remarks yesterday
15 about what we were trying to achieve with this meeting, we
16 will not repeat that, and we will move directly into our
17 first presentation, which is on the Yucca Mountain TPA
18 Code and External Review. And it's my understanding that
19 Jim Weldy of the center will be the lead-off presenter.

20 MR. WELDY: Thank you, Dr. Garrick. My name is
21 James Weldy, and I'm a member of the performance
22 assessment group in the CNWRA, and I'm going to be talking
23 to you about the external review of the TPA Code, and my
24 colleague, Tim McCartin will be discussing the current
25 plan of capabilities in the code group.

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1 The outline that I'll first off describe the
2 peer review as conducted of the Version 3.2 of the TPA
3 Code. I'll discuss the development of an action plan for
4 responding to these comments, and then give you a current
5 status of implementation of that plan; how we're coming
6 and who's funding the comments so far.

7 The peer review of TPA 3.2 was conducted during
8 the summer of 1999, which documents the strengths and
9 weaknesses of the TPA Code, and to evaluate the
10 suitability of the Code for use in reviewing the DOE
11 license applications.

12 We selected -- we attempted to select the
13 members of the external review through peer acclimation
14 process; wherein, we sent nomination forms to a large
15 number of experts in the field, in the various type of
16 disciplines that we wanted experts from.

17 We received nominations and attempted to select
18 the person who received the most nominations from the
19 various experts. And unfortunately, we did run into some
20 problems with availabilities of the experts, and problems
21 with conflict of interest, such that the person who
22 received the post nominations was not always available to
23 serve on the panel.

24 And in some circumstances, in fact, none of the
25 people who were nominated were able to serve on the panel,

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1 and we were forced to nominate the NRC work force staff to
2 nominate other experts, who we felt were capable in the
3 area, in order to perform the peer review.

4 MR. GARRICK: How did you get the candidates in
5 the first place? How did you identify them?

6 MR. WELDY: It was really just a matter of we
7 sent a -- you know, to a very broad number of people in
8 the field that we were familiar with. And this was sent
9 internationally to -- I think there were 120 total people
10 who were initially selected for the nomination process,
11 and people were allowed to nominate themselves as well, if
12 they thought they were able to serve on the panel.

13 MR. GARRICK: So there was a formal
14 announcement of -- that asked people to nominate
15 themselves if they so wished?

16 MR. WELDY: That was one of the options
17 included on the form that we sent out to all these people.

18 MR. GARRICK: Okay. Thank you.

19 MR. HORNBERGER: How many responses did you get
20 of the 120?

21 MR. WELDY: I'm going to have to give that one
22 off to Gordon. I'm not sure.

23 MR. WITTMAYER: I'm Gordon Wittmeyer. I don't
24 recall the number of responses that we got from the 120 or
25 more letters that we sent out. I would say it was a

1 little bit less than half.

2 We probably received over a hundred names of
3 potential experts. And I think most votes that any one
4 person was probably six or seven. That gives you a rough
5 idea. I think the numbers are actually in the report, if
6 you have copies of that.

7 MR. GARRICK: Yeah. Yeah. The decision as to
8 who, except for those that nominated themselves were made
9 by the center staff and the NRC; is that right?

10 MR. WELDY: Well, the desire was to take the
11 people who got the most nominations.

12 MR. GARRICK: Yeah.

13 MR. WELDY: But when those people weren't able
14 to serve, due to availability or conflict of interest
15 concerns, we either -- we went down the list until we ran
16 out of people on the list. And that point, we were forced
17 to nominate people ourselves between NRC and CNWRA staff.

18 MR. GARRICK: Okay. Thank you.

19 MR. WELDY: The conduct of the review was -- we
20 sent the Code documentation to the experts for their
21 review in early June of 1999. This consisted of the
22 user's guide for the TPA 3.2 code, and also a sensitive
23 studies analysis conducted on the code, which hopefully
24 allowed them to see what the important areas of the code
25 were, and get an idea -- a better idea of how the code was

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1 actually running and working in the word processes
2 involved in the code.

3 They had about a month and a half to review the
4 documentation prior to the formal meeting that we had.
5 And several of the experts submitted questions during that
6 time. Questions for clarification, on how things were
7 working, or what we were doing, which we responded to
8 prior to the formal meeting.

9 MR. GARRICK: I'm sorry, Jim. I want to make
10 sure I understand this. The documentation, was it all NRC
11 documentation, or did it include DOE material, such as
12 part of the TSPA?

13 MR. WELDY: It was just on our see
14 documentation. It was two documents related to the TPA
15 Code specifically. It did not -- we did not send them the
16 full slew of documentation that we had about all of the
17 detailed process level models that went into the
18 development of the code and supported the code.

19 We limited it to just the user's guide and the
20 sensitivity studies report, because we didn't want to
21 overload them with too much information, since it would've
22 been --

23 MR. GARRICK: Yes.

24 MR. WELDY: -- boxes and boxes and boxes, which
25 they would've had a very difficult time going through

1 completely.

2 MR. GARRICK: That was the one thing I was
3 curious about, is how much of this documentation would
4 help them understand enough about the repository itself
5 to, you know, be able to make good judgments about the
6 representativeness of the models of the site.

7 So I was curious as to how much site
8 information, for example, they might have received.

9 MR. WELDY: The user's guide has some
10 information on site characteristics, but beyond that,
11 there wasn't any additional site information sent to the
12 experts.

13 MR. GARRICK: Okay.

14 MR. HORNBERGER: Except the -- if you look at
15 the report, it's clear that all of your experts consulted
16 lots of documents including DOE documents, and USGS
17 documents in conducting their review.

18 MR. WELDY: Yes. Many of them were already, at
19 least in some aspect, familiar with the program. And they
20 were certainly went out on their own and found any
21 information that they needed to conduct their review.

22 In late July 1999, we held the formal meetings
23 for the experts, during which we made presentations on the
24 code, and we encouraged the experts to ask questions for
25 clarification, or that they had any additional information

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1 that they wanted. And we attempted to get all the experts
2 together at one time, so that they could -- so questions
3 from one expert could feed the questions and lead to
4 active discussion among the experts.

5 We were able to get seven together at one time,
6 but due to limited NRC and CNWRA staff availability in one
7 technical discipline, we were forced to have one of the
8 experts have an individual review; have an individual
9 presentation session.

10 MR. GARRICK: I've already apologized for
11 interrupting. How much -- you said that you were able to
12 get seven of the experts together at one time. How much
13 time together did they spend?

14 MR. WELDY: It was most of a week.

15 MR. GARRICK: Uh-huh. So there was interaction
16 and cross-talk and --

17 MR. WELDY: There was a lot of interaction and
18 cross-talk. There was very lively and interesting
19 discussions.

20 MR. GARRICK: That didn't come through the
21 report as much as I would've expected. Because that's one
22 of the things we were a little concerned about, is just
23 how effective this could be, because it had the appearance
24 of being somewhat isolated; each expert being somewhat
25 isolated. And not having the advantage of exchange. So

1 I'm very pleased to hear that.

2 MR. WELDY: Yeah. That was probably one of the
3 main goals --

4 MR. GARRICK: Yeah.

5 MR. WELDY: -- of the large meeting, was to get
6 them all together, so they could feed each other with the
7 active discussion.

8 MR. MCCARTIN: Tim McCartin, NRC. Also at that
9 meeting, we were, the staff, NRC and center staffs were
10 making presentations to give them a sense of the
11 regulation and they would ask questions about the
12 regulation. What we understood about the Yucca Mountain
13 Code, et cetera, so there also were in that -- there was
14 that interaction between --

15 MR. GARRICK: That's good.

16 MR. WELDY: The expert review group consisted
17 of members with expertise in a number of different
18 technical areas. We attempted to select people with
19 expertise in areas that covered all of the main important
20 processes modeled in the TPA Codes, so there could be a
21 thorough review given to the code.

22 And we selected experts -- people with
23 expertise in rock mechanics and mining engineering,
24 rockanology (phon.), hydrology, a drill site and corrosion
25 engineering, geochemistry, health physics and then two

1 people with more of a general background of an overall
2 assessment, and then FEPS analysis. We thought that would
3 give a very full coverage of the code, and would lead to
4 an excellent type of a review of what's in the code.

5 Following the meetings, the experts were asked
6 to write up a report, documenting their findings of the
7 review. In which they were asked to examine the methods
8 and assumptions made in the TPA Code, make any
9 recommendations for improvements for future versions of
10 the Code, evaluate how we implemented our conceptual
11 models, including which parameters choices we made. And
12 make some sort of assessment as to whether the NRC
13 approach to the EPA was sufficient to review the DOE
14 license application.

15 This is why in some of the discussions on the
16 regulatory framework were important in these meetings,
17 because we did ask them to make some sort of an
18 assessment, as to whether our code would be sufficient to
19 -- for the NRC to use as a tool, and evaluate the DOE's
20 license application.

21 And then each expert submitted an independent
22 review report. It was not a consensus report, because we
23 wanted to get all of the suggestions that all of the
24 experts had individually, and then we would compile them
25 in determining which ones we wanted to implement

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1 ourselves, rather than having them decide outside which
2 ones they thought were the most important.

3 The overall impression that we got from the
4 reviews was that the code was very well developed, and
5 captured the important physical processes associated with
6 the repository very well. And there was general agreement
7 within the reports that the code, with some improvements,
8 would be sufficient in technical quality and flexibility
9 to review the DOE's license application.

10 So, in general, the reports were pretty
11 positive and we thought, gave us a good -- pretty good
12 confidence that we would be able to review the DOE's
13 license application with the code.

14 Of course, they did have a number of
15 suggestions for improvements. There was -- these
16 suggestions covered a wide variety of areas. Some of the
17 issues that came off on -- numbered different of the
18 reports included things such as the level of code
19 documentation, placability of the analyses, documentation
20 of our FEPS analysis. Items such as this, where the TPA
21 Code fell within the regulatory framework.

22 There are a number of comments on that. There
23 were a number of comments on how we were modeling a couple
24 of processes and the level of decoupled that we put into
25 the code, and whether that was appropriate.

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1 There was one fairly serious comment about our
2 lack of data in the saturated zone modeling.

3 One expert felt that we really didn't have
4 enough data to support the model that we used for our
5 saturated zone model, which is a concern that we have also
6 voiced to DOE in the past, and continue to voice to DOE.

7 So we do expect to collect more data and will
8 improve the model as necessary, as additional data comes
9 in.

10 There were -- a number of experts indicated
11 that the basis for selecting the rated new buds track
12 (phon.) really wasn't sufficient. We really needed to be
13 a little more explicit on how we selected those -- rating
14 new buds that were tracked, and how we eliminated the ones
15 that we didn't track.

16 And there were a number of experts who
17 indicated we really didn't track and take into account the
18 chemical composition of the water as well as we could, in
19 various locations within the repository in the -- on the
20 surface, the waste package, within the waste package, and
21 the outside traded zone of the local repository. They
22 thought we could do a better job of tracking the chemical
23 composition, at least determining what it would be, and
24 whether it would change the results, it needs to be
25 tracked.

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1 In order to reply to these comments, we
2 developed an action plan, in which all the questions and
3 comments of the -- about the applicability of the code
4 when it's directed from these reports, they were grouped
5 together, so similar comments could be addressed by a
6 similar -- by a single response. And they were all
7 assigned individual tracking numbers.

8 Each of these sets of comments were then sent
9 out to the technical experts for the response, in order to
10 document -- how we were going to respond to that.

11 This is an example of what the action plan
12 looks like. You can see it assigns an identification
13 number, and it indicates which reviewer made the comment.
14 It quotes the comment from the report, it also cites
15 within the report where that comment was made, so that if
16 someone's coming -- just looking at this, they could go
17 back to the original report, and actually understand what
18 the expert is getting at.

19 Because sometimes when you just pull out a
20 small segment of text, you don't really understand what
21 they're going after, and we encourage the responders to do
22 that, to go back to the actual comments, so that they
23 could understand the expert was looking for.

24 The next four columns indicate the technical
25 areas that were assigned to respond to these comments.

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1 They were divided down by integrated subissue, which is a
2 subblock within the TPA Code. And for a number of the
3 comments, particularly those that dealt with -- and the
4 level of coupling within the code, it required more than
5 one technical area to respond to the comment.

6 And, as you can see, for 160 down there, some
7 of them required a number of interaction between a number
8 of different technical discipline, in order to fully
9 respond to the comment.

10 MR. GARRICK: Has there been any attempt to map
11 these into the KTI's?

12 MR. WELDY: There was an initial attempt to map
13 them into the KTI's. We decided that the ISI was a more
14 appropriate venue for responding to them.

15 Basically, because they map -- the ISI's map
16 more directly to the TPA code, and it's the -- ISI is
17 already involve a certain amount of coupling within
18 themselves, so we felt that was a more appropriate way to
19 respond to the comments.

20 So, in total, we had -- we came up with 234
21 unique comments from the external reviewer's reports. And
22 this covered a wide range of technical areas.

23 And, as I said, the response may require input
24 from multiple technical areas.

25 Generally, the plan is to respond to the

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1 comments using one of the following methods. The
2 responders do have flexibility to choose their own way,
3 their respondent comments as they deem appropriate. But
4 most of them, we expect will be responded to either by
5 indicating how the comment has already been addressed as a
6 newer version of the TPA Code, TPA 4.0 and 4.1 have been
7 released since the version that the external reviewers
8 looked at, and therefore, some of these comments have
9 already been addressed.

10 Another way is to cite a document, a
11 sensitivity analysis that indicates the issue does not
12 really have a significant affect on performance. A third
13 way is to state that the issue will be addressed to future
14 versions of the TPA Code. We're currently in the
15 development phase of TPA 5.0.

16 Or finally, the technical expert could provide
17 additional justification that assumptions made within the
18 code, within the modeling, or within the selection of
19 parameters are appropriate.

20 Current status of the external review is that
21 we have completed full responses for approximately 25
22 percent of the comments. The number of the other ones, at
23 least, partial responses, too, but need additional
24 information or justification in order to be considered to
25 be complete.

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1 We plan on completing all of the responses by
2 June of next year. And the responses may refer to work
3 that has not been completed, even though all the responses
4 will have been developed by then. We still -- it may say
5 a future report, something that people are working on or
6 will be working on in the next year or so, in order to
7 respond to the comment.

8 The next couple of slides, I provided just a
9 couple of sample responses that we've received so far, to
10 give you an idea of the types of -- what we're doing to
11 respond to these comments.

12 This first one refers to the chemical -- how we
13 model our -- how well we know the chemical composition of
14 water, particularly in the unsaturated zone. And says
15 that using the J-13 water may not be appropriate to model,
16 et cetera, in its own waters.

17 In our response, we indicate that we agree that
18 J-13 water may not be appropriate, and cite some
19 additional data that have been made available since our
20 review, since the documentation that the reviewers looked
21 at.

22 We cited some analyses that we performed on
23 that data, in order to determine whether it's applicable
24 or useful. And we indicate that we're -- we will perform
25 sensitivity analyses on these changes in chemical

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1 composition between J-13 water and unsaturated zone water,
2 in order to determine whether it has a significant effect
3 on the results of the code. In which case, we will -- if
4 it does have a significant effect, we will incorporate the
5 changes into the TPA Code, as necessary.

6 The second sample response that I included
7 deals with our modeling of the thermal pulse from the heat
8 from the repository.

9 The reviewer indicated that he thought it would
10 be difficult for NRC to justify the assumptions made in
11 those models. And our response indicates that we have
12 done additional research into whether the parameters used
13 for these models are appropriate, especially for the new
14 design that has been laid forth by DOE since the version
15 3.2 of the code was made by us.

16 We also indicate that it's not just the
17 abstraction in the TPA Code. That's the only model that
18 we're dealing with here. We do do more detailed process
19 level modeling, and we do do lab research and do
20 experiments, and we ensure that the abstraction, the TPA
21 Code matches very well, the detailed process level
22 modeling, and the experimental results.

23 So we feel that we can justify the model within
24 the TPA Code, using those more detailed experiments.

25 So in version 4.0 of the TPA Code, as I said,

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1 we had made some changes that already responded to
2 external reviewer concerns. The version 4.0 was in the
3 process of being developed when the review was conducted,
4 so many of the changes that we made with 4.0 had already
5 been decided upon by the time that review was conducted.
6 So therefore, most of these were changes that we were
7 already planning on doing before the review was conducted,
8 and matched up what all with what the experts said, that
9 was important to deal with with the code.

10 Some of these things that we've done are, we've
11 modified how we treat the parameters that affect the
12 amount of water entry, that enters the drift, that
13 contacts and enters the waste package, so that we can make
14 it time dependent, instead of just having a single
15 constant value. So that we can account for processes such
16 as drift collapse or increase degradation of the waste
17 package through time, to modify those parameters in time.

18 Another thing that we've done to TPA 4.0, was
19 we incorporated a commercial dose assessment software
20 package into the TPA code directly, so that we can sample
21 the biosphere data, in order to develop our dose
22 conversion factors, rather than just using a single
23 constant mean value. This allows us to assess the
24 variability of these factors more accurately.

25 Doing that also allowed us to model the build-

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1 up of radionuclides in the soil, due to multiple years of
2 irrigation of contaminated water.

3 We are currently in the development stages of
4 TPA 5.0, and are considering a wide range of changes to
5 the code, in response to the external review group
6 comments, and based on our own judgment of what needs to
7 be done for the next version.

8 And some of the things that we're considering
9 implementing, based on the -- in response to the comments
10 include modifications to track the chemical composition of
11 water at various locations within the repository system.
12 That a consideration of the effect of year-to-year
13 variations and rainfall on infiltration.

14 The ability is currently in the code, but we
15 normally leave it shut off when we run the code. We did a
16 sensitivity analysis a while back, stating -- showing that
17 it wasn't too significant on the results. We plan to look
18 back at that, and see whether that still holds true after
19 the changes that we've made to the code, and make a
20 decision on whether we need to reconsider that decision.

21 We plan on -- we've -- we're considering
22 developing an improved basis for estimates of water,
23 contacting and entering the waste package, possibly with
24 some detailed process level modeling, as in multi-flow.

25 And we're also discussing whether we want to

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1 include redistribution of ash following a volcanic
2 eruption. Following a volcanic eruption, large quantities
3 of ash will be deposited on the side of the mountain, and
4 -- which will be an unstable surface, which eventually
5 will be washed down to the 40-mile wash, which is the
6 direction of the critical group. And we were looking at
7 whether that's going to have a significant effect on
8 results, and if so, we're looking at what we can do to
9 incorporate that effect in the TPA Code.

10 In summary, the peer review identified many
11 areas of the TPA Code that could be improved, and we've
12 taken these comments very seriously, and have already
13 incorporated some of these suggestions in version 4.0 of
14 the TPA Code.

15 Additionally, we plan on adding more of these
16 improvements into TPA 5.0, and we believe that the conduct
17 of the external review -- has confidence that the code
18 reasonably models the repository system, that's
19 appropriate for the use in the review of DOE's license
20 application.

21 And in the back-up slides, you can see the
22 identities of the experts who were selected for the
23 external review, if you're interested.

24 And that's all I have. Do you have any
25 questions for me?

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1 MR. GARRICK: We'll see. Ray?

2 MR. WYMER: I have a couple of questions, two
3 actually. The first question is, did you unearth
4 anythings that would surprise you that can't be dealt with
5 if you can't get enough data to future codes, that will be
6 available, the time that you will need to have the code
7 used? Is that a particular thing that -- there's a couple
8 of processes, but anything?

9 MR. WELDY: Well, one place where the -- we had
10 significant problems in the data is the saturated zone
11 modeling, which is not something that we can really go out
12 and collect. It's really the responsibility of the DOE to
13 go out and collect, and we will continue to incorporate
14 that data, and improve our models in the saturated zone
15 model, as necessary.

16 A couple of processes we are evaluating; we
17 have a number of -- some groups who have gotten together
18 to evaluate the effects of couple of processes.
19 Primarily, we're looking at thermal, hydrological,
20 mechanical and chemical evolution of the repository.
21 That's a lot of the coupled processes that are important,
22 and we are looking at that, in deciding -- in trying to
23 determine whether it is -- these effects are significant
24 enough, that we need to incorporate them directly into the
25 TPA Code, or whether they're already covered within the

1 conceptual models that we have in there.

2 MR. WYMER: Was it an enormous amount of --

3 REPORTER: I can't hear you, I'm sorry.

4 MR. WYMER: Was a tremendous amount of kinetic
5 data needed to really address the processes adequately,
6 and I don't think that they are necessarily available, it
7 could not be made available in the time -- if it could be
8 available, and that was my concern.

9 MR. WELDY: Yeah. We're currently using the
10 multi flow coat to do the modeling, to model. And we're
11 trying to match it up to the drift scale test that DOE's
12 continuing. It's running right now and seeing how well
13 the multi flow can reflect the results of that test and
14 calibrating it to those tests.

15 MR. WYMER: But you don't see any flows -- show
16 stoppers?

17 MR. WELDY: We haven't -- at this point, we
18 haven't found any show stoppers that would say absolutely
19 we won't be able to use the TPA code in the review of the
20 DOE license application.

21 MR. WYMER: Second question was, how much --
22 what parts have you used, if any, of DOE's code? How much
23 have you used what they have done?

24 MR. WELDY: We certainly track what they have
25 been doing. Obviously, we incorporated the latest design

1 that they have proposed and the TPA Code directly. We
2 don't use any of their models in the TPA Code, but we look
3 at what they tend to see as significant in their code
4 certainly and re-evaluation periodically when we get a new
5 version on a new document from DOE showing what is
6 significant.

7 We look at our models and make sure that we've
8 modeled the processes appropriately, in order to reflect
9 importance of that process.

10 MR. WYMER: You don't use their basic structure
11 even?

12 MR. WELDY: No, the TPA Code was developed
13 completely independent of the DOE Code.

14 MR. WYMER: That's all I have, thanks.

15 MR. GARRICK: Milt?

16 MR. LEVENSON: Yeah, I've got a couple of
17 questions. The first one is were any of your experts,
18 what I would call generalists or systems people, since
19 clearly are the important things that a review should do,
20 is put the pieces together properly, rather than are you a
21 good programmer.

22 MR. WELDY: Yes. We did have one general, an
23 expert in the overall performance assessment area, that
24 was Dr. Brian Thompson, and he was -- he looked at it at a
25 more global scale, and looked at how we put things

1 together, and how we documented the code, and those sorts
2 of issues.

3 We also had an expert in FEPS analysis, Dr.
4 Frits Van Dorp, who looked at it to ensure that we had
5 fully and completely done an appropriate FEPS analysis,
6 and incorporated all of the appropriate FEPS within the
7 code.

8 MR. LEVENSON: I have a couple of specific
9 questions that came from new graph. On new graph A, you
10 identified the basis for selection of radionuclides
11 tracked, was something they commented on.

12 Was that a rather arbitrary decision made by
13 somebody? You didn't allow the code to reject what was
14 unimportant?

15 MR. WELDY: How we currently have our FEPS --
16 have selected the radionuclides that we tracked, is
17 basically the result of an evolution of the code.

18 We looked at what was important in previous
19 versions in the code, and the radionuclides that were --
20 we initially tracked a large number of radionuclides, but
21 for confrontational efficiency, we wanted to cut down on
22 that number.

23 So we looked at what was important in earlier
24 versions of the code. And through that evolution, is how
25 we reached the number of radionuclides that we track at

1 this time.

2 A lot of their comments were that due to
3 changes in the modeling, that that mix of radionuclides
4 may change, that ones that are important, so you may want
5 to periodically go back and do it, an additional analysis
6 and make sure the ones that you continue to track are
7 still the most important radionuclides.

8 MR. LEVINSON: On slide 50 in response to the
9 comment of parameters for thermal pulse, did a multi-flow
10 code being used to get liquid fluxes above the drifts, et
11 cetera, I'm not a computer-type, as you probably have
12 gathered already, but did the multi-flow code include
13 gravity? And if not, how do you use it in this case?

14 MR. WELDY: Yes, the multi-flow does include
15 gravity. Multi-flow is the code developed here at the
16 center, in order to look at these processes specifically.

17 MR. WYMER: So it does include gravity?

18 MR. WELDY: It does include gravity.

19 MR. WYMER: On page 16, you talk about the
20 build-up of nuclids in the soil due to the multiple years
21 of irrigation. Were the assumptions for that the same as
22 used in analyzing whether you or don't get retardation,
23 when the water's running through the same ground?

24 MR. WELDY: The -- actually, the
25 characteristics of the soil in ermogos evaluate are not

1 the same as the characteristics of the rock within the
2 mountain.

3 We looked at them separately, to ensure that
4 the data that we used for KD values were appropriate for
5 the -- each location.

6 MR. WYMER: Is the build up determined
7 experimentally or from analysis and calculations? The
8 context of my question is that, the Israelis have
9 discovered to their surprise, in some of their sandy
10 soils, don't absorb things, and they're now irrigating
11 crops with salt water, because there is no build-up.

12 Contrary to everybody's feelings. So I
13 wondered whether this could be a fairly important one,
14 whether this build-up is, in fact, based on technical
15 measurements of the actual soil with the actual materials
16 involved.

17 MR. WELDY: It is actually just based on
18 modeling, and use of some generic data. However, we've
19 looked at the importance of the build-up, and it really
20 doesn't affect the results very much. It's only a few
21 percent for most radionuclides. There's one or two that
22 it's a little more significant, but most of them, it is
23 very insignificant.

24 MR. WYMER: That's all I have, John.

25 MR. GARRICK: George?

1 MR. HORNBERGER: The -- I just have a couple of
2 questions on your action plan for responding. I think
3 that the examples that you cited, it's clear that you can
4 move forward with a lot of the comments.

5 It strikes me that there are some that may be a
6 little different from your examples, however. The one you
7 used as an example in your response to raised question,
8 that Demorceli (phon.) said well, we simply don't know how
9 water flows in the saturated zone. That's not a comment
10 on your TPA code. That's a comment on the availability of
11 constraints through the -- that bound the calculation, in
12 any sensible way.

13 How do you plan to -- and there are other
14 comments from your reviewers that I would put in the same
15 category. That's not the only one. How do you plan to
16 put that into your action plan for responding?

17 MR. WELDY: The main plan with comments such as
18 that, that really involved data collection are to pass
19 them on to the DOE, and make sure the DOE has sufficient
20 data to support their models. If the DOE has more data
21 that's available, then as that data becomes available,
22 we'll incorporate it in the DOE code to make any changes
23 to the models there, that are necessary.

24 MR. HORNBERGER: Does that -- I guess what I'm
25 trying to get to, does -- do you agree with the assessment

1 of all of your reviewers that these are critical that are
2 missing, and that DOE absolutely has to provide these, or
3 they won't be doing their job?

4 MR. WELDY: I don't think I can answer that
5 broad of technical areas. I think there's certainly some
6 filtration that goes through our technical experts' minds,
7 based on analyses that they've done, sensitivity studies,
8 as to whether the data is absolutely critical, or whether
9 it could only change the results a little bit. So it's
10 not really as necessary.

11 MR. HORNBERGER: There are perhaps fewer cases
12 of this. You've responded about a couple of processes.
13 But things that may relate specifically to the structure
14 of your TPA Code and whether you could answer some of
15 these things.

16 The one that comes to my mind is the comment on
17 the potential importance of lateral flow diversions in the
18 unsaturated zone when you're using the one dimensional
19 vertical model. How do you respond to something like that
20 in your action plan?

21 MR. WELDY: That one hasn't been responded to
22 yet. I'm not sure how we're going to respond to that. I
23 believe that we'll conduct some sensitivity studies.
24 Maybe look at some of the DOE results where they have the
25 three dimensional code, and see how that affects their

1 results. And do a comparison between the two to make an
2 assessment as to whether that process is important under
3 the results of the code.

4 MR. GARRICK: One of the suggestions had to do
5 with the lack of data that George was just referring to.
6 The lack of data for the saturated soil modeling.

7 My earth scientist, Collie Zavalos (phon.)
8 impressed with the fact that the greatest unknown in this
9 whole process is how to do detailed modeling in the
10 unsaturated zone.

11 So I was a little surprised to see, and that
12 modeling is kind of old hat in the saturated zone. So I
13 was a little surprised to not see something on here about
14 the unsaturated zone, as far as modeling of rainfall into
15 the -- and infiltrating into the near field.

16 MR. WELDY: We actually got a very limited
17 number of comments on our modeling of the infiltration
18 within the mountain.

19 MR. GARRICK: Uh-huh.

20 MR. WELDY: I assume that means that we've done
21 a pretty good job.

22 MR. GARRICK: Yeah. Well, that's encouraging.
23 As I say, I've been led to believe that where the
24 analytical models is weakest is in how to model ground
25 water movement if -- of an unsaturated zone. So that's

1 kind of encouraging.

2 MR. WELDY: Yeah. One thing is, we don't give
3 a -- within a TPA Code, we don't give a lot of performance
4 from the outside unsaturated zone, due to fracture flow
5 through a lot of the --

6 MR. GARRICK: So --

7 MR. WELDY: -- zones.

8 MR. GARRICK: -- it's pretty much a matter of
9 just the rainfall?

10 MR. WELDY: Right. The amount of rainfall to
11 contend, and we really didn't receive many. There was one
12 comment on that the thermal effects causing fractures in
13 surface might could increase your infiltration. There are
14 one or two other comments, but there wasn't anything too
15 significant.

16 MR. GARRICK: The only other comment I'll make
17 at this time, and maybe this one should come up later, is
18 the comment having to do with insufficient modeling of
19 chemical composition of water. I'm not surprised to see
20 that there.

21 If I were asked to, on the basis of my
22 reactors' friends, how I would model this, I would model
23 it the way we discussed here a couple of years ago, of
24 creating an infiltration model that had output states that
25 basically become the input states to the near field.

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1 And those output states would, in this case, be
2 water composition of different types of water, if you
3 wish. And that would be a way to build in to the model
4 explicitly the ability to consider all the evidence that
5 would support one water composition versus another,
6 because you could basically assign likelihood values to
7 each of the different water states.

8 Now, have you considered doing anything like
9 that?

10 MR. WELDY: I know that our technical experts
11 are giving it a lot of consideration, and they're doing a
12 lot more of looking at how we can incorporate that into
13 the TPA Code.

14 I'm not sure which way -- how they're going to
15 decide to actually incorporate that.

16 MR. GARRICK: It just seems to be a rather
17 straight-forward approach, and would enable you to
18 incorporate into the model, the different water
19 compositions, as well as your full state of knowledge
20 about which funds you referred, and what the supporting
21 evidence is for that, and to characterize it with some
22 sort of a probability distribution curve.

23 MR. WELDY: Uh-huh.

24 MR. GARRICK: It's an opportunity for some real
25 nice modeling that addresses a fundamental question that's

1 been around for a long time.

2 MR. WELDY: Uh-huh. Lora Browning, and she
3 could probably assess that a little bit better.

4 MR. MCCARTIN: Yeah, I'll address it in a
5 subsequent talk.

6 MR. WELDY: Okay.

7 MR. HORNBERGER: And your earth sciences
8 colleagues thank you for taking the time to -- chemistry
9 on that unsaturated zone, such as straight forward --

10 MR. LEVENSON: I've figured out a way to do
11 without the --

12 MR. GARRICK: Algebra. I have one more
13 question. I think, and the reason I think is because we
14 received a little over six inches of paper for this
15 meeting, so I'm not sure what I read where, but I think
16 one of the peer review comments addressed a matter of
17 conservation of mass not being your code. Is that
18 correct, and if so, what's your response to that?

19 MR. WELDY: We're looking into that. Whether
20 we have full concentration of mass within the code. I'm
21 not sure off hand if we explicitly tracked that. Tim, do
22 you know?

23 MR. MCCARTIN: I'd be amazed if it isn't
24 concerned.

25 MR. HORNBERGER: And you did that comment?

1 MR. MCCARTIN: Yeah, we did get a comment. I
2 think -- my understanding is, it was related to oh, I
3 think some of the disruptive events, where we don't
4 account for, say, when volcanizism occurs, we assume X.
5 We just accounted for the decrease in inventory from
6 disillusion. I'd have to go back and check for sure.

7 And in that sense, I will say, yes, we do not
8 conserve mass.

9 MR. HORNBERGER: All right. We may double
10 count that in inventory in that stuff that's removed by
11 the volcanic event might not -- but still remain in the
12 river.

13 MR. LEVENSON: The context for the question, I
14 don't know if peer review if a context, but my context
15 was, a couple of years ago, when I was involved with the
16 DOE Code, we discovered that, in fact, they didn't have
17 conservation of mass, so that from a one curie source term
18 a hundred years later, you could have one curie per cubic
19 feet or soil out 20 miles. So conservation of mass is
20 incredibly important.

21 MR. MCCARTIN: And in that regard, with respect
22 to the brown water pathway, when stuff leaves from the
23 source, mass is concerned.

24 MR. LEVENSON: I wasn't asking about this
25 second order.

1 MR. GARRICK: Jim?

2 MR. CLARK: I have just a couple of questions,
3 kind of in the general heading of background. You're
4 writing an independent model from DOE's?

5 MR. WELDY: Yes.

6 MR. CLARK: They're different, they're about
7 the same. If you just look at the subsurface, yours is
8 one dimensional, isn't it?

9 MR. WELDY: Unsaturated zone modeling is --

10 MR. CLARK: Okay. Okay. So you're doing --
11 you're looking at major confusion and saturated zone
12 absorption?

13 MR. WELDY: We are looking at absorption, we
14 are looking at main distribution, yes.

15 MR. CLARK: Okay. Now, you don't generate any
16 data, so the data that you need for your model comes from
17 the DOE; is that correct?

18 MR. WELDY: The DOE is technical literature.
19 Certainly the -- all the unsaturated zone data has come
20 from DOE reports. We certainly screen it, and determine
21 whether we believe that it was requested appropriately
22 before we --

23 MR. CLARK: Are you -- their data gathering
24 effort is going to give you all the data you need, since
25 they're different models.

1 MR. WELDY: Where there's not DOE data
2 available in an area, we generally will use data in the
3 technical literature. If it's not available in either
4 place, then we need to look at that and see how we're
5 going to -- how we can come up with values for those
6 processes.

7 MR. CLARK: Because, you know, you can get into
8 trouble using data developed specifically for one model
9 and another model.

10 MR. WELDY: Uh-huh.

11 MR. CLARK: If you -- do you know, what's the
12 process? What happens when you get results and then get
13 results and you get together and compare them and --

14 MR. WELDY: Yeah. We --

15 MR. CLARK: How does this work?

16 MR. WELDY: We have periodic technical
17 exchanges where they'll discuss the results from their
18 code and we'll discuss the results from my code, and we'll
19 do a comparison of what we -- our different codes show, or
20 are the important processes.

21 We compare results, the different individual
22 sub-modules and see how similar they are or how different
23 they are and have discussions and discuss why they're
24 different.

25 MR. CLARK: And so far, you're comfortable with

1 this process at least --

2 MR. WELDY: I think it's working very well. I
3 think it improves both of the codes to have these sorts of
4 exchanges, because both staffs could --

5 MR. CLARK: The meeting with the experts was
6 your meeting. That was something you did.

7 MR. WELDY: Right.

8 MR. CLARK: I assume the responses were
9 generated by your folks and they were in the meetings
10 where the experts were discussing, so there was good
11 communication on your side. How does this get
12 communicated to the DOE? What came out of it?

13 MR. WELDY: We'll certainly discuss any results
14 that we have at the technical exchanges, any weaknesses
15 the experts identified in our code, we'll look at their
16 code and see what their -- they might have a similar --

17 MR. CLARK: Okay. So it's not being done
18 through KTI's as John asked, but there is a mechanism of
19 working groups.

20 MR. WELDY: To transfer the data?

21 MR. CLARK: Yeah.

22 MR. WELDY: The members of the --

23 MR. CLARK: That's where it concerns.

24 MR. WELDY: Okay. The members of the ISI's are
25 also members of KTI's, that's the way our organizational

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1 structure is right now. Is it would've been KTI's, so
2 there's a lot of crosstalk between the ISI's and KTI's.

3 MR. CLARK: And I appreciate the concerns about
4 your code, which may or may not -- concerns about what
5 they're doing, but there is a mechanism to have that
6 communication.

7 MR. WELDY: Yes, there is that communication.

8 MR. GARRICK: I might point out that one of the
9 KTI's is total system performance.

10 MR. CLARK: Do you think your -- well, do you
11 think your approach is more conservative, given the
12 differences in the models, since you have a one-
13 dimensional model?

14 MR. WELDY: It varies. Actually, there are
15 some areas that were more conservative at EON. There's
16 some areas that DOE is more conservative than we are right
17 now. We attempt to do the bodily best we can. We don't
18 attempt to be overly conservative, by any means. We have
19 to be as realistic as we can in our modeling.

20 And if the DOE feels that they don't have the
21 data or the information support, our models, like ours,
22 based on that are even a more conservative model.

23 MR. CLARK: But in the unsaturated zone, you
24 stated -- your deep speculation is shown in -- there are no
25 loss mechanisms along the lines.

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1 MR. WELDY: Yes. We assume uniform flow from
2 the shuttle service to the deep percolation. Looking at
3 the DOE's three-dimensional model, we looked at that, and
4 there's very little difference between their shell on
5 completion and depercolation values. So we felt that that
6 somewhat justified our approach.

7 MR. CLARK: Thank you.

8 MR. GARRICK: Dr. Ewing.

9 DR. EWING: Just by way of -- background for
10 myself and others may have the answer. Did you contrast
11 the two codes, the NRC code and DOE code, in terms of
12 general size, number of input, parameters, percentage of
13 use of expert opinion, for the input of granditures, one
14 dimensional versus three-dimensional, number of sub-
15 routines or sub-models?

16 MR. WELDY: We haven't done a formal comparison
17 like that. Tim, do you want to --

18 MR. MCCARTIN: Yeah. I guess part of that I'll
19 be talking about later and the use of the Code, and -- but
20 I don't know if -- we are trying to directly compare the
21 two.

22 Our code is a tool for us to help us review
23 what DOE's doing. And so in a way, we use it to inform
24 our process. We use it to get insights to then query and
25 probe the DOE analyses.

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1 So in some respect, there is a comparent
2 contrast, in that, we might see something in R CO G or
3 very sensitive to say, temperature or release rates.
4 Maybe the DOE Code, they're not seeing that type of
5 sensitivity. We would want to understand why. What are
6 they doing.

7 But it really is a review tool, and we are
8 trying to say, we have the right approach.

9 DR. EWING: I guess what I'm asking, I'm asking
10 several things, but from your answers, I've expressed some
11 concern about the process of licensing the -- being of one
12 comparing one code to another. And the discussion is,
13 both your answer is different because yours is one
14 dimensional, or your expert opinions are different, or you
15 used a different chemical base.

16 The real issue is, do the codes represent, in
17 some sense, the performance of the site. Not do the codes
18 give the same range of answers.

19 MR. MCCARTIN: Absolutely. It's not the
20 comparison, does our code sort of match theirs, in any
21 sense. It is really what is the DOE's result and what's
22 the basis for their results.

23 Now, we use our code to assist us in probing
24 DOE's analysis, in terms of what's important to
25 performance, what kind of results they're getting. But it

1 really doesn't fall upon our code and the results of our
2 code. It's really what DOE's getting, our understanding
3 of what DOE's getting, and the technical basis they have
4 supporting their results.

5 DR. EWING: Let me ask the question in a
6 different way. The comparison can be very useful as an
7 example, if you compare different ways of batching your
8 sub-models. I mean, it could break your -- the DOE Code
9 might be very detailed and have a sub-routine for
10 corrosion of glass, a sub-routine for the air fuelogy of
11 chemistry.

12 Or you could batch them in a simple way, or in
13 a complex way, but in different combinations. It would be
14 interesting to see the answer to the same.

15 So does that happen? Are you so different that
16 you see the different batchings of the sub --

17 MR. MCCARTIN: We -- there's no question in
18 some areas we have very different approaches than the DOE.
19 Some places we're similar. There's all kinds of different
20 kinds of combinations, and you're right. I mean, it is
21 useful to see when DOE does some of their sensitivity
22 analyses, all kinds of results they get, based upon
23 different concepts of approaches.

24 We do it different. We (inaudible), and we use
25 a different conceptual model, are they that different, why

1 are they that different, why -- or in terms of
2 intermediate results, are they the same.

3 There's a lot of -- you're right, there's a lot
4 of different combinations of looking at the system, and
5 abstracting different processes. And between the two
6 groups, I think there's a fairly broad spectrum. And I
7 think that's one of the purposes of the NRC Code.

8 We probably have, if I had to guess, if I
9 broadly would state, that we probably have more
10 combinations of things to look at than DOE does, because
11 we're interested in a lot of different things of what
12 could go wrong.

13 DR. EWING: And one last question. In terms of
14 the usefulness or I don't want to say usefulness, of the
15 TPA Code, do you test it against natural analog data?

16 MR. MCCARTIN: To the extent that we can, we
17 have used some analog data. One of our --

18 DR. EWING: is that a large extent, small
19 extent or --

20 MR. MCCARTIN: To date probably the -- I'll
21 point to two examples. One would be the Pena Blanca
22 natural analog we use for release rates for source term is
23 one that we try to extract some information from.

24 The other would be, I would maintain Chlorine
25 36 and Yucca Mountain gives some evidence that there are

1 relatively short travel times in the unsaturated zones.

2 DR. EWING: Thanks. You use Pena Blanca in
3 your example as an input into your code.

4 MR. MCCARTIN: Right.

5 DR. EWING: I'm asking, did you try to model
6 something and then you (inaudible) using it.

7 MR. MCCARTIN: The fusion.

8 MR. GARRICK: Andy?

9 MR. CAMPBELL: Do you guys have a copy of DOE's
10 Code? Have you kind of picked it apart and taken it
11 apart, looked under the hood and see how it works, or are
12 you getting this from a far?

13 MR. WELDY: We don't yet have a copy of DOE's
14 Code, but we're currently working on acquiring a copy,
15 hopefully prior to the release of SR, so we can do a
16 little of that probing, as we're doing our review of SR.

17 At this point, I don't believe we have a copy
18 of the Code yet.

19 MR. ESH: Yeah, that's right. This is David
20 Esh. We're working on getting that.

21 REPORTER: I'm sorry, what's your name?

22 MR. ESH: David Esh. We're working on getting
23 that, and we should have the Goates (phon.) in, you know,
24 Goates and Cook Code very shortly, then we have to get all
25 of the dynamic link libraries and the other stuff that

1 goes with it from DOE.

2 But our goal is to have it before the SR, and
3 that start -- and this discussion of we tear our code
4 apart, and I'm going to talk about that some. We expect
5 DOE to tear theirs apart, and understands how it's
6 working, and we have plans to get theirs, too. And to
7 evaluate to the extent that we can.

8 So all three of those things are a part of our
9 review.

10 MR. CAMPBELL: How long a process do you
11 anticipate that to be? Because that could get to be a
12 fairly lengthy and involved process of getting into the
13 guts of the code and everything else.

14 MR. ESH: I think the answer is, we'll do what
15 we can with the resources that we have, and the time that
16 we have. We'll do your best -- we'll do our best, that's
17 all we can say.

18 MR. CAMPBELL: The political escape.

19 MR. GARRICK: Okay. Any other questions from
20 the staff?

21 All right. Tim, we've already warmed you up a
22 bit.

23 MR. MCCARTIN: James answered them, so it
24 should go easy.

25 MR. HORNBERGER: You've already done half of

1 your presentation.

2 MC. MCCARTIN: Yeah, exactly.

3 Okay. Up to this morning, for the rest of the
4 part of the presentation, I'll give a status of the NRC
5 performed assessment code clearly in the time allotted. I
6 am not going to go into great detail on the code.

7 I'm going to give a quick overview of the key
8 things, and I would say that I'll try to go quickly.
9 There are people here and in Rockville, that while the
10 committee and consultants in their particular areas, to go
11 into more detail, feel free to ask the question.

12 Generally, I'll talk briefly about the roles of
13 the performance assessment code, key aspects for
14 estimating performance, which will be those areas. Then
15 I'll then go into the status and there's some bias, in
16 terms, I had to pick what parts were key. I selected
17 among the ones that -- which ones I determined to be
18 appropriate in terms of fascinating performance at this
19 time.

20 I'll talk briefly about gaining confidence in
21 the performance assessment.

22 In terms of the rules of the performance
23 assessment code.

24 Generally, we're going to use TPA to review
25 DOE's performance assessment. In the MZTPA, there's a

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1 couple of areas, we'll certainly risk inform our review
2 process. We want to probe at DOE's analysis, where we
3 think the most important impact, the largest effect on
4 assumptions, where there's uncertainties, et cetera,
5 there's three categories in this particular --

6 MR. GARRICK: You changed that for your live
7 show, the whole page will come up.

8 REPORTER: It's in Word Perfect, can you --

9 MR. MCCARTIN: Go to view page and reduce the
10 mag -- the percentage magnification.

11 MR. GARRICK: A full page. There you go.

12 MR. MCCARTIN: Of the three bullets, I think
13 there's two aspects there that I'd like to at least talk
14 about.

15 My subsequent talk later in the day, actually
16 gets into more detail, but one in terms of evaluation of
17 overall performance.

18 We can certainly do some side calculations to
19 get a sense of the waste package lifetime, do some
20 calculations on the brown water pathway, look at
21 retardations. But there really isn't any substitute for
22 doing a side calculation on what the dose is going to be.

23 We used the overall performance assessment to
24 do that. It's a way to integrate all our understanding of
25 the site. That also includes both the uncertainty and

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1 availability of the site. What we don't know, as well as
2 what we know, but that's the one benefit of a TPA Code, is
3 you have no substitute for, well, what should the dose be.

4 You have all these separate modules that, all
5 in their own way, affect that final dose. You need to
6 integrate it some way. And that's one of the advantages
7 of a performance assessment.

8 Then, with that result, we can look at the
9 sensitivity and uncertainty, with respect to what's
10 driving the result, looking at the parameters,
11 assumptions, conceptual models, in terms of both overall
12 performance. And you'll see with our code, as you know,
13 we have many, many different intermediate outputs, so we
14 can look at the sub-system performance.

15 And finally, hypothesis testing. One of the
16 things that we've tried to do with our code is include a
17 number of features that we can test different concepts, be
18 it the release rates, be it the transport in the
19 unsaturated zone, saturated zone, all kinds of things can
20 be tested doing the what if calculations. That's also
21 very important.

22 You'll see some of these types of analyses and
23 ability as Dave Esh purported to tear apart the model in
24 the subsequent presentations.

25 In terms of the key aspects, we're estimating

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1 performance. First, deep percolation. How much water is
2 getting down to the repository level. Near field
3 conditions; what is the temperature, water chemistry, how
4 much water is getting to the waste package.

5 Degradation of the waste package, radionuclide
6 release rates, transporting the unsaturated zone, the
7 saturated zone, and finally, the exposure scenario.

8 I'll talk to each one of these, in terms of our
9 approach in the TPA Code, what's included, what isn't
10 included, in a very broad sense, and what our plans are
11 for potential improvements to the code.

12 First, deep percolation. I know one of the
13 interests of the committee has been what kind of coupled
14 processes, and I'll try to give a sense of what kind of
15 interactions we have within the code, what kind of
16 correlations, climate variation, certainly precipitation
17 and temperature are very important to what the shell
18 infiltration rate is.

19 We have both rows in the code. There's surface
20 features, the elevation, the thickness of the soil,
21 evaporation at the surface all contribute to what the
22 shallow infiltration is going to be.

23 Next, obviously the site is very heterogenous
24 at the surface. There's facial variation. We do account,
25 in a limited sense, on that facial variation, we do

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1 averaging over what we call sub-areas. We break the
2 repository into specific units.

3 It's primarily for efficiency purposes. We're
4 not going to simulate say, a very complex three
5 dimensional grid, but we do face it in sub-areas when we
6 represent the repository, it's infiltration, it's
7 temperature for a particular sub-area.

8 Right now, I think -- at one time, we had
9 seven. I think we're at ten now. It varies a little bit
10 that and those sub-areas vary depending on the
11 characteristics of the unsaturated zone and portable
12 aspects of the repository design.

13 And then there's a thermal reflux. We
14 certainly have to account for the thermal reflux. Right
15 now, that is primarily a temperature dependent process
16 that we use, a conduction only model for the mountain
17 scale, thermal temperature model.

18 The -- that particular one, we're not
19 accounting for the interaction between the temperature and
20 fluid flow, where we're looking at just conduction only.

21 There are the multi-flow code is used to
22 provide some additional parameters, in terms of how much
23 reflux we would expect to see and there is some parameters
24 that account for that, that are derived from multi-flow.
25 But right now, the temperature aspect, where the boiling

1 isotherm is based on a conduction only model.

2 In terms of what processes aren't included in
3 the deep percolation. Surface run-off and plant
4 transpiration, there is a pre-processor to our
5 infiltration that does try to consider the effects of run-
6 off and transpiration, but there isn't a very explicit
7 model for run-off and plant transpiration.

8 Non-vertical flow, as was brought up. Is there
9 some diversion that interfaces between layers above the
10 repository that would account for less infiltration in
11 some areas versus more infiltration than in other areas,
12 that's not accounted for.

13 And as I said, the explicit coupling of
14 temperature and fluid flow, it's -- we do some off-line
15 calculations in multi-flow to give us some sense of the
16 reflux, but there is an explicit modeling of fluid flow
17 and temperature within the code.

18 Right now, in terms of improvements, we don't
19 see any. However, you know, I would say, we clearly, as
20 you'll see, we're doing a lot of simulations with respect
21 to the non-isothermal conditions, and we certainly could
22 change some of the parameters within the code to simulate
23 different types of reflux conditions. But we aren't
24 anticipating any model changes. We'll still stick with
25 the particular conduction only model, and trying to

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1 represent reflux in a -- in this way, where we've
2 abstracted for multi-flow.

3 MR. GARRICK: Tim, is there deep percolation or
4 recharge anywhere except underneath the mountain? That
5 is, I'm thinking about the connection to your saturated
6 zone model?

7 MR. MCCARTIN: No, there's -- there are --
8 yeah. There's no --

9 MR. GARRICK: The only input of water is from
10 the mountain?

11 MR. MCCARTIN: Right, yeah. There's no
12 connection between the recharge and the saturated zone
13 flow.

14 Near field conditions, heat transport is
15 modeled in three scales; the mountain scale, the drift
16 scale, and the waste package scale to meet the temperature
17 at the waste package for porrosion. We need the
18 temperature and the spent fuel for dissolution rates. The
19 relative humidity is dependent on temperature.

20 Now, the effects of coupling of water chemistry
21 and flow and temperature is considered using specified
22 conditions. We will take -- right now, we'll have the
23 fluoride concentration is represented from a file that's
24 input from multi-flow. Multi-flow does a calculation to
25 see what the temperature -- what the fluoride concentrate

1 is, say at the drift wall.

2 We then have a multiplication factor to account
3 for, well, what would the chloride concentration be on the
4 waste package surface. It's a strict multiplier.

5 So there isn't this explicit coupling of the
6 water chemistry and the fluid flow, but we do have this
7 external file, and we do try to account for any increase
8 in chloride concentration. Currently, we believe that's
9 one of the more serious conditions for modeling the
10 corrosion of the waste package.

11 Things not included. Like I said, we don't
12 have explicit coupling of the water chemistry flow and
13 temperature. We don't have the effect of precipitation on
14 fluid flow during the thermal phase.

15 What if precipitation nears to drip (phon.)
16 occurs and precludes infiltration from coming in to the
17 direct. That's not accounted for.

18 Evaporative losses from -- of the thermal
19 output, and in that sense, the chemistry that -- like I
20 said, we have that multiplier, but there isn't an explicit
21 consideration of evaporation, where we just have a
22 straight multiplier, and just assume that the chloride
23 concentration is increased.

24 Planned improvements. Obviously, we -- you
25 heard yesterday some of the things with the waste package,

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1 there could be some trace elements that could cause
2 problems for the waste package.

3 Some of these chemistries we're looking into,
4 we think we'll be able to include other types of
5 chemistries into the TPA Code. But once again, there
6 wouldn't be this explicit coupling, but what we're trying
7 to do is, let's do some detailed modeling, let's look at
8 the problem, what are the kinds of conditions that we
9 think are going to cause problems to the waste package.
10 Include that condition into the code as an option to model
11 it this way.

12 And that's sort of what I'm talking about, to
13 explicitly model all the things that would go on, would
14 take a massive code. But we can be very smart in what we
15 choose to pull in, and like I said, the multi-flow code is
16 one code. Some of the experiments have done on the waste
17 package.

18 What kind of chemistry should we be worried
19 about. Let's get those effects into the code. Although,
20 it won't be directly tied to the flow per chance, but the
21 effect of increasing corrosion rates, we can get that in.
22 And I think that's how we'll deal with these -- the water
23 chemistry per se.

24 Degradation of the waste package. Right now,
25 our corrosion is dependent upon humidity, temperature and

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1 chloride concentration. Obviously, you saw the previous
2 life, why we have chloride concentration in the near
3 field. We have mechanical disruption, the rock fall,
4 fault movement. We have the drip shield.

5 The drip shield is included in our code, and
6 currently fairly simplistically, we do all flying modeling
7 in the sense of when the drip shield will fail. Can be
8 sampled, and so we have a failure time for the drip
9 shield.

10 When the drip shield isn't intact, the chloride
11 concentration on the surface of the waste package is not
12 increased. That chloride multi -- chloride concentration
13 multiplication factor is not used.

14 We also have juvenile failures. Processes not
15 included, once again, this explicit coupling of water
16 chemistry, flow, and temperature is not included.

17 Also, one of the things that we've thought
18 about, we don't think it's that important; however, we
19 continue to look at it, and are aware of it, and that
20 would be the effect of mechanical disruption on the
21 corrosion process.

22 Some rocks fall off the ceiling of the drift,
23 they hit the waste package, dent it, do some damage; does
24 that increase the corrosion at that particular point of
25 impact. Right now, we don't think that's important,

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1 that's why it's not in there. But certainly, it's one of
2 those things you want to be aware of, that you're not
3 considering, that could affect corrosion rates.

4 Planned improvements. Once again, we think we
5 need to include some additional water chemistries to
6 account for potential trace materials that could increase
7 the corrosion rates.

8 Two things though, the last two things for
9 planned improvements I probably should have put them up.
10 Also under processes currently not included, and I didn't
11 want to put it in both places, probably should have, but
12 one is we'd like to include stress corrosion cracking,
13 which is currently not in the code, and consideration of
14 weld and crevice corrosion, also in the code, that
15 currently is not there.

16 Radionuclide release rates. Obviously, there's
17 a -- once again, you get inside the waste package.
18 There's a lot of things that can go on.

19 Currently, we have four different release
20 models that we can -- in the code, that are dependent on
21 temperature of water chemistry. We aren't explicitly
22 coupling the water chemistry in all these four release
23 models. But what it is, it once again, somewhat like the
24 waste package, you have a particular condition that you're
25 worried about, or you want to represent or include what

1 the release rate is. For example, some silicon and
2 calcium and the bions in the water, et cetera.

3 So we're -- account for specific conditions,
4 and look at how that affects the release rate. We have
5 two waste package degradation modes, the back-up and the
6 flow through. Solubility limits, gap fraction and the
7 seepage is coupled to the thermal reflux.

8 When we look at -- the release rate is
9 dependent on how much water is getting into the waste
10 package. It is coupled to the thermal reflux.

11 One thing I would like to say, item number
12 four, the gap fraction, I think is a very important aspect
13 of the way we model the system, and iodine and technesium
14 both have gap fractions.

15 Iodine is pretty high. I believe it's six
16 percent. It's instantly available for release. That
17 means, once the waste package fails, six percent of the
18 iodine inventory is available for release.

19 When you look at how bad things could be,
20 clearly, having six percent of the inventory instantly
21 available, it can't get much worse than that. It's a
22 fairly rapid release rate, and a significant amount of the
23 gap fraction or of the overall inventory of iodine and I
24 think we're -- we've looked at those percentages. I think
25 that's an important parameter.

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1 In terms of processes not included in the code,
2 we don't have explicit inclusion of the water chemistry
3 inside the waste package. As I said, we have some
4 particular water chemistries we're accounting for, in
5 terms of the release rates. But we aren't modeling this -
6 - the coupled processes of what's going on inside.

7 The thermal affects on seepage, once again, in
8 terms of precipitation, if the -- if precipitation during
9 the thermal period of certain minerals and fractures and
10 in the matrix that shut off water into the drift, we
11 aren't accounting for that.

12 The affect of drift collapse on seepage, we are
13 accounting for that. Obviously we do try to account for
14 some diversion at the water at the drift, but as the drift
15 collapses over time, and rather than a smooth surface,
16 it's a more jagged surface, there could be a larger
17 perpensity for drips to occur, where rocks have fallen
18 off, we look out for that.

19 And we take no explicit consideration of coil
20 release. There are ways, as the developers of the code,
21 we can trick the code into simulating common and release,
22 but we don't explicitly consider that.

23 In terms of planned improvements, once again, I
24 think we tried to include -- look at including at
25 additional water chemistries, as we do more modeling. We

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1 see more data from the DOE, in terms of what are the
2 things that are going to cause problems, increase release
3 rates. We'd like to include different chemistries to
4 account for that.

5 Glass waste form. Right now we have just spent
6 fuel. We'd like to explicitly consider a blast waste
7 form, and coil release, we think we can include in the
8 code.

9 The unsaturated zone, obviously the fracture
10 versus matrix flow is important, we account for that.
11 Retardation, we also account for; although, right now,
12 when we run our code, we aren't accounting for retardation
13 in the fractures. And matrix diffusion, we have the
14 capabilities, but we rarely use it. Based upon our rather
15 rapid travel times in the unsaturated zone. It doesn't do
16 a lot, and it computationally takes up a lot of computer
17 time. So to date, we really haven't used it
18 significantly.

19 Processes not included. We don't include any
20 thermal effects on flow below the repository. Whatever
21 our deep proferlation rate is, we get some average rate,
22 and we use that for each of the sub-areas.

23 Diversion at layer interfaces, we have not
24 accounted for. Although, one could look at it, if you had
25 some 3-D models that showed, in particular, regions of the

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1 repository, that there was diversion of flow.

2 Say, you got to a particular layer, you went
3 horizontally for a while, and then went downwards
4 somewhere else, there's no reason NEFTRAN can't handle
5 that. In fact, NEFTRAN, the code we use for flow and
6 transport has been called a quasi 2-D model. It's a pipe
7 model. You can make your pipes go anywhere you want.

8 So there's no reason we can't include that. To
9 date, we have assumed predominantly -- well,

10 MR. GARRICK: Tim, why do you use the average
11 rates, when you could use some sort of distribution of
12 rates?

13 MR. MCCARTIN: Well, average in the sense for
14 each sub area, there's an average. And it is time
15 dependent. But we are explicitly -- we take a -- we do it
16 on a sub-area basis. To not do it that way, part of the
17 problem gets to just a mere computation problem.

18 MR. GARRICK: Of course, if the sub-areas are
19 small enough, that's okay.

20 MR. MCCARTIN: Right. You can certainly shrink
21 the sub-areas down, if one wants to, but --

22 MR. GARRICK: Yeah, okay.

23 MR. MCCARTIN: And then disruptive events, we
24 aren't including the effect of disruptive events on flow,
25 seismicity faulting, one could imagine, could cause some

1 perturbations to the flow system, that's not included.

2 Planned improvements. We're looking at
3 including the dependence of K_d 's on the water chemistry
4 and once again, adding colloid transport.

5 Saturated zone transport. Some of the same
6 things, fracture versus matrix flow. In the top, we're
7 assuming fracture flow. In the alluvium matrix flow,
8 retardation is primarily the alluvium and in the matrix
9 portion of the fractured path and -- we do account for
10 matrix diffusion in the saturated zone.

11 Variability in the flow path is considered. We
12 can make the extent of the alluvium, as little or as much
13 as we'd like, and that's where, in terms of the peer
14 review, they weren't happy with the support we had for the
15 -- our depiction of the saturated zone, but we feel with
16 the code, we can account for very short travel times, all
17 in fractured tuff, or slower transporting alluvium.

18 So we somewhat have the water front covered, in
19 terms of what can happen.

20 What exactly is the case that really is -- DOE
21 will need to come in and support that, but our code has
22 the capability to analyze the impact. And once again,
23 that's what we're trying to get with our code capability.
24 We -- the onus on DOE to come in with a licensed
25 application that provides performance assessment and they

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1 can defend. We need to analyze the -- and review what
2 they've done.

3 Planned improvements. Once again, we'll do the
4 Kd's on water chemistry, and add colloid transport.

5 Finally, exposure pathways. In the code, we
6 have variability in the wellhead dilution, basically the
7 volume of water that's pumped by the receptor group.

8 We have variability in the diet of the receptor
9 group, something we didn't have before, but we can account
10 for a range of different diets.

11 The irrigation for the locally produced crops
12 is coupled to precipitation. Obviously, as rainfall
13 increases, the amount of irrigation drops a little bit.
14 It isn't that significant in this particular environment.

15 We did couple it. It's one of those things you
16 put in, trying to see if it is a big effect.

17 Processes not included. The volcanic
18 disruption only considers the air pathway. When that
19 occurs, obviously, there's radioactive ash spread out over
20 a significant surface area. That water rainfall will
21 eventually go in there at leach radionuclides, eventually
22 to the water table. There could be some doses, due to
23 ground water. That's not included in the exposure
24 pathway. We were just counting on the air pathway that it
25 -- it's relatively -- fairly large. We think it isn't a

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1 big contributor, but it is not included.

2 We aren't looking at variability between
3 individual wells. Clearly, we have a receptor group that
4 one well isn't producing all the water means. There's a
5 variety of wells, concentrations, just heterojavium
6 (phon.) the area. The concentrations would be higher at
7 one well, lower in another. We think in terms of assuming
8 all the locally produced food is contaminated on average,
9 gets us a reasonable number, but we do not account for
10 that spacial variability in the plume. We do, as you
11 know, assume that the entire plume is intercepted by the
12 receptor group at 20 kilometers.

13 The question is, okay, that in a very short
14 nutshell was the -- some of the key aspects of the code.
15 How do we gain some confidence in performance assessment,
16 and I think there's three aspects to what we do.

17 Certainly, we're going to use the data and
18 observations that are out there to compare it to. Be it
19 laboratory field experiments, physical mathlaw (phon.)
20 analogs, to the best, to the extent we can.

21 We also use, I think the analytical approaches
22 and methods that we have as Dave Esh, tearing apart the
23 code, we have done over the years extensive evaluation of
24 the sensitivities, what matters, what doesn't matters --
25 doesn't matters -- that's not English.

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1 But the -- not only looking at the final
2 result, but the intermediate results, and the basis for
3 those intermediate results. And I think it's very
4 important. We've done -- and it's just not the parameter
5 sensitivity, looking at different conceptual models. And
6 we have a variety of ways to include different concepts
7 into the TPA Code.

8 In addition to, we have an importance analysis,
9 where we can pending grade, particular barriers, see what
10 the results are. I think all of that is part of that
11 process of understanding the code. That clearly is at the
12 heart of what we need to do.

13 Doing this work, I think helps us in looking at
14 DOE's results. We need to understand their code, why did
15 they get the results they did, and what does it mean.

16 There's certainly administrative controls that
17 we have. The Center has a configuration management
18 system, Top 18, the software and development and the
19 inputs, I think we keep a pretty good control of what
20 we've done, how we've changed it over the years, what was
21 the basis for the parameter selection, et cetera. And I
22 think that's all important.

23 And I would like to -- my next line is -- and I
24 know the committee has been interested in it, I think were
25 interested in it; how do you explain the results of this

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1 PA to other people?

2 When we talk amongst ourselves inside our
3 little cubicles at NRC, we're in up to our elbows into the
4 code, we don't necessarily require a lot of discussion as
5 to what's being done, because we sort of know it.

6 When we go out to talk to the public, talk to a
7 licensing board potentially, commissioner's assistants,
8 how do you explain the code. Why will people have
9 confidence in your results.

10 I think one of the keys is evaluation of the
11 subsystem performance, and I'll look at the influence of
12 seepage. What does it really mean? I think I'll look at
13 my code results.

14 How many waste packages get wet? When do they
15 get wet? How much water gets into the waste package. I
16 can explain that to people and show what our codes doing,
17 different concepts, how it will affect that particular
18 aspect.

19 The low rainfall, everyone's going to have a
20 good sense, gee, we get around six inches of rain here,
21 but walk through that, right now, for our code, the way we
22 run it, not seeing it's right, but on average, we have 50
23 percent of the waste packages getting wet.

24 I think you can tell that to someone, well,
25 okay, it can't get much worse, two times higher and it's

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1 all of them getting wet. And there's several things like
2 that that you can explain what it matters, and especially
3 for radionuclides like iodine, where it isn't dependent on
4 that much water, it's more how many packages get wet.

5 Because as I said, the gap release releases six
6 percent instantaneously. It isn't terribly solubility
7 limited, so you can get a sense of why the results come
8 off the way they do, what should I be worried about.

9 Going back to waste package degradation. We
10 will have a failure time for the waste package. Be it
11 5,000 years, 50,000 years, 500,000 years, whatever it is,
12 you can tell people the failure time is X. You better
13 have some understanding of the uncertainties and the basis
14 for that.

15 But people will understand the failure time and
16 certainly you have to count for the juvenile failures.
17 Things that, yeah, you intended to build it this way, the
18 properties weren't to be this way, but it just didn't work
19 out that way. And as you know, with our code on average,
20 I believe we have 35, 36 failed containers from the
21 beginning from T0.

22 Release of radionuclides. Once again, if you
23 have retardation, such that iodine technesium are the
24 primary nuclides getting out in the first 10,000 years.
25 Once again, we can look at the gap fraction, driving six

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1 percent instantly in one year, how much worse can it be.

2 And I think there's things like that, that you
3 can explain that will give people a sense why the results
4 came up the way they did, how much worse could it be,
5 which is what I think the public will be interested in.
6 What have you accounted for, what have you not accounted
7 for, et cetera. And then finally, transport in the
8 unsaturated and saturated zones.

9 You'll certainly have some idea, well, how long
10 did it take you. Again, from the repository to my
11 critical group, for retarded radionuclides, it's going to
12 be than 10,000 years. What is the reason you didn't see
13 those there, you better have a basis for the retardation
14 values.

15 If it's alluvium, how much alluvium, what
16 experiments have you done to look at the retardation
17 mechanisms. For other things, once again, iodine
18 technesium, to a limited extent, petitiun that aren't that
19 retarded.

20 Right now, for our code, based on -- merely
21 upon chlorine 36, we think there's certain some portion of
22 the flow system is fairly rapid. There's very little
23 hold-up in the unsaturated zone. There are a few subareas
24 that have significant thickness of Calco Hills venture
25 (phon.), where it's primarily matrix flow, and that is --

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1 that has a significant tie. It does delay things.

2 Then the saturated zone. There's certainly --
3 you can give people a sense of -- it's not going to be
4 instantaneous. We're at 20 kilometers. It's not going to
5 go from Yucca Mountain to 20 kilometers downgradient in
6 one year. Is a hundred years the right number? A
7 thousand?

8 But once again, you get a travel time. What's
9 your basis for it, et cetera. And I think as you walk
10 through, and I've thought about -- been thinking about a
11 way to explain that in approximately 30 to 45 minutes in a
12 very simple way, what the results of the code are, what
13 are the uncertainties, and how bad do we think it could
14 be. And just explain that in very simple terms, in travel
15 times, release rates, waste package lifetime, and the
16 number of packages of whatever filtration that I think
17 would give people a sense of why the numbers came up.

18 But understanding all those things, the basis
19 for them, et cetera, I think is how you ultimately will
20 provide a sense that indeed, the performance assessment is
21 giving you numbers that you have an understanding of
22 what's going on.

23 And in summary, I think the TPA Code gives us
24 an independent approach to review DOE's performance
25 assessment, looking at a lot of different things.

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1 We certainly expect to selectively probe the
2 DOE analyses, part of the risk informed aspect or certain
3 things that affect performance far more than other things,
4 and we'll certainly use the code results to help us there.
5 And I would maintain the confidence in the performance
6 estimates is obtained in a variety of ways.

7 And with that -- I went longer than I expected,
8 but I'll certainly be happy to answer questions.

9 MR. GARRICK: Thank you, Tim. We do have a
10 real challenge here. We have a tremendous number of
11 things on the agenda. We want to get through all of them,
12 and unfortunately, we're not going to have the opportunity
13 to discuss each of them to the level that maybe some of us
14 would like, but we're do our best.

15 We'll allow a few questions now and then take a
16 break. George, do you want to start off this time?

17 MR. HORNBERGER: I'll pass.

18 MR. GARRICK: I didn't mean to -- Milton?

19 MR. LEVENSON: Yeah, I have one. One of the
20 disadvantages is most of what we know is what people tell
21 us.

22 There are -- a couple of meetings ago, one of
23 the slides showed that the Navy field was not going to be
24 buried in C-22 canisters, but in stainless steel
25 canisters. Have you looked at that at all?

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1 MR. MCCARTIN: I thought the Navy field, and I
2 could be wrong on this, I thought it was going to be
3 inserted into a similar container.

4 MR. LEVENSON: That's my premise, but I --

5 MR. MCCARTIN: I'm seeing nods shaking, yes, so
6 I -- yeah.

7 MR. LEVENSON: Okay.

8 MR. WYMER: Well, I'm not going to be
9 intimidated, John. A couple of --

10 First, let me say your presentation was
11 excellent. I thought it was very --

12 I'm a little bit disturbed that the effect of
13 the in drift materials and chemistry has not been directly
14 fully addressed, particularly you mentioned calcium and
15 silicon, for example, being in the water. But as you
16 know, I'm sure, you will have a possibility of all kinds
17 of soluble formations, you'll have absorption on oxidized
18 iron, things like this and level of read-outs potentially
19 because of the materials in there, like the titanium.
20 Titanium 3 is a very strong reducing agent.

21 So that's not a question, that's just an
22 observation. It seems to me that's an area for
23 improvement.

24 MR. MCCARTIN: Absolutely, I agree. I mean, I
25 can't -- the code doesn't have it, so I can't blame that

1 it does. But I think we have recognized that -- and we're
2 in a constant source of development, and that's one of the
3 areas that we're looking at. But it's a fairly complex
4 problem. What is the right kind of chemistry include
5 there, and that's where I think we need to do more
6 detailed process level models to see well, what could
7 happen, and then try to abstract it in there. Because it
8 is such a complex problem. But --

9 MR. WYMER: Right. And my second and final
10 question, observation probably, is that you're not talking
11 about the water chemistry in the waste package, but how
12 about chemistry below the waste package when the water
13 starts passing through a lot of other reducing materials
14 and it quite dramatically change the nature of what
15 actually is then getting out and being transported. How
16 do you deal with that?

17 MR. MCCARTIN: Well, right now, the only thing
18 we have, we do have the invert, we account for transport
19 through the invert, which could have some properties, but
20 it doesn't account for say that the -- your water
21 chemistry is quite a bit different than the typical -- I
22 mean, it's got the things from the titanium drip shield,
23 the waste package, all kinds of stuff. You know, right
24 now, yes, that's another thing I'm --

25 MR. WYMER: That's going to have a

1 considerable, if not profound effect on what happens.

2 MR. MCCARTIN: Right.

3 MR. WYMER: Okay. That's just two
4 observations.

5 MR. GARRICK: Tim, picking up with just a
6 second on what Rod Ewing was talking about earlier.

7 One of the things, of course, that's very
8 interesting here would be to make comparisons between your
9 results and TSPA results. And there's some obvious points
10 at which comparisons can be made. And the most obvious is
11 the beginning and the end, what input data you're using
12 and what results you get.

13 But I think what's also important is to be able
14 to pick intermediate spots or pinch-points in the two
15 approaches, in spite of the fact that they're very
16 different, where you can compare results.

17 Are you attempting to do that, and where are
18 some of the critical -- what are some of the critical
19 intermediate results that you think lend themselves to
20 comparisons?

21 MR. MCCARTIN: Well, we certainly, even in the
22 VA, we attempted to take what DOE used as input and use it
23 in our code, to the extent practical.

24 Sometimes you have to tweak a model, some of
25 the data. Obviously they're developed by different

1 groups. Some of the models are slightly different. We
2 can try to represent things.

3 MR. GARRICK: I think that would be an example
4 of something that would instill confidence.

5 MR. MCCARTIN: Sure. And --

6 MR. GARRICK: To not just look at the beginning
7 and the end, but be able to look at what happens when you
8 begin to crank this stuff through a logic engine.

9 MR. MCCARTIN: Oh.

10 MR. GARRICK: And your logic will be different
11 than theirs, and if you get likely differing results,
12 that's one thing. If you get the same, that's another
13 thing.

14 MR. MCCARTIN: Right. And certainly, the
15 intermediate outlooks when we look at DOE's PA are
16 critical.

17 MR. GARRICK: Uh-huh.

18 MR. MCCARTIN: How many packages give what.

19 MR. GARRICK: Right.

20 MR. MCCARTIN: That is a critical aspect. How
21 much water actually gets into the waste package. They
22 have a particular patch model that determines that.
23 There's all those things, and you're absolutely right, the
24 intermediate outputs.

25 The only thing, I guess, I would preface it

1 with, is the fact that they -- we might match with our
2 code doesn't help DOE much.

3 MR. GARRICK: Yeah.

4 MR. MCCARTIN: That's nice. But ultimately,
5 it's what has -- what is the basis DOE's provided of why
6 their performance assessment provides a reasonable
7 representation for us to make a decision.

8 And certainly, you know, you're right, but just
9 the fact that we might compare isn't that or --

10 MR. GARRICK: Where I see this as being very
11 valuable, is in getting a better handle on the
12 uncertainties. Because the uncertainties will be
13 promulgated through the model in some systematic fashion
14 in both cases. And if you begin to ask your -- if
15 uncertainties begin to play a major role in the bottom
16 line results, then it becomes important to be able to back
17 track the results to where you might be able to do
18 something physically or mitigated-wise to deal with those
19 uncertainties. Or maybe it's just a modeling problem.

20 MR. MCCARTIN: Sure. Yeah.

21 MR. GARRICK: Yeah.

22 MR. MCCARTIN: Yeah, it's -- and I'll say
23 probably the healthiest aspect of the performance
24 assessment between ourselves and DOE is the fact that
25 we're -- we share results, we interact. We like to

1 understand, well, how did they get that result. We don't
2 necessarily see that in our code.

3 And I'll give you a prime example of that. The
4 release, which is incredibly important obviously, we get
5 similar kinds of numbers for drastically different
6 reasons.

7 MR. GARRICK: Yeah. Well, the way I would
8 characterize that is the source term.

9 MR. MCCARTIN: Yeah.

10 MR. GARRICK: Yeah. And that's -- you know,
11 that's where the ballgame is, is what kind of source term
12 you're reading in here.

13 MR. MCCARTIN: Right.

14 MR. GARRICK: Okay. Rod?

15 MR. EWING: Just one brief comment following up
16 Ray's comment. I noted, as Ray did, that the water
17 chemistry inside the waste package is not considered
18 corrosion products, et cetera. And that's not a planned
19 improvement, but I wanted to point out, that will, in
20 fact, have a profound effect on less wasteful on release,
21 formation and ability. Even the discussions of
22 criticality depend on what's going on in the waste package
23 and the corrosion products.

24 So -- and it's a longer discussion, but it
25 seems to me some of the planned improvements may not be

1 possible without assess of the processes that aren't in
2 the list finally being on the list.

3 MR. MCCARTIN: Well, I would say that some of
4 those corrosion products could be. When I included the
5 additional chemistries, part of that would be we would
6 include specific chemistries that affect the release
7 rates, which I think would hopefully -- if it appears a
8 significant effect, would account for corrosion products,
9 the less waste form clearly is different kinds of things
10 that will be occurring and don't have the model.

11 MR. EWING: Right.

12 MR. GARRICK: Jim?

13 MR. LESLIE: Tim, this is Bret. I'd like to
14 try to amplify his response. What we're looking at -- and
15 also to reflect something of what Ray said. What we're
16 looking at in terms of including new capabilities for the
17 code, are those things that would detract performance?

18 The licensee is perfectly capable of deciding
19 what they want to take credit for. And for instance, they
20 want to try to take credit for all that mass absorption,
21 then they would have to provide the database.

22 We have that capability currently to do it, but
23 it's not our responsibility to determine what their
24 licensing safety key should be.

25 So while there might be a lot of great

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1 chemistry that could enhance performance, we're not going
2 to add to the code until the DOE suggests that they're
3 going to take credit for.

4 MR. WYMER: Bret, I would say that just so you
5 have the capability of addressing it if DOE decides to,
6 that's all that really is necessary to ensure that you
7 have the capability.

8 MR. LESLIE: And we have that capability in the
9 invert model already. We just -- we don't use it, because
10 they take zero retardation in the engineer vario-system.

11 MR. GARRICK: Jim?

12 MR. CLARK: I'd just like to support what John
13 said yesterday. I suggested maybe a look at uncertainty
14 and what they're doing, and as a way of checking
15 consistency and identifying areas of concern, and there
16 would be a, I think, very useful thing for you to guys to
17 do as well. And to looking towards the day when you have
18 two models with results which may understandably differ
19 for good reasons, and support each other for other
20 reasons. Just that whole topic of how uncertainty is
21 handled, I think is going to be very important.

22 MR. MCCARTIN: I would agree. And hopefully
23 Dave Esh will be presenting some of the sensitivity
24 analyses that we've done that might provide a little more
25 information.

1 MR. GARRICK: All right. According to the
2 clock, our break is over. Thanks, Tim, that was very
3 good.

4 All right. Let's take a break, and let's keep
5 it, if we can, to ten minutes. Thank you.

6 (A break was held at this time.)

7 MR. GARRICK: All right. Moving right along.
8 Our first speaker this afternoon, and we're now talking
9 about the session that's labeled, capability of NRC staff
10 to evaluate risk significance of information submitted by
11 DOE for postclosure. And the lead off speaker will be
12 David Esh. And I'd like each speaker to just briefly say
13 who they are and the organization they represent, and the
14 work they've been doing.

15 MR. ESH: I'm David Esh. I'm in the
16 Environmental and Performance Assessment Branch of the
17 NRC. And I came there from Argon National Laboratory, and
18 I work primarily on the TPA Code, but pretty much anything
19 related to performance assessment.

20 And I'm going to talk to you about kind of the
21 analytical analyses, methods and techniques that we do in
22 performance assessment, which is some of the things we
23 discussed earlier.

24 Do we believe what the code is generating?
25 Does it make sense? You know, that type of analyses is

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1 really what I'm going to talk about today.

2 This little picture here is just kind of how I
3 view or how maybe we view how performance assessment
4 fights into high level waste. And as somebody pointed out
5 to me earlier, this may imply that it's endlessly
6 cyclable, but that's not the impression I want it to give.
7 But these are the main components from a PA perspective
8 that we do.

9 And I'm going to talk about the bottom line
10 importance and sensitivity analyses, but they all relate,
11 they all influence one another. It's kind of the program
12 is coupled, to use a key word.

13 Why do we do this? Well, one of the main
14 reasons that we do this is, it's a crucial step in
15 implementing the risk-informed, and performance based
16 regulations in high level waste, because you can't really
17 do that unless you know this thing matters more than this
18 thing. Or this thing I need to worry about, and this
19 thing I don't need to worry about.

20 So that's one of the main reasons why we go at
21 it, and I also want to highlight the second bullet here,
22 which is we can evaluate the impact of uncertainties that
23 are not in the model, by doing analyses, stressing things
24 further than what we expect, being creative with our
25 analyses.

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1 So sometimes you can address some of the
2 concerns. You know, maybe it's a patch to a problem that
3 might not be very agreeable to some people, but it is a
4 somewhat of a solution, and you can just judge for
5 yourself when you see some of the things that we can do,
6 and some of the things that we would expect the DOE to
7 potentially do.

8 But we need to evaluate the risk significance
9 information submitted to us by the DOE. That's the key
10 goal here. So we do this analyses, we compare it to that
11 information that they will give to us, and we'll say, you
12 know, yeah, we believe that. Yeah, this thing is
13 important, this thing is not important.

14 And by independently doing this analysis, we
15 also developed the questions that we should ask about the
16 methodology. You know, I'm going to show you first off
17 some importance analyses, and one of the key questions
18 there is, how much the level of under performance you
19 assign to a barrier.

20 So the importance analyses, I called them
21 subsystem under performance, they're really ISI's kind of,
22 and ISI's are integrated subissues for -- if we didn't
23 identify that accurate earlier with our acronym.

24 But there's two types here that I'm going to
25 talk about, and feel free to interrupt me at any time and

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1 ask questions.

2 One is, we want to -- the first type of
3 analyses is evaluate the significance of a subsystem, and
4 you're kind of asking the question at least, what I
5 thought about this and when we did this is, what if I'm
6 wrong about this. You know, how wrong can I be is kind of
7 what you're getting at.

8 And they have a couple of options here about
9 how you can do this analyses. The justification needed
10 for level of under-performance. Well, you could -- say
11 you have a parameter, I and I retardation and alluvium,
12 and it has a value of like five to ten for the retardation
13 factor.

14 Well, you could under-perform that, set that at
15 like 5.5, and maybe say, that's an under performance,
16 because my speculated value is going to be 7.5.

17 Or you could say, well, I'm going to set it at
18 three, take it outside of the distribution, that's an
19 under performance, because maybe there's some
20 uncertainties related to iodine retardation that aren't in
21 the model.

22 What if you take a -- you completely neutralize
23 it, set it to one. Iodine's going to move at the speed of
24 water.

25 So what we tried to do in this analyses, is we

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1 felt somewhere in between. We didn't operate within the
2 probability distribution functions, we didn't completely
3 neutralize things. Because, in my opinion, the complete
4 neutralization, while you may get an answer, it's not
5 really meaningful. Because some of the -- you can't
6 physically get as bad as you can if you take something out
7 completely.

8 What it was, if you operate within the
9 probability distribution functions from many parameters or
10 subsystems, you might not be completely addressing the
11 uncertainties that aren't in those parts of the code or in
12 the model.

13 So I call those one-off, but they're really
14 everything's working as you would expect, and then one
15 part of it is under-performing, so it's not completely
16 out, it's just under-performing.

17 And then the same thing likewise, would be one-
18 on calculations, they're self-explanatory. Nothing is
19 working except for that one piece, and you get slightly
20 different answers and we'll see that there.

21 On page five is the acronyms that we used. I
22 just did that to simplify the figures, so you can refer
23 back to it if you need to. Hopefully, they're somewhat
24 explanatory.

25 I did notice an error. In the figures, I used

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1 "Bio" for the things related to the biosphere and here I
2 identify Dose, so just be aware of that.

3 Okay. But here's some results from under
4 performing different subsystems with a nominal scenario.
5 And what you can see from this is, when we under perform
6 the engineered system, the Ace package and the drift
7 shield, that is the largest response.

8 It's kind of like we have this old radio or
9 whatever, and we're turning the knobs and we want to see
10 when we turn the knob so much, whether we get a clear
11 signal from the station or not. I don't know whether
12 that's a good analogy.

13 That's kind of the way I think of this. We're
14 tripping all these knobs and we want to see what happens.
15 And what we see happening here, is we're getting a lot of
16 performance out of the engineered system, duh, we already
17 knew that.

18 Well pumping, actually get quite a bit. How
19 much the critical group is pumping, whether it's a farming
20 scenario, residential scenario, a lot of work went into
21 defining the well pumping scenario and the development of
22 the regulation, and I think they felt they chose
23 conservative options when they developed that.

24 So this is even -- maybe we shouldn't even
25 evaluate well pumping, because they already conservatively

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1 set that. But I did that anyway just for completeness.

2 The saturated zone, SZ1, SZ2 --

3 MR. WYMER: These are in 10,000 units?

4 MR. ESH: These are in 10,000 units, yes. And
5 these are peak of the mean though, stock mean of the peak.
6 So it's what we regulate on.

7 The critical group, transform the saturated
8 zone, well pumping and waste package, engineer barrier
9 system and conduct is what it boils down. For -- this is
10 kind of how our model is working, and the phenomenal
11 scenario.

12 The one-on evaluation is basically nothing is
13 working, and you compare that one of these things is
14 working, and see how much it can reduce your dose.

15 Of course, when nothing is working, your doses
16 are quite large, but what you kind of see is that the
17 engineered barrier system, the well pumping will get you a
18 lot. But then also, the radionuclide release rates and
19 solubility limits, and the quantity and chemistry of
20 water.

21 Now, the interesting thing here when I did
22 this, was saturated zone one and two, while in the flow
23 and transport in the unsaturated zone don't show up really
24 as getting you a whole lot. And that's because in
25 isolation, they don't get you a whole lot.

1 Flow-through porous media doesn't get you a
2 lot. Retardation and fracture of media doesn't get you a
3 lot. You need flow and transport through porous media to
4 get you a lot in our model. Now, this is based on our
5 model.

6 So I did that calculation where I turned on
7 both saturated zone flow and saturated zone transport at
8 the same time, and you got a production dose of about 200.
9 So that's -- that type of thing is the type of thing that
10 we hope to identify in this analyses, so that DOE does
11 analyses and presents information to us. We know what
12 questions to ask them.

13 And Dick Codell has been working on an
14 extension of this, and I'll talk about that later using
15 the factorial design to maybe pull -- more fully evaluate
16 the problem.

17 MR. GARRICK: Now, Dave, when you do this
18 turning on and off, and you're talking about something
19 like flow, I can see how you don't have to change much
20 downstream --

21 MR. ESH: Sure.

22 MR. GARRICK: -- in the model. But if you turn
23 off something like an engineer barrier, like the drift
24 shield or the invert, --

25 MR. ESH: Sure.

1 MR. GARRICK: -- where it might have a major
2 impact on the chemistry that takes place during the source
3 term development stage. Do you account for the downstream
4 effects of the off-condition, or are they treated
5 separately -- differently than they were before?

6 MR. ESH: I did try to take account for that.
7 For instance, like in the flow factors, how much water did
8 this perforating in this uniform sense, how it gets
9 modified and what gets into the drift.

10 We have a number of components that define
11 that, and like one of them is a large scale focusing,
12 diversion or focusing phenomena that we say could happen
13 due to the UZ geology. That's one component.

14 Then there are four other main components to
15 that. One is a capillary diversion at the surface of the
16 drift, one is film-flow in the surface of the drift. One
17 is the effect of corrosion products within the partially
18 failed package, preventing water getting in. And then
19 there's also the effect of the intact package itself, the
20 extent of the degradation of the package.

21 Well, if I go to neutralize the package, then I
22 can't be taken credit for --

23 MR. GARRICK: That's right.

24 MR. ESH: -- it's still diverting some of the
25 water.

1 Now, maybe we can argue otherwise and say, if I
2 want to look at these things in kind of a theoretical
3 sense, what could it do, then I still leave that phenomena
4 in there. Maybe you wouldn't, you know.

5 It takes some thought, I think, on the
6 analyst's part to make sure they don't create those
7 problems. And they're also trying to be cognizant of how
8 you should do the analysis, you know, you just don't
9 blindly take -- turn things on and off and, you know.

10 Let's go back a second to the slide before
11 this.

12 Now, one thing I would highlight here, and I
13 think I mentioned it later. Where we say, well, okay, we
14 need to worry about engineer barrier system and well-com
15 bay and saturated zone biosphere. Well, no, not really,
16 because how do you get the NG1 to this state. This state
17 was characterized by the drift shield failed between 50
18 and 1,000 years with a mean of 500. The waste package
19 failed between 1,500 and 3,500 years, I think, with a mean
20 of 2,500.

21 Some sort of, well, yeah, I could -- the
22 reasoned argument, maybe you could get this performance
23 out of it, because we do expect the repository to be dry
24 for roughly 1,500 years, due to the thermohydrology.

25 So it's unlikely you could -- is it physically

1 reasonable? It could fail all the packages times zero,
2 and I would say no, but then you start running into, well,
3 what could you have happen, and to what extent.

4 But the mechanism to get widespread failure of
5 the engineer barrier system in early time, is either via
6 aggressive chemistry or maybe mechanical. We already have
7 mechanical effects in the model. Maybe there are some
8 sources of uncertainty in the mechanical model that we
9 need to further evaluate. We continually do that.

10 But really, it would require aggressive
11 chemistries that say you didn't test yet under chemistries
12 you didn't expect. Maybe you have thermohydrological
13 processes that react to the rock. That, in combination,
14 decrees the grout around the rock bolts, well, the rock
15 bolts also degrade, they create this chemical see (phon.),
16 that gets to the waste package and then you have
17 evaporation of the water, you form crazy salts, and you
18 know, it gets really complex, and I think that's what Dr.
19 Wymer was getting at earlier.

20 At least maybe we're working on that, a group
21 of us and PA, and a number of people at the center, to try
22 to more fully evaluate all those permeations of chemistry
23 we may get and what that means for these surfaces of these
24 materials.

25 So if you look at the analysis blindly and say,

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1 well, you know, I'm only worried about these three things,
2 so not worry. Not really. You know, you need to use some
3 thought even when you look at the results of the analyses.

4 MR. GARRICK: And you're doing that?

5 MR. ESH: And we're doing that, yes. And
6 that's what we -- what we would hope is DOE does analyses
7 like this, and we can understand from them how their
8 models are working, what we should worry about, you know,
9 questions we should ask.

10 It doesn't address the question -- well, in a
11 way it does. Most of these under performances are way
12 outside of the probability distribution function. So like
13 when you look back here at say, UZ transport, all the
14 distribution code emissions are set to zero. No
15 retardation of anything in the UZ.

16 Obviously, you're going to have some
17 retardation of highly sorbing species in the UZ to some
18 degree, no matter what. Maybe you're not going to have a
19 retardation factor of 100,000, but you don't need it. You
20 know, maybe you're going to get 50 or 100 at least.

21 So many of these analyses were really stressing
22 this thing hard, and this is the picture that you get from
23 that.

24 MR. WYMER: I don't have an understanding of
25 this one-on concept. Suppose you just turn one thing on,

1 like mechanical disruption of engineer barriers. Does
2 that mean that there is instantaneous transport of the
3 radionuclides from the drift, the 20 kilometers, there's
4 nothing in between retarding anything?

5 MR. ESH: No. Say like what you're doing in a
6 one-on and say I only have waste package working. The
7 waste package -- or waste package and drift shield. The
8 waste packages and drift shields are working as we expect
9 them in our nominal case model.

10 Everything else is under-performed, but they're
11 still working. So like you may have a minimal travel time
12 through the UZ. You may have a minimal travel time
13 through the SZ.

14 MR. WYMER: So you put them --

15 MR. ESH: You still have the wells pumping at a
16 residential community rate instead of a farming community
17 rate, you know, --

18 MR. WYMER: Things don't go to zero at one
19 time?

20 MR. ESH: They don't go to zero, no.

21 MR. WYMER: Yeah. I think at one time, the
22 concept was you turn things totally off, and that really
23 is not sensible at all.

24 MR. ESH: Well, that's what I thought. I felt
25 like, well, it's nonsense. Well, sure, I can generate

1 some numbers, but what do they mean. So I tried to do
2 something I thought well, it's still not maybe sensible,
3 depending from your viewpoint, you know. But at least,
4 from my viewpoint, it's somewhat less sensible.

5 MR. WYMER: One more question. UZ1 is
6 described as climate and infiltration. What do you mean
7 one-on and one-off in that case?

8 MR. ESH: So when climate and infiltration is
9 working, we have the infiltration rate, it's between a
10 uniformed distribution of one to ten millimeters per year.
11 When it's off, it was set to I think 30 millimeters per
12 year. So three times higher than the maximum value was
13 how it was under performing.

14 MR. WYMER: It held at that constant value?

15 MR. ESH: Yeah. You could assign a range to
16 it. You could do a number of things, you know. It's
17 subjective, but I tried to use some sort of reason.

18 That wasn't the only thing though, like there's
19 a number of climate parameters. These are subsystems, so
20 there's a lot of parameters that were all tweaked at the
21 same time, not just one parameter. So it may have been --
22 there's a parameter that defines the climate cycle and how
23 much infiltration you get based on the temperature
24 changes. That was altered. You know, a number of things
25 were all changed at the same time.

1 MR. EWING: So it's essentially on and off
2 between climate extremes wet/dry?

3 MR. ESH: Yeah. But all things are not equal
4 in terms of importance and nor would you expect that in a
5 natural system. Some things are going to be more
6 important than others.

7 The level of under performance selected as
8 important. Of course, like for some of those things that
9 didn't show much effect, they're practically -- they were
10 practically taken out of the analyses, so I can't under
11 perform them anymore and show much of an effect.

12 The waste package and drift shield, I couldn't
13 under perform it more, and I did that calculation, setting
14 them both -- taken out at times zero and I still only got
15 a D3 mills, like a 32 milligram or something like that.

16 I talked about the consideration for quantity
17 and chemistry, and you get different answers, kind of
18 depending on what type of analyses you do. And I'm going
19 to move on to the sensitivity analyses, it's another set
20 of different answers.

21 And so what we basically did with sensitivity
22 analyses is we want to evaluate which parameters or
23 subsystems are contributing to variability and the output.
24 It's kind of traditional.

25 I think both Dick Codell and Sid Metacalantha

1 (phon.) have talked to you in the past about a lot of
2 their work that they found in this area, and it's really
3 good work. Neither of them were able to be here today, so
4 I'm going to talk a little bit about where we're going in
5 that area and some analyses we did at the substance of
6 multi sensitivity.

7 But these are kind of with inside the model
8 then which things are contributing the variability and the
9 output, that's what this analysis is going to show.

10 We evaluated a number of techniques. We
11 settled on one that's tended to yield the most stable
12 results, and I'll comment on that in a slide coming up
13 here.

14 Basically, we generate a CDF of our nominal
15 response, then if we want to look at say, climate and
16 infiltration, we'll set all the climate and infiltration
17 parameters to their mean values with a very small
18 distribution, a very small range to preserve the random
19 number sampling, and then we rerun the calculation, and if
20 it changes the CDF, then that subsystem is contributing
21 significantly to the sensitivity.

22 If the CDF's are the same, that subsystem is
23 not contributing to the sensitivity. Each of these runs
24 are full Monte Carlo's with thousand vectors, and
25 actually, I tried to -- I started looking into well, can I

1 make the conclusion of this guy is more -- say, NG1 is
2 more sensitive than BIO1, for instance.

3 And to do that, I had to look at the stability
4 of the results, and so I ran the analysis three times
5 through with different random number sampling, 1,000
6 vectors per simulation, and I developed those computations
7 and -- not at statistical confidence intervals, but I can
8 kind of look at the data and see it's highly unlikely that
9 doing this analysis, the results are going to fall outside
10 of those ranges. And I ran it up to 50,000 years to try
11 to see if things made sense, based on how the model.

12 So this figure, I hope you appreciate, is --
13 represents like 40 days of computer time. So this -- we
14 talk about complexity in adding things in and, you know,
15 you started running into a cost benefit where things get
16 prohibitive. So you have to try to preserve the
17 uncertainty and all the underlying phenomena processes,
18 but still make it runnable so that you can do analyses and
19 make sense of it. And that's the constant battle that we
20 have.

21 So this figure is a lot of computer time, and
22 what you see is the engineered system, and some things in
23 the near field, one in chemistry, your release rates and
24 solubility, climate and infiltration, saturated zone flow
25 and transport, well pumping, and placed that on a critical

1 group, all contributed to the sensitivity in 10,000 years.

2 And then, I did a lot of further analyses to
3 explain why things would decrease from 10,000 years to
4 50,000 years, and a lot of that is contained in the back-
5 up slides, which we would be -- I would be happy to
6 discuss, I mean, if that would -- for instance, why the
7 Brendon Clyde (phon.) transport, lower transport in the
8 UZ's show up as doing a lot, either in the importance
9 analyses, or in the sensitivity analyses.

10 One of those is contained in the backup slides,
11 and maybe if we have time, which I doubt, we can look at
12 those.

13 We'd also do sensitivity analyses at the
14 parameter level. And this is a lot of what was reported
15 to you in the past.

16 That analysis is ongoing for the SR case, the
17 new design, the new parameter values, et cetera. And
18 generally, applying the same methods which were used in
19 the VA, and basically, a number of different techniques
20 listed here were all evaluated, and then the number of
21 times a parameter was identified as being sensitive with
22 each of those techniques, say like, juvenile failures
23 shows up with all six of the techniques that received this
24 six of six.

25 And then using that procedure with every

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1 parameter in the TPA Code, they just filled out basically
2 in the GA, 19 parameters were identified as being pretty
3 sensitive.

4 Where some things that Dick wanted to talk
5 about, but he was not here and he was unable to, are the
6 factorial design and neuro networks, which is what I'll go
7 in to now.

8 MR. CODELL: I'm on the line?

9 MR. GARRICK: Yes, San Antonio. Richard Codell
10 from the speaker phone.

11 MR. ESH: Oh, good.

12 MR. CODELL: From Washington. I just wanted to
13 tell you I was here.

14 MR. ESH: All right, Dick. Thanks.

15 MR. CODELL: Okay.

16 MR. ESH: So the factorial design was spurred
17 because DOE intends -- or they expressed the intention to
18 us to evaluate parameters of the fifth and ninety-fifth
19 percentiles and use that as a way to identify which
20 parameters are sensitive.

21 And, of course, a complete sampling of all
22 combinations requires them to be M samples where M is the
23 number of samples for parameter 2 and 3, and N is the
24 number of sample parameters.

25 So you have a lot of parameters and you want to

1 look at a couple of states, you end up with a very large
2 number of permutations in a hurry.

3 So Dick did a lot of analyses with factorial
4 design, to see if he could do partial factorials, and what
5 he could still identify the sensitive parameters. And
6 within our computational budget, which is a concern for
7 us.

8 And here the main advantages and disadvantages.
9 Advantages, rich literature, less ambiguous than Monte
10 Carlo and allows an easier analysis. Multi-parameter
11 sensitivities, which is one of the things that we didn't
12 do DOE on.

13 Disadvantages of factorial methods are really
14 having only two samples per parameters, honestly effects
15 that might be important in the middle of the range, and
16 use three at a price, but that price accelerates very
17 rapidly when you have a lot of parameters.

18 And if you do a less than full factorial, then
19 you might get confounding of say, single parameter facts
20 with multiple parameter effects, et cetera.

21 But the simple model is this, and he designed
22 it to be -- to give them highly skewed results, which is
23 what we get from the TPA Code. And it's just really
24 simple, we wanted to test the method, and see whether it'd
25 be able to fly it with the TPA Code, and so he got a

1 source term at M curies, and all these ten parameters were
2 represented by uniform distributions.

3 At M curies at fail time T fail at a half 1,000
4 years, the number of different transport properties, and a
5 couple of properties for their receptor model. And two of
6 the transfer of properties were selected to have no
7 effect, so that he could see whether the technique would
8 identify those which weren't sensitive.

9 And you may say, well -- I asked him the same
10 question. Well, why wouldn't the effect of porosity have
11 an effect, but it was the way he abstracted it with the
12 mass transport that it would have truly no effect in the
13 model.

14 And the results are shown here with these bar
15 charts. Basically, he did the full factorial, which
16 required 1,024 runs, and he identifies sensitivity of the
17 various parameters, and these are the two that were
18 selected to be insensitive were, in fact, identified as
19 being insensitive in the analysis.

20 Then he did a number of different partial
21 factorials, and concluded that you can still identify the
22 sensitive parameters with the partial factorials, but you
23 start running into confounding effects as I mentioned
24 earlier, and you might -- if you reduce it too much, you
25 might make inaccurate conclusions about what is sensitive

1 and what is not sensitive.

2 He's compared the results of the factorial
3 analysis with LHS, concluded the factorials at a reduced
4 factorial state was better able to identify sensitivities
5 than the LHS method would be.

6 So that -- basically, this is a summary of that
7 comparison of the factorial and shows good results.
8 Comparisons between the factorial and LHS showed the
9 ability of the latter deteriorating greatly, for fewer
10 rocks containing the back-up slides.

11 And also he did a lot of work with the
12 parameter trees identifying what sequence of parameters or
13 a combination of those parameters lead to the highest
14 doses. That's something that the regulator is concerned
15 with.

16 And he wanted to state that the ANOVA
17 techniques can easily be applied to the results of these
18 calculations.

19 So our path forward is kind of -- is developing
20 this design or to say we're developing this design for all
21 our sample parameters, or a lot of sample parameters,
22 which is around 300, a question that Rod asked earlier,
23 how many sample parameters we have.

24 And basically, the full factorial. For the
25 system under performances that I talked about earlier,

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1 what I was concerned about was the effect of multiple
2 under performances for multiple things on at the same
3 time, which ones of those -- which combinations give you
4 the biggest effect. And we can do that analyses, too,
5 with this factorial design.

6 The full factorial would take like 2,048 runs,
7 which would be too much for us. But the partial or the
8 combining flow and transport, taking it down to seven
9 subsystems would give us, I think, 128 runs, which we
10 could easily do, would just take a little bit of computer
11 time.

12 But that's what we're headed with the
13 sensitivity analyses. And the main conclusions from all
14 of this, is that the code I think is flexible enough for
15 us to do our job.

16 Sometimes you've got to think and use your
17 brain, too, when you do this sort of stuff, so that's why
18 I wanted to highlight it and that's what we'd expect from
19 the license applicants.

20 And it's important to do a number of different
21 things to understand, because you get different answers,
22 and you also want to be cautious about the conclusions
23 that you make, so if something isn't in the model, of
24 course, you can't see it, no matter how much you take the
25 model apart, you can't see that effect.

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1 You can do that, to some extent, but under
2 performance could say, well, this is the effect, it's not
3 in the model, it's going to result in an under performance
4 of this type, and then you can, in a way, identify what
5 the impact would be.

6 Tim McCartin is going to talk about the last
7 presentation of this segment, pro-active and reactive uses
8 of risk information in high level waste project, which is
9 something you've asked about.

10 And my last main conclusion is that if you
11 focus on these key parts, and you have a finite amount of
12 effort available, you're going to necessarily most
13 adequately protect public health and reduce unnecessary
14 regulatory burden. If you had an infinite budget, then,
15 of course, you could study all these things, and as not,
16 that isn't realistic either, so.

17 There are a number of slides in the back-up
18 that we can talk about if you'd like. I'll open the floor
19 for questions now if you have any additional.

20 MR. GARRICK: Okay. Milt?

21 MR. LEVENSON: No.

22 MR. GARRICK: Ray?

23 MR. WYMER: No.

24 MR. GARRICK: What's happened. George?

25 MR. HORNBERGER: Dave, some of your sensitivity

1 results, for example, your slide on page six where you did
2 your one-off show a really big bar for the engineering
3 subsystem, ENGL, okay. And some people when they see
4 these kinds of results will immediately infer that what
5 that means is that the engineered barrier is the only
6 thing that is securing the waste at Yucca Mountain.

7 How do you respond when somebody infers that
8 and asks you a question on it?

9 MR. ESH: Certainly it's contributing a lot
10 more into the performance, but if it was the only thing,
11 this number, this 25 would be much, much larger than
12 what's shown on the figure, it was the only thing.

13 So I didn't show those values specifically on
14 the one-on, I don't think I converted it in a factor, but
15 the doses are much, much larger than that. If you only
16 have one thing, say, engineer barrier system, when you
17 turn it off, you're going to get a much, much larger dose
18 than 25 millimount.

19 MR. HORNBERGER: So you're confident that the
20 kind of analyses that you have done and have planned will
21 be adequate for investigating the level of contribution of
22 different systems to the overall performance?

23 MR. ESH: What I would expect is, you know, we
24 do this analyses to try to understand what should be
25 considered while you're doing the analyses, and how things

1 are working.

2 I think we would expect from a license
3 applicant, that they would do whatever analyses they think
4 are appropriate, and they would make a justification for
5 why they are identifying which things are contributing for
6 and how they're contributing, et cetera.

7 So like in the figure six where the unsaturated
8 zone isn't showing much, that's because this -- for
9 nominal cases, what Tim highlighted on earlier, we're
10 primarily looking at iodine and technisim getting out,
11 99.9 percent in 10,000 years is iodine and technism
12 chloride. Everything else is retarded.

13 And a lot of it is retarded in the unsaturated
14 zone. So it is contributing to a barrier, but it's not
15 contributing to the things that are showing up as risks in
16 our analyses.

17 So you can look at the problem a number of
18 different ways, and come to different conclusions, and
19 that's what I would stress is you do as much analysis as
20 you can to allow somebody else to make their conclusions
21 about how things are working, and not just do say, one
22 analyses and say, this is what it is. Because you get
23 different answers on how --

24 MR. GARRICK: In the middle of your
25 conversation or your presentation, you dropped a number of

1 32 milliram.

2 MR. ESH: Yeah.

3 MR. GARRICK: Per year. What was that for?

4 For --

5 MR. ESH: That was when I failed all of the
6 waste packages and drift shields at times zero.

7 MR. GARRICK: Failed all of the waste packages
8 at drift shield?

9 MR. ESH: At times zero.

10 MR. GARRICK: Now is that -- was that result a
11 surprise?

12 MR. ESH: It was a surprise it wasn't higher
13 than that.

14 MR. GARRICK: Yes, I'm impressed with that
15 number. Why are we spending the money we're spending to
16 build -- to design this? That is an impressive result.

17 MR. ESH: Well, you know, I would like to see
18 that result from the DOE and see what that number is.

19 MR. GARRICK: Yes. Yes.

20 MR. ESH: Certainly, that would be a good
21 comparison.

22 MR. GARRICK: Yeah, okay.

23 MR. ESH: But, yeah, it's not a question for me
24 to answer.

25 MR. GARRICK: I understand. Okay. Rod?

1 MR. EWING: Going back to the parameter
2 unsaturated zone one, where you have wet and dry climate,
3 why does it have such a small effect?

4 MR. GARRICK: It has a small effect basically
5 because the engineered barrier system, retardation and the
6 unsaturated zone, the well pumping, or retardation flow
7 and transport in the saturated zone, and well pumping are
8 all still working. You know, when you have that under
9 performance of the climate.

10 So the climate may be changing flow, and it may
11 be increasing the amount of water that are getting to the
12 packages, but you're still in that 35 packages failed. So
13 you can't -- even though you under perform climate, you're
14 still only able to release from those 35 packages that
15 have failed. Because that's why you see it really doesn't
16 have a large effect on this type of analyses.

17 Now, if you do the -- I'm sorry. If you do the
18 full factorial, you may see the climate has a bigger
19 effect when you start getting to those combinations of
20 things, turned on or off. You might --

21 MR. EWING: You know, going back to George's
22 question though, isn't this the answer that I think you
23 didn't want, that is that the repositories, essentially,
24 the engineer's variable.

25 MR. ESH: I don't interpret it that way. But

1 sure, it's open to interpretation.

2 MR. EWING: It sounded like it from here, but -
3 - and then finally a comment. I understand why, you know,
4 to make risk informed decisions, the vertical accesses in
5 milligrams per year, but in fact, in order for the
6 scientific community to think about the results of the
7 analysis, it's more useful to maybe break it down by
8 principle nucleis, so one can think about the chemistry
9 and the process, and see where the major contribution of
10 doses come from.

11 MR. ESH: Well, let's look quickly, I know I'm
12 over, but let's go to slide 23. We have just a minute.

13 MR. GARRICK: Only a minute.

14 MR. ESH: Only a minute. Okay. Slide 23 is
15 basically for a base case listing release. The average
16 here is released from the engineered barrier system, the
17 unsaturated zone, and the saturated zone. And this is the
18 type of analyses we do with our model, to say, does this
19 make sense. Do the sensitivity results make sense, do the
20 under performances make sense, you know. Should I believe
21 this, how is the thing working. Those are all the
22 questions we know how to answer.

23 But you can see from this, that iodine doesn't
24 -- in terms of curies, may be you should normalize it
25 based on a source term, but it isn't the highest released,

1 but it gets out, you know, plutonium, neptunium are
2 basically knocked out by the NSE.

3 And there's a lot of other analyses back here
4 about say the unsaturated zone and saturated zone that I
5 encourage you to look at, as the type of things that we
6 do.

7 MR. GARRICK: Jim?

8 MR. CLARK: No thanks.

9 MR. GARRICK: Andy?

10 MR. CAMPBELL: When DOE -- the question John
11 raised earlier about the -- when you fail all the waste
12 packages, you're looking at doses that are pretty close to
13 the regulatory limit. Now, is that a 10,000 year
14 calculation?

15 MR. ESH: Yeah.

16 MR. CAMPBELL: So if you go out in longer
17 periods of time, you may see a growth of radionuclides
18 that are significantly retarded.

19 MR. ESH: Yeah. You certainly see an
20 opportunity comes in 50,000 years, like there's a pie
21 chart in the back here, that shows in 50,000 years, 75
22 percent of the dose is from neptunium.

23 MR. GARRICK: If that's true, I take back
24 everything I said about the natural setting.

25 MR. ESH: So, yes, you've got longer times, the

1 numbers get different. You've re-established his belief
2 in the impact areas. I might do a follow-up to that. DOE
3 has done these things called neutralization analyses where
4 they "neutralize" the waste packages, and they get
5 substantially higher doses even within 10,000 years. I
6 mean, orders of magnitude of higher than you're talking
7 about here.

8 MR. CAMPBELL: Now, is there an effort ongoing
9 to try and get to the reason why that is the case?

10 MR. ESH: Yes.

11 MR. CAMPBELL: I mean, the licensee has orders
12 of magnitude of doses than the old estimates by the
13 regulator?

14 MR. ESH: There is an effort to get to the
15 bottom of that, and that's what we hope in the analyses
16 that DOE gets us, that they provide enough information
17 that we could determine if that is the case, why that is
18 the case, for instance.

19 And one of the main things we've discussed with
20 them is, they have a diffusion model, that as soon as they
21 form a hole in the waste package, they send water from the
22 humidity and the air couldn't get in there, and then you
23 have no resistance pathway from the fuel in the package to
24 maybe this micron-sized hole, it's instantly transported
25 from the fuel to the outside of the package.

1 And, you know, maybe they don't want to try to
2 collect data to take any such a credit for that phenomena,
3 but maybe it's driving those doses, whenever they do a
4 neutralization, they have a huge diffusing release that's
5 causing those large values.

6 But certainly we would want to get to the
7 bottom of, if there are substantial differences between
8 this model and their model, why, you know, what are the
9 sources of that.

10 MR. WYMER: One of the most disturbing things
11 I've heard today so far was the statement that -- and I
12 understand DOE arrived at the same result for widely
13 different reasons, that inspires confidence.

14 MR. ESH: Way to go, Tim. Let me comment on
15 that, that was the source term issue though.

16 We have effective release from our source term,
17 and they had a high diffusive release.

18 MR. WYMER: Okay.

19 MR. ESH: And so they gave the same results for
20 that -- on to the specific problem that he was talking
21 about, although it was through different phenomena,
22 there's diffuse of ours has actually been --

23 MR. WYMER: Oh, I see. Okay.

24 MR. MCCARTIN: Yeah. They take credit for --
25 which knocks their source to fuse and release down quite a

1 bit. We do not take credit for clatting, but we don't
2 have the diffusive releases that we believe -- while we
3 have primarily an effective release model. And so our
4 release rate is lower, no credit for clatting, their
5 release rate is higher, no credit for clatting.

6 MR. WYMER: So once you --

7 MR. MCCARTIN: We end up at about the same
8 place, but they are very different modeling assumptions.

9 MR. WYMER: So instead of being disturbed,
10 you're gratified?

11 MR. MCCARTIN: Well, we need to understand what
12 the Ph represent, and in essence, we understand when the
13 PA's represent, yes.

14 MR. GARRICK: And this is interesting stuff,
15 and I'd like to dwell it on a lot longer, but I guess we
16 better move on. Thanks a lot, Dave.

17 Okay. Our next speaker is Stan Kaplan. Stan,
18 tell us who you are, et cetera.

19 MR. KAPLAN: I'm Stan Kaplan and I'm consulting
20 to the Sensors for Nuclear Waste here. And the problem
21 we're talking about is producing a graphical post-
22 processor for the TPA Code.

23 The purpose of it is to make the results of the
24 TPA Code transparent. Transparent, of course, means we
25 want to be able to see through, so we want to be able to

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1 see through these kinds of numbers that come out of the
2 TPA Code, to see the things we'd like to learn.

3 So what are those things. Well, we'd like to
4 see whether we're getting the same results out of the TPA
5 as DOE is getting of theirs.

6 We'd like to track quantitatively the movement
7 of water and isotopes through the overall model. We'd
8 like to clarify the effects of the individual submodels on
9 that movement. We'd like to visualize and understand the
10 overall repository performance and effects of design
11 features, site characteristics.

12 We'd like to understand the uncertainties and
13 the parameters in the models, and the effects of those
14 uncertainties on performance. And we'd like to examine
15 the effect of assumptions and candidate possible design
16 changes.

17 So in response to that desire, we have an idea
18 for a graphic that would explain the performance.

19 I'm showing you here the original hand-sketch,
20 what this display would look like, and we call it a
21 performance summary diagram.

22 So against the time axis here, this shows the
23 rainfall coming down. This shows -- this curve, the water
24 that gets below, that actually infiltrates into the ground
25 below the root level and the transpiration, et cetera.

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1 The next one is the water getting down to the
2 surface of the drift. The water then enters the drift.
3 The water that falls on the drift shield and here we're
4 characterizing somehow the integrity of the drip shield,
5 which after a while deteriorates. Which after a while
6 deteriorates, allowing the water to reach the canister,
7 waste canister.

8 Shortly after that then, we begin to see a
9 release from the waste canister. Release from the
10 barrier, this curve like that, and release from the
11 unsaturated zone and release from the saturated zone and
12 finally dose to the target.

13 So that was the concept. And the idea was on
14 one page you could see a statement of the whole
15 performance of the repository through a -- and all the
16 intermediate steps.

17 And I showed the difference between water
18 falling on the surface, and water getting into the ground
19 and such, to recognize that -- these are opportunities
20 perhaps for engineered intervention.

21 So the difference between rainfall and the
22 water getting into the ground that's run-off or
23 transpiration. So I suggest some engineering actions to
24 increase the run-off.

25 The difference between infiltration and surface

1 of the drift, there's also engineered features that have
2 been suggested, to intercede that step, like Richard's
3 barrier. The water entering the drift, well, part of the
4 difference between the water reaching the surface of the
5 drift, and not entering the drift, is a capillary
6 transport of the water around the circumference.

7 Without seeing that, there may be -- give us
8 some ideas for some things we can do to increase the
9 capillary transpiration.

10 So that was the idea of presenting it this way.
11 So this is the original sketch. I'll show you in a little
12 bit, what we -- you know, where we stand with respect to
13 actually having the computer draw the diagram.

14 So given that sketch, the total performance
15 diagram, we could display uncertainty now in two ways.
16 One would be to display the whole courier as our best, the
17 whole graph, as our best estimate. And then a high and a
18 low. That'll be one way of giving a sense of the
19 uncertainty of the performance.

20 Another way would be to take individual curves
21 from there and show the percentiles.

22 Effect of design modifications, once again, we
23 could compare the performance summary diagrams before and
24 after the modification. And we can convey our individual
25 performance curves, or in the probalistic families of

1 curves before and after the design model.

2 So this is sort of a first version of the
3 computerized reproducing this summary diagram, and we have
4 some work left to do to get the scales right and the
5 colors right, and lineaments right and things of that
6 sort.

7 But basically here's where we stand. And let
8 me see, there's a -- you've seen that. Precipitation and
9 infiltration the flow reaching drift, the flow hitting the
10 waste package.

11 We see here the release from the -- canister
12 failure time. I guess the -- I guess this is the pink one
13 on this -- and it shows that the canisters fail within a
14 short time interval of each other.

15 MR. GARRICK: Once they start.

16 MR. KAPLAN: Once they start. Now, there is a
17 little piff down in here, which results from -- I mean, it
18 presumes a percentage of defective canisters, so they fail
19 earlier.

20 So there it is, and what's going on now,
21 refining and cleaning up of these diagrams.

22 This is a display of uncertainty, by comparing
23 individual performance curves and percentiles. So this is
24 dose to receptor, 10th, 50th and 90th percentiles.

25 This just shows the effect of the -- building

1 the individual realizations here into percentiles. We're
2 calling that a regular -- a breaking and rising process,
3 from an old language, which refers to this kind of figure
4 as a spaghetti occurs, and this as a regular rise
5 spaghetti.

6 Here, something similar is done, except we used
7 different colors to denote grouping the spaghetti into
8 five subfamilies denoted by different codes. And then, we
9 have simplifying this by plotting the 50th percentile for
10 each of those five groups in different colors.

11 So that's where we are. We're just beginning
12 to get these graphs off the computer, and we're testing it
13 and shaking down the little bugs and it looks like it has
14 the capabilities to give us the kind of transparency we
15 want.

16 MR. GARRICK: Here you can see the results of
17 the PA, Stan, and manipulate them?

18 MR. KAPLAN: Present them?

19 MR. GARRICK: Yeah, present them. You're not
20 suggesting any different approach, for example, of
21 calculating the uncertainties themselves?

22 MR. KAPLAN: No.

23 MR. GARRICK: Yeah, okay.

24 MR. HORNBERGER: I'm interested, Stan, on you
25 say that one of your objectives was also to clarify the

1 effects of the individual submodels.

2 MR. KAPLAN: Yeah.

3 MR. HORNBERGER: On the movement of water and
4 isotopes.

5 MR. KAPLAN: Right.

6 MR. HORNBERGER: Do you think that, in your
7 mind obviously your diagram does that.

8 MR. KAPLAN: Yeah. And in yours?

9 MR. HORNBERGER: Well, I'm still wondering a
10 little bit. The -- you know, I'm trying to sort out here
11 the difference now as we come down here between
12 precipitation, for example, precipitation and water
13 hitting the waste package.

14 MR. KAPLAN: Uh-huh.

15 MR. HORNBERGER: Now, how am I to interpret
16 that?

17 MR. KAPLAN: Well, you've got so many inches
18 coming down on the surface.

19 MR. HORNBERGER: Right.

20 MR. KAPLAN: And as it goes down, you've got
21 fewer and fewer inches of water.

22 MR. HORNBERGER: So by the submodel then, you
23 would be saying, okay, it's the unsaturated zone transfer
24 with the focusing factors and everything else that is
25 built into that, and it gives you a sense that -- I guess

1 what I would like to understand better, I suppose, is how,
2 let's say in this case, how the unsaturated zone flow
3 contributes to the performance of the repository.

4 And I guess what this diagram tells me is that
5 the unsaturated zone diverts a certain fraction of the
6 flow around the drift, but that's not very transparent for
7 me to get -- to take that and say, aha.

8 You know, suppose it diverted half as much. I
9 don't know what that means over here on the performance
10 side.

11 MR. KAPLAN: Well, that is a case of parameter
12 variation. We run these runs changing --

13 MR. HORNBERGER: So we'd have to look at your -
14 -

15 MR. KAPLAN: You're changing your model and
16 design parameters.

17 MR. HORNBERGER: -- last --

18 MR. KAPLAN: Oh, no, this is just uncertainty.

19 MR. HORNBERGER: It's uncertainty.

20 MR. KAPLAN: Yeah.

21 MR. HORNBERGER: Okay. Here you would be
22 changing the parameter on the model?

23 MR. GARRICK: You've got to get to a mic.

24 MR. HORNBERGER: All right. So I guess what
25 you're saying is that, to fully understand -- she can hear

1 me. Can you hear me? She can hear me.

2 To fully understand the contribution of
3 subsystems, we will wind up having a family of these
4 curves. In other words, you haven't anviated a need for
5 sensitivity analysis here.

6 MR. KAPLAN: No. This is a presentation. This
7 one figure summarizes the performance of the repository.

8 MR. HORNBERGER: Under those conditions?

9 MR. KAPLAN: Under those conditions.

10 Now, if you wanted to change the model of how
11 it -- the water drifts down and passes between and so on,
12 that would be another run and you'd get another whole live
13 in like this that we'd put along side.

14 MR. HORNBERGER: Uh-huh.

15 MR. KAPLAN: And that would be the difference.

16 MR. HORNBERGER: Okay.

17 MR. KAPLAN: Hopefully, it would make sense
18 physically.

19 Oh, I wanted to say on that. Yeah, another
20 reason for showing all these curves, one is to -- as you
21 said, to understand the workings of the model. Another is
22 to be able to use your physical reasoning, looking at the
23 numbers.

24 MR. HORNBERGER: I see.

25 MR. KAPLAN: So is it reasonable that this

1 curve should have this volume, and this curve should have
2 that volume, so we can get a rough physical check.

3 MR. HORNBERGER: Right.

4 MR. KAPLAN: And the third one, the third
5 reason for that, is to see opportunities for intervention,
6 design models.

7 Anything else?

8 MR. GARRICK: Yeah. I think one of the points
9 that you're also making, George, is that the layman and
10 the public are -- tend to be afraid of curves. And are
11 much more conditioned for looking at tables and --

12 MR. HORNBERGER: Are you putting me in that
13 category?

14 MR. GARRICK: No, no. I wouldn't think of
15 doing that. But there are certain presentations they're
16 much more comfortable with, like pie shapes, and isograms,
17 and tables of comparison. And, of course, you can compare
18 mean values as a function of time, you can cast this
19 information in various forms.

20 But I think one of the things that this brings
21 forward is taking a tremendous amount of information and
22 boiling it down into a simple presentation, a simple
23 comparison to what's behind it. And I think that's the
24 idea. That idea was enormously beneficial in other
25 applications, we found. We have found.

1 MR. WYMER: I don't know whether it was
2 intentional or not, but if you look at Tim's four points
3 as a means of communicating effectively with the public,
4 those are seepage, waste packages, conditioning, release
5 of radionuclides, transport, et cetera, et cetera, and
6 zone. It's a one-to-one correlation here.

7 MR. KAPLAN: Completely an accident. We're all
8 trying to do the same thing.

9 MR. GARRICK: Okay.

10 MR. KAPLAN: But to John's point, you can't
11 think in terms of this system with a number or a couple of
12 three numbers, you know.

13 MR. GARRICK: Right.

14 MR. KAPLAN: Our performance of the system, at
15 its simplest, is a chart with seven or eight curves on it.

16 MR. GARRICK: This is a --

17 MR. KAPLAN: If you can hold that in your head,
18 you know, that whole picture. Excuse me.

19 MR. GARRICK: Yeah, this is a classic example
20 of the old Einstein adage of making things as simple as
21 you can, but no simpler.

22 MR. KAPLAN: That's right.

23 MR. GARRICK: And in order to capture any kind
24 of a totality of what's going on, it would be very
25 difficult to get away from the curves.

1 MR. HORNBERGER: But again, taking this as a
2 presentation, and I accept what you said, but I'll play
3 devil's advocate here.

4 MR. GARRICK: Why?

5 MR. HORNBERGER: An unusual role for me. If I
6 look, for example, at the curves of precipitation and
7 infiltration, as we come down, these are very smooth
8 curves, and I look at the curve of the release from the
9 engineered barrier, it's very jagged, which immediately
10 leads me to question whether or not we -- this captures
11 the important mechanisms for what we care about.

12 MR. KAPLAN: That's a good question. You're
13 referring to this stuff here?

14 MR. HORNBERGER: Yes. Yes. And down here.

15 MR. KAPLAN: Yeah. Well, that's a result of
16 the many realizations that we're running. But it's a good
17 point.

18 Even so, we want to understand exactly how they
19 got there, and maybe modify the form of display, so we
20 don't introduce extraneous stuff, which is unimportant.
21 Maybe it's real, in that it's a real 50 percent
22 percentile, but it's not a real physical thing and it just
23 confuses people.

24 So it's that kind of refinement that we might
25 have to --

1 MR. GARRICK: Yeah. It's possible you'll want
2 to address other mitigating features that begin to map
3 more closely with these curves, you know, individual
4 barriers, the performance of individual barriers.

5 MR. KAPLAN: Well, we have some of the barriers
6 there.

7 MR. GARRICK: Yes.

8 MR. KAPLAN: Some we couldn't get because like
9 the water entering the drift is evidently not easily
10 accessible in the TPA Code. There's no file anywhere
11 which lists those numbers, so we haven't sorted out
12 whether and how you can get at them. But that would be a
13 very nice one to add.

14 MR. GARRICK: Jim?

15 MR. CLARK: Let me do a sound check first. Can
16 you hear me okay? All right.

17 MR. GARRICK: This must be important then.

18 MR. CLARK: I was advised during the break. I
19 really like slide five, and what strikes me about it, is
20 you mentioned design modifications, you just run down all
21 the different components before you get to the repository
22 you can look at. And engineering controls, --

23 MR. KAPLAN: Yes.

24 MR. CLARK: Additional engineering controls,
25 and the failure times as well. If that failure time would

1 delay, it would shift the whole curve to the right.

2 MR. KAPLAN: Yes.

3 MR. CLARK: So it would provide a tool of
4 deciding whether or not some of these additional things
5 had merit, how much time do they buy you, what does it do
6 to degradation, what does it cost, and it just struck me
7 as -- also as -- well, you know, the plumes at the bottom
8 might take a little explaining, but it struck me as a
9 pretty powerful tool to just show all the different
10 components and how they effect performance.

11 It struck me as especially powerful in
12 evaluating additional things that might be done.

13 MR. KAPLAN: Yeah. That's what I was thinking.
14 I want to engineer something, in the mean and control
15 nature. So my head naturally got the --

16 MR. CLARK: For a landfill, for example, you --
17 by putting in a cover there, that's one thing that could
18 consider, well, with that cost, how much time would it buy
19 you.

20 MR. KAPLAN: Uh-huh.

21 MR. GARRICK: Rod?

22 MR. EWING: I'd like to make a statement based
23 on figure nine or the figure that's on page nine, so that
24 others can correct me as we pass through the day.

25 And in this figure, you proposed to display the

1 uncertainty by plotting the different percentiles for dose
2 as a function of year. And the statement I think is that
3 I don't think this captures the uncertainty of the
4 analysis.

5 The analysis, of course, involves all the
6 hydrology, your chemistry and all of the propagated
7 uncertainty of that part of the analysis. And that's
8 different than the range of values you get per dose.

9 And the way I would argue this, is if you go
10 the long enough time with decay, the uncertainty would
11 become zero, because everything's decayed away. But
12 certainly at very extended times, the uncertainty of the
13 analysis is very large.

14 MR. KAPLAN: Uh-huh.

15 MR. EWING: So I may be wrong, but I think this
16 method of displayed uncertainty actually doesn't -- it's
17 just a range and expected doses.

18 MR. KAPLAN: It's uncertainty, in that it goes
19 to the receptor, right?

20 MR. HORNBERGER: I don't think so.

21 MR. KAPLAN: As a function of --

22 MR. EWING: It's just the range of values. But
23 those ranges have, let's say, air bars on them, and those
24 values -- those air bars are growing as a function of
25 time. Right?

1 MR. KAPLAN: No. To use your own example, if a
2 dose goes to zero -- if the dose goes to zero, the
3 uncertainty isn't huge. The uncertainty goes to zero,
4 too.

5 MR. EWING: The uncertainty of the analysis and
6 the uncertainty --

7 MR. HORNBERGER: No, the uncertainty of the
8 analysis goes to zero. We're really confident that that
9 goes to zero if it's long enough.

10 MR. EWING: Now what I'm saying is, at the
11 extreme, that value goes to zero, but the performance
12 assessment involves the analysis of the hydrology, the
13 geochemistry, water flow over time. And there's real
14 uncertainty --

15 MR. HORNBERGER: Oh, yeah.

16 MR. EWING: -- with all those parameters.

17 MR. HORNBERGER: Right.

18 MR. EWING: Propagated over time.

19 MR. HORNBERGER: But the uncertainty and dose
20 goes to zero.

21 MR. EWING: Right. But I think when we talked
22 about uncertainty, we're not talking about radioactive
23 decay. I mean, that's not the big problem here, right?
24 It's the uncertainty and the analysis of the hydrologic
25 and interview systems.

1 MR. HORNBERGER: That's built in here.

2 MR. KAPLAN: Yeah.

3 MR. EWING: But not captured by -- because if
4 we just a little further, you see that -- and you see this
5 in the DOE analyses, due to decay, the uncertainty or the
6 range in values of doses going down. But -- well, let's
7 say if there's a crossover point.

8 There's a point, and from DOE curves, it looks
9 to me to be between 10,000 and a million years. Where the
10 uncertainty in the analysis, the geochemistry, the
11 hydrology has a big effect on dose, because you still have
12 activity.

13 MR. HORNBERGER: Right.

14 MR. EWING: And that's the relevant period of
15 time. And so you want to calculate the uncertainty in
16 your analysis during the relevant period of time. It's
17 not important to calculate the uncertainty at times that
18 are so short there's no release, or times that are so
19 long, that the activity is zero.

20 MR. HORNBERGER: That's right.

21 MR. KAPLAN: Right.

22 MR. EWING: But there is --

23 MR. HORNBERGER: That's right. But that's
24 what's shown. That window is what's shown here.

25 MR. KAPLAN: It's not important to calculate

1 it, because we know it already. Is that what you're
2 saying?

3 MR. EWING: In this window, though, the
4 uncertainty is just not the dose. It's the propagated
5 uncertainty of the geochemistry and hydrology.

6 MR. KAPLAN: Sure. And all of that
7 uncertainty, finally, what we're interested in is the dose
8 to the people, so all those uncertainties are there,
9 continging on these curves.

10 MR. EWING: I preface by saying, so I can be
11 corrected. I'm still not convinced.

12 MR. WITTMAYER: I'm not going to correct
13 anyone. I'm just going to add an extra dimension.

14 It'll lead into what I'm going to talk about
15 next. In a way, this does more than just talk about
16 uncertainty. It makes uncertainty useable, but we're a
17 decision-maker. It's more important than knowing what
18 uncertainty is, but also how it affects the risk, and this
19 is what this right here --

20 MR. KAPLAN: Yeah, this -- right.

21 MR. WITTMAYER: A way of displaying --

22 MR. KAPLAN: What this has attempted to do is
23 you recall in all of our previous WHIP association, we
24 used to deal with this question. So what?

25 This attempts to deal with the question of so

1 what. This is the bottom line, and the only reason I'm
2 interested in the uncertainty of subcomponents, is how it
3 effects the parameter that I'm using to measure safety or
4 risk.

5 MR. EWING: Right, and the so what though, and
6 again correct me. This range of values, say, the 10th to
7 the 90th percentile, those are on individual realizations,
8 say you had 300 realizations, and you picked those
9 boundaries accordingly. But each realization has error
10 bars, right.

11 MR. GARRICK: This is getting into the
12 uncertainty of --

13 MR. KAPLAN: That's not the way we --

14 MR. GARRICK: Yeah. That's not --

15 MR. KAPLAN: -- treat uncertainty.

16 MR. GARRICK: No.

17 MR. WITTMAYER: It may not be the way you treat
18 uncertainty, but I'm saying for each realization, there's
19 a propagated uncertainty, right?

20 MR. GARRICK: What you're saying is, what's the
21 uncertainty of the uncertainty.

22 MR. WITTMAYER: Of the single realization you -
23 - there's no error for, right?

24 MR. KAPLAN: The error associated with
25 uncertainties? I mean, to a certain extent.

1 MR. HORNBERGER: Just do a single realization.

2 MR. KAPLAN: It has no uncertainty. What
3 uncertainty are you talking about?

4 MR. HORNBERGER: You sampled over ranges of --
5 I see what you're saying, yes.

6 MR. KAPLAN: The way we express uncertainty is
7 through the sampling. Each sampling does not have
8 uncertainty.

9 MR. GARRICK: It's a different concept. It's a
10 different concept. I think we better move on.

11 MR. HORNBERGER: Moving right along.

12 MR. GARRICK: Moving right along, thank you.
13 Don't walk away with the microphone.

14 MR. KAPLAN: Uncertainty of uncertainties.

15 MR. WITTMAYER: I'll try to make this brief.

16 MR. GARRICK: Okay.

17 MR. WITTMAYER: It was sort of an interlude to
18 what we've been talking about, but it follows along nicely
19 after the discussion we've had.

20 I'm supposed to be talking about the philosophy
21 of uncertainty and I've changed a little bit. I'm talking
22 about uncertainty in HLW performance assessment, and
23 actually talking about uncertainty from the perspective of
24 the regulator.

25 And how you treat uncertainty depends very much

1 on who the decision-maker is, what decision you're trying
2 to make, and who the effected people are by the decision.

3 Briefly discuss the role of uncertainty. In
4 NRC's decision, first I would note that uncertainty and
5 variability, which people like to distinguish. They are -
6 - I won't say -- they're somewhat more phenomenal
7 concepts, but they can get confused very easily.

8 But they -- both of those things do effect your
9 decision, the decision that you make.

10 We treat both uncertainty and variability,
11 usually in a problemistic matter, but let me distinguish
12 between the two of them.

13 I'm going to use a quote that I saw in a book,
14 I know remember who it was attributed to, but it sounded a
15 lot like Stan Kaplan, so I think I'll blame him.

16 We know that variability is a property of the
17 system that is being analyzed, such as tossing a dice, or
18 variations in how people respond to dose, from person to
19 person or uncertainty is actually an attribute or a
20 property of the analyst. It's not a property of the
21 system.

22 It reflects the state of knowledge about
23 something. It's a real -- quite a different concept, but
24 they get melted and mixed quite quickly when they do these
25 types of analyses.

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1 Now, the decision that NRC has to consider -- I
2 see Stan's raising his hand.

3 MR. KAPLAN: I just had a little additional --

4 MR. WITTMAYER: You certainly may, since I
5 blamed you.

6 MR. KAPLAN: I was going to say, this being the
7 cause of hundreds of years --

8 REPORTER: I can't hear you, I'm sorry.

9 MR. GARRICK: You've got to get to a mic.

10 MR. KAPLAN: Would you say the uncertainty of
11 the property of the analyst, yes, but it doesn't reflect
12 the personality of the analyst. That's with the whole
13 issue between the basins and the statisticians for the
14 last few hundreds of years. Our ability is subject to --
15 so we're saying, uncertainty is a property really of the
16 evidence that you have. It's a property of the hypothesis
17 and the evidence that you have in front of you.

18 MR. WITTMAYER: That's a good distinction to
19 us.

20 MR. KAPLAN: Not personally.

21 MR. WITTMAYER: Right. The decision that NRC
22 has --

23 MR. GARRICK: You took that personally, didn't
24 you?

25 MR. WITTMAYER: Never accuse Stan of being

1 uncertain.

2 The decision for NRC is really quite simple.
3 To either reject or accept an application or a licensed
4 application construct and offer it a hot oil waste
5 repository at Yucca Mountain.

6 Now, let's look for segment of risks that NRC
7 faces as a decision-maker, and then how uncertainty comes
8 in and effects that.

9 One risk is the failure to reject the
10 application when the repository does not protect public
11 health, safety and environment.

12 The other side of the coin is that NRC may fail
13 to approve the application when the repository does indeed
14 protect public health and safety and the environment. I'm
15 going to tie those somewhat to what we originally called
16 Type 1 and Type 2 errors in statistical hypothesis
17 testing. Although, you need to be a little bit careful
18 when you do this, because it all depends on how you pose
19 your know hypothesis. But I'll probably use that
20 terminology.

21 And just to define things a little bit better.
22 When I talk about protection, I am talking about whether
23 or not the repository poses or does not pose a risk to
24 public health and safety and the environment. Those are
25 different risks there.

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1 Go to the next page here. Now, one of the
2 requirements that DOE must meet, and this is just one of
3 them. They must demonstrate the expected annual dose to
4 an average member of the critical group and shall not
5 exceed 0.25 mSv at any time during the first 10,000 years
6 after permanent closure.

7 There's also a requirement how DOE shall
8 demonstrate this one requirement, that we use in
9 performance assessment, that accounts for uncertainty and
10 variability in parameter values and considers alternative
11 conceptual models of the repository system.

12 Moreover, there's a second requirement to help
13 bolster this, and it keeps -- this really keeps with NRC's
14 requirements or philosophy of defense and depth that DOE
15 must also demonstrate that the repository includes a
16 system of multiple barriers, including at least one
17 engineered barrier, and one natural barrier.

18 Now, how does uncertainty affect this. If
19 uncertainty is small, then we can estimate the risk to
20 human health and safety and the environment quite
21 accurately, okay. And the likelihood of making an
22 incorrect decision is reduced. I mean, that's sort of
23 common sense. If you know exactly what the risk is, then
24 you can make the right decision quite readily.

25 Where uncertainty is great, the regulator has

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1 to be very careful that if we make the correct decision.
2 And again, I distinguish here more clearly the two types
3 of decisions that we don't want to make. That's the Type
4 1 error, I'll call it, and the Type 2 error, failure to
5 reject a bad place, a bad repository; failure to accept a
6 good repository.

7 Now, one of these are, you know, two sides of
8 the same coin. If you use conservatism to reduce the
9 likelihood of making a Type 1 error, that is, failing to
10 reject a bad site, you naturally increase the odds that
11 you will -- that you will not accept a good repository.
12 This is sort of the thing that you probably learned if you
13 were in quality control 20 years ago, or you look
14 operating characteristic curve between a supplier's curve
15 and a procurer's curve, in making a decision to accept or
16 reject material that was being provided.

17 MR. GARRICK: Gordon, I just would like to talk
18 about another point that's important in quantifying or in
19 communicating about risk and uncertainty.

20 You imply with that slide that when the risk
21 is small or the uncertainty is small, it's accurate. And
22 when the risk is large or the probability of
23 distributions, that it's not accurate. You don't say
24 that, but you say accurate for the small.

25 And the way a risk analyst thinks is, that in

1 both cases, they're accurate. You have -- if you have
2 quantified the risk and it happens to be large, and it
3 characterizes the state of knowledge of -- and the -- and
4 represents the evidence produced, it's just as accurate,
5 in terms of quantifying the risk, as is the tightly
6 bounded case, and that's a very important point, in terms
7 of the language of the business.

8 And so when we talk about quantifying risk,
9 what we mean is, expressing on the basis of all the
10 evidence that you have, your total knowledge about a
11 particular parameter and whether that happens to have a
12 narrow distribution, or a wide distribution, they're both
13 equally accurate.

14 MR. WITTMAYER: Well, you're basing your
15 measure of risk simply on the central tendency.

16 MR. GARRICK: No, I'm basing the risk on the
17 whole curve.

18 MR. WITTMAYER: Okay.

19 MR. GARRICK: And I'm saying, when I quantified
20 the risk, I don't care whether it's narrow or wide, I've
21 quantified it. They're both quantitative expressions of
22 the risk.

23 MR. WITTMAYER: And you do not see any
24 difference in how it affects your -- the likelihood of
25 making the correct decision?

1 MR. GARRICK: I'd say it's a tremendous
2 difference in how it effects the decision.

3 MR. WITTMAYER: Okay.

4 MR. GARRICK: Because I could have, for
5 example, two possible situations of both having the same
6 10th century parameter, but one having a much tighter
7 distribution than the other one and the decision is
8 obvious.

9 MR. WITTMAYER: And that's what I'm really
10 focusing on there.

11 MR. GARRICK: Yeah.

12 MR. WITTMAYER: Is where you have overlap of --

13 MR. GARRICK: But they're both quantified.
14 They're both accurate.

15 MR. WITTMAYER: Okay. I agree. They're both
16 accurate.

17 MR. GARRICK: Yeah.

18 MR. WITTMAYER: But I think your ability to
19 separate to clearly identify what's -- when you are making
20 a correct decision --

21 MR. GARRICK: Yes.

22 MR. WITTMAYER: -- becomes more troublesome the
23 greater the uncertainty is.

24 MR. GARRICK: Yes.

25 MR. WITTMAYER: Let's talk a little bit more

1 about uncertainty here and where you can use uncertainty.

2 For some reason, my right pointing arrows
3 become downward pointing arrows, but we can invoke
4 conservatism at several stages on decision-making process.

5 One, called the pessimistic PA where you
6 actually don't propagate your true state of knowledge if
7 you want to use that word or true state of lack of
8 knowledge or uncertainty into the performance assessment.

9 You actually use conservative values, and
10 things that tend to under estimate the ability of the
11 repository to protect public health, safety and the
12 environmental. Or you can use a more realistic approach,
13 where you try and propagate the true state of knowledge
14 that you have about a parameter or a process through the
15 entire performance assessment.

16 And then you apply conservatism, kind of
17 upistiliority (phon.) before you decide to whether to
18 construct or not. And it's two different ways of doing
19 it.

20 Moreover, I'll add at the end, because
21 uncertainty may be large, the multiple barriers
22 requirement is imposed, and that adds an additional degree
23 of upistiliority conservatism to the decision making
24 process.

25 Now, the next page, there's a little more

1 discussion about conservatism and multiple barriers using
2 a diagram that, in this particular format, I think Joe
3 Holonich presented a number of years ago, or just a year
4 ago at the end of the ERV. But it really looks very much
5 like a hazard curve, although they're blocked out here
6 separately.

7 Along one axis, I have listed increasing public
8 hazard, that's the XX, as the YX is increasing
9 uncertainty. And then the arrow that's drawn diagonally
10 out from the origin at a 45 degree angle, sort of shows
11 you the increase need for conservatism.

12 You get to a point where you have very high
13 uncertainty and high public hazard, so that the risks you
14 take, a product of those two conceptual things, and you
15 have higher risks associated there. You may want to
16 increase the need for multiple barriers or some sort of
17 defense in depth.

18 I've put some things on there to give you an
19 idea what -- where different facilities might lie. Some
20 of these came directly off Joe Holonich's presentation. I
21 know people will differ where these things are placed.

22 But, for example, I think that we probably know
23 more about how a power reactor would operate. We have a
24 greater degree of knowledge than we would for a high level
25 waste repository. But the public hazard from something

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1 like a power reactor is probably considerably greater,
2 than that posed by deep geologic repository. And I put
3 some other things on here as well.

4 Smoke detector having a small amount of, I
5 guess, amairicm of some isotope in it, poses a very small
6 public hazard, we probably know quite well what mechanisms
7 may lead to its release and uptake by people.

8 As we stage out here, these -- the bars, let me
9 see if I can -- maybe I can use this to point, sort of
10 shows the things in this area, you probably don't have a
11 real high level need for defense and depth.

12 As you go further out along here, you need to
13 use increasing levels of defense and depth in this area.
14 Greater conservatism, if you will.

15 I'm just going to summarize here and then
16 hopefully, there will be a state of questions. We expect
17 the or I should say the NRC expects that the applicant
18 will make a very strong effort to accurately quantify
19 uncertainty and variability in their risk assessment.
20 They have to really justify their use of parameter
21 distributions that are reflective of both those different
22 types of variability and the output.

23 And NRC expects the applicant to define where
24 the uncertainties are very large in the risk assessment,
25 and what measures have been taken or need to be taken to

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1 compensate for them.

2 And that's the end of the philosophy lesson.
3 I'm learning as much from you during this as I'm sure
4 you're learning from me, but --

5 MR. GARRICK: All right. George, have you got
6 any questions?

7 MR. HORNBERGER: Gordon, on your slide five,
8 you say that conservatism can be invoked at various
9 stages, and you talk about the pessimistic PA versus the
10 realistic PA. You started out by saying that really the
11 treatment of uncertainty is through the analysis and we'd
12 like to think that what we're doing is using the state of
13 our knowledge, and the uncertainty reflects the, in part,
14 the state of our knowledge and in some sense, the
15 inadequacies of the state of our knowledge.

16 It's never been clear to me how one justifies
17 your pessimistic PA case on those grounds. Because how
18 are we using our -- the state of our knowledge, if what
19 we're doing is propagating or not propagating our
20 knowledge, but just using the pessimistic PA?

21 MR. WITTMAYER: Well, it depends on what stage
22 of a project you're in in many times. I mean, you might
23 use a pessimistic PA at a very recognizance level. Do you
24 even need to be concerned about something.

25 If I think about the worst things that could

1 happen, and I'm way before doing a design, this gives me
2 an idea of what level of concern I need to have, and how
3 much more information I need to gather.

4 So when you finally get to the point of doing a
5 full fledged analysis, and you're pretty well along on
6 developing a design for a repository, I'd think you'd want
7 to definitely turn to doing more realistic PA.

8 But somebody correct me if I'm wrong here, but
9 I think in probably decommissioning the area of
10 decommissioning, we use one code that uses a screening
11 approach. And that might -- you might term that a
12 pessimistic PA.

13 Well, if you use that pessimistic values and
14 it's not a problem, perhaps you can dismiss that and not
15 do a lot of further analysis. On the other hand, if you
16 have real concerns, then you better get in there and
17 refine it, and be -- you know, improves your state of
18 knowledge. And propagate estimates of true uncertainty as
19 I put it in here, through the performance assessment.

20 MR. GARRICK: Yeah. I think the problem here
21 again is language and I think conceptual meaning. I think
22 that there's nothing wrong with pessimistic calculations
23 and bounding analyses and conservative calculations. I
24 think the only thing that some of us in the business are a
25 little sensitive to, is referring to a risk assessment as

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1 conservative or non-conservative.

2 Because, by definition, risk assessment is
3 supposed to be a realistic assessment of your state of
4 knowledge about something.

5 MR. WITTMAYER: Uh-huh.

6 MR. GARRICK: And the issue of conservatism and
7 non-conservatism comes later. The risk assessment
8 provides the reference or the base line against which you
9 make decisions as to how -- and that you're able to
10 measure how conservative you are.

11 So, I think in that sense, it's a bit of an
12 oxymoron for us to think in terms of a conservative risk
13 assessment. It just doesn't quite make sense.

14 MR. WITTMAYER: I agree with you completely
15 actually. I prefer that the risk assessment be done
16 accurately, but whatever the decision maker chooses to do,
17 he may use the information from the risk assessment and
18 some other material that he hasn't included in reaching
19 his decision. That's where, if conservatism is to be
20 invoked, I would expect it to be invoked at that point.

21 MR. GARRICK: Yeah. And I think the way most
22 of us have gotten around that, is to -- those of us that
23 tend to be purists on this, is that we identify what we do
24 as quantitative risk assessment.

25 MR. WITTMAYER: Okay.

1 MR. GARRICK: To indicate that we've quantified
2 the uncertainties. And if you quantify the uncertainties,
3 the only sensible way to quantify uncertainties, is to do
4 it in terms of what you -- what the -- what's your -- what
5 the evidence can support.

6 And so that moves you in the direction of a
7 realistic model, but a model that gives you a full view of
8 your lack of confidence, if you wish.

9 Ray?

10 MR. WYMER: I have an observation and a
11 question. The observation is, like so many things that
12 are sort of philosophical in nature, the words you used, a
13 great many of us recognize these things intuitively
14 without really articulating them. That's the observation.

15 And then the question is, how do you use these
16 philosophical or intuitive things directly and meaningful
17 in this work? What input does it make?

18 MR. WITTMAYER: Well, I mean, what it means is
19 that -- I think this is the bottom line from all this
20 presentation, I'll tell you what we like to do in our
21 performance assessments, and this puts in on the bottom
22 line.

23 We like to accurately reflect our state of
24 knowledge about something in the performance assessment.
25 Whether we have a great deal of certainty servitude or we

1 have very little, that's the practical implementation.

2 We'll also use caution that we don't allow
3 cases where people allow a great deal of uncertainty to,
4 in a way, elude the actual risk posed by a repository
5 system.

6 I'll give you an example that my boss gave me
7 about Budda Sagar at Hampford. People's degree of
8 knowledge about when waste packages might fail, had a
9 great effect on, I guess I'll say the peak release at that
10 time. If you assume that they fail over a long period of
11 time, in effect, you're spreading out the mass release
12 over a long period of time.

13 If you're concerned about the earliest time of
14 release, well, that doesn't dilute the risk, if that is
15 indeed the measure of risk. If it's -- if what matters is
16 the height of that curve, how much mass is released at a
17 certain time, then in fact, you would --

18 MR. WYMER: My thrust of that question was more
19 direct use. Do you look at all this stuff and then make a
20 pronouncement one day that you're making a Type 1 error?
21 Just -- how do you do this?

22 MR. WITTMAYER: Oh, okay. No. I think what we
23 do, is we do the analysis and, you know, so that we can
24 preclude against making -- we don't want to make either
25 type of error, right. But you'd guard on the side of

1 trying to preclude making a Type 1 error. That, I think,
2 is probably the greatest -- the riskiest for the decision
3 maker. But I feel I'm still not answering your question.

4 MR. WYMER: Well, I'm not sure that you --

5 MR. GARRICK: Let me -- let me just quickly
6 take a crack at it. I think the way I tried to answer
7 similar questions, is to pretty much dodge it by saying,
8 the risk analyst calculates the risk. He doesn't make the
9 decision.

10 And also a risk assessment is not a decision
11 analysis. Now, risk assessment techniques are employed in
12 decision analysis, but there are other attributes that
13 enter into the decision making process, such as societal
14 benefits, costs and what have you.

15 So it's just part of the evidence for -- to put
16 in front of the decision maker, which may be the citizenry
17 for making a decision. But if -- it turns out, in most
18 cases, to be enormously beneficial, in terms of the amount
19 of evidence it captures, and the basis and the format that
20 it's in, gives you some specific reference to working at.

21 So a risk analyst is not in the business of
22 making decisions. He's in the business of analyzing the
23 risk. But he's -- he has a responsibility to present that
24 risk in a form that enhances the decision making process
25 that will include other considerations.

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1 MR. WYMER: I think I understand that. What I
2 was thinking was, directly from what you've presented, I
3 would say one of the ways you could use it, maybe the only
4 way I could see you could use it, is you stand before the
5 public and say, we are working very hard not to make any
6 Type 1 or Type 2 errors. That's about what you've been --

7 MR. GARRICK: Well, I think the aspect that
8 we're really looking for here, Ray, is quantification.

9 MR. WYMER: Right.

10 MR. GARRICK: And --

11 MR. WYMER: That isn't what you addressed.

12 MR. GARRICK: Yeah.

13 MR. WYMER: Particularly.

14 MR. WITTMAYER: No. I didn't really go into
15 detail on quantification. I think the presentations
16 probably that follow may talk more about that, some of the
17 earlier discussions.

18 MR. WYMER: I'm ragging you a little.

19 MR. WITTMAYER: That's fine. I mean, that's --

20 MR. GARRICK: Milt?

21 MR. LEVENSON: Yeah. I have -- for different
22 reasons than John's, I object to the use of the
23 pessimistic and conservative analysis, because I think
24 they are very, very unfair to the decision maker.

25 I was once a decision maker and if somebody

1 gave me a pessimistic or a conservative analysis, my first
2 question was, is it conservative of a factor of 2, by a
3 factor of 10, or by a factor of 10 to the 4th. And if you
4 can't tell how pessimistic or conservative it is, and
5 generally you can't in the way you're doing things, then I
6 think it is very destructive, rather than informative,
7 that in fact, on a completely a different subject.

8 There's a Commission paper, SECY 00-70, control
9 of solid materials with the staff has been instructed to
10 determine how conservative are the conservative estimates.
11 Which really brings it to the point that for a decision
12 maker to tell him it's conservative, when he has to
13 consider other factors, and he does not know it's
14 conservative by 2 to 10 or 10 to the 4th, it's not a very
15 useful thing.

16 MR. WITTMAYER: I agree with you. And I guess
17 it's what Dr. Garrick said about the role of the risk
18 analyst, is probably to give the best estimate of risk
19 that he can, and the decision maker should use that
20 information and whatever else he needs to, to come upon a
21 conclusion.

22 MR. GARRICK: Andy?

23 MR. CAMPBELL: A couple of questions. In the
24 beginning of your presentation, you talked about how
25 uncertainty and variability and distinguish those.

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1 How do you distinguish those through the model?
2 How do you reflect those differences that we usually lump
3 together in this Monte Carlo-type of an analysis? How do
4 you distinguish that in the model?

5 MR. WITTMAYER: We don't make a great deal of
6 effort to distinguish this of output from the code. If
7 you'll look through the input, you can often -- you can
8 tell what -- whether it's uncertainty about the true
9 parameter value, or if it's actual variability, and you
10 have a good knowledge of what that -- how you describe
11 that variability.

12 We haven't made a real extreme effort to
13 propagate those two types of still-castic effects
14 separately and separate them out. They both play into
15 effecting the bottom line risk value in very much the same
16 way, effecting the bottom line number.

17 MR. CAMPBELL: So do you need to separate them
18 out or do you feel that that's not necessary?

19 MR. WITTMAYER: Well, that's a philosophical
20 thing. I have seen various risk analysts who say, yes,
21 you must. In fact, I think that EPA requires in doing
22 exposure analyses to make some effort to do that. Other
23 risk analysts I've seen say no. Often times, you have
24 attended uncertainties with describing variability itself.

25 So it's -- and I'm making a very clear

1 philosophical distinction in practice, it gets to be a
2 little more difficult in times.

3 MR. CAMPBELL: You have eluded to it, is a
4 number of cases, the model and the TPA Code, and TSPA,
5 they may do similar things. You have proxy
6 representations of processes. You're not actually
7 modeling an actual process. But you have, you know, kind
8 of a numerical value selected between, you know, some low
9 value and some high value as a proxy for a process.

10 MR. WITTMAYER: Uh-huh.

11 MR. CAMPBELL: But when you propagate the
12 uncertainty in that, you're not really propagating. I
13 think this gets to one of Rod's issues. You're not really
14 propagating the uncertainty in modeling, you know, the
15 natural world or this engineered barrier. You're really
16 propagating the uncertainty in this distribution.

17 MR. WITTMAYER: In some cases, I don't care.
18 You talk about crane failures. I could model
19 mechanistically all the physical effects that cause a
20 crane to fail, to propagate uncertainty through that in
21 doing very quantitative analysis, a still castic approach,
22 or I could simply take actuarial data, preconceived crane
23 failure, non-mechanistic. Hopefully, I'd be able to
24 propagate the same information. I have the same
25 uncertainty being propagated with more variability

1 actually in the one case, propagating through. I think
2 I've given you a good philosophical answer, but I'll let
3 you ask me again if I didn't answer it right.

4 MR. GARRICK: You're absolutely right, Andy,
5 it's a big subject that information uncertainty versus
6 modeling uncertainty. And maybe we'll have a workshop on
7 that some day.

8 MR. CAMPBELL: Okay.

9 MR. GARRICK: Jim?

10 MR. CLARK: No questions.

11 MR. GARRICK: Rod?

12 MR. EWING: I'll pass for the moment.

13 MR. GARRICK: All right. Okay. Thanks very
14 much, Gordon. Tim, it's up to you to get us out of here
15 at 12:30 for lunch.

16 MR. MCCARTIN: We're concluded. Okay. I'll
17 try to wrap things up in a relatively short order, in
18 talking about how we're going to use TPA Code and
19 regulatory reviews.

20 Let me just right go to the role of the
21 performance assessment of the code.

22 Once again, we have an independent approach to
23 review DOE's TSPA. And there's really two ways we're
24 going to review things. There's a proactive way and a
25 reactive way.

1 And the proactive way, both licensing and
2 prelicensing, we can risk inform what we're doing. We
3 have the development of the review plan, development of
4 analytical tools. You'll see later, either today or
5 tomorrow, the Center's working on confrontational
6 approaches for coupled processes, work with multi-flow, et
7 cetera.

8 Why are we working on those particular tools?
9 Well, obviously, there's something about either the
10 chemistry, the thermal aspect that we think are -- is
11 important enough when we look at our performance
12 assessment, also DOE's, that we want to have some approach
13 for evaluating things in detail.

14 In terms of confirmatory testing. There are
15 certain things that you'll see I believe, either Wednesday
16 or Thursday, some of the laboratory work, and obviously,
17 why do we do a particular confirmatory test? Well, we
18 think they're specific aspects of the performance that we
19 think are important. A lot of that's based on our TPA
20 calculations.

21 Then there's the reactive side of it. We want
22 to be able to probe DOE's analyses. They're going to come
23 in with a performance assessment, this is our approach,
24 our tool to try to take apart the DOE's assumptions and
25 verify our understanding of what's going on.

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1 And with that, I'll go to a set of specific
2 examples. The first is, confirmatory calculations. DOE's
3 going to have a performance assessment that does overall
4 performance, human intrusion and the capabilities of the
5 barriers.

6 In the proactive sense, obviously, we have, as
7 you saw, today we've done an independent calculations of
8 what are the important barriers. What are the
9 capabilities? What's going on with those particular
10 capabilities? What's supporting them? What are the
11 important and intermediate results to look at, et cetera?

12 Reactively, I think DOE is going to have their
13 performance assessment. They're going to have assertions
14 about what they believe the barrier capability is. We
15 need to go in and possibly use our code to modify it to
16 the parameters they're using or tweak our models,
17 hopefully.

18 We'll do some confirmatory tests that, gee, why
19 don't we see, as was brought up earlier with the
20 neutralization analysis that DOE does, where they see
21 approximately at times, almost a two ram dose. We don't
22 see a similar thing when the waste package fails, in our
23 barrier controloziation.

24 And as was brought up, once DOE's analyses,
25 when they fail a barrier, the waste package, they lose

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1 their credit for the clatting. We haven't taken credit
2 for clatting, so it doesn't have as dramatic of an effect.

3 But there are reasons for that, but we want to
4 use the TPA Code to look at the capabilities of barriers.

5 Next, as we've talked about,
6 conservative/bounding calculations and I guess there is
7 that dilemma with what exactly is considered a
8 calculation, what exactly is a bounding. But we expect
9 that DOE, in the performance assessment, will in certain
10 areas, potentially where there's a lot of uncertainty,
11 rather than collect a lot more data, try to defend a
12 particular approach, they may say, we're going to take a
13 conservative approach here.

14 React -- that's a reactive aspect for our
15 review. We would like to use the code to evaluate the
16 degree of conservatism. What exactly does this mean?
17 They said this is conservatism, is it? Isn't it? We can
18 look at different approaches in our code, et cetera.

19 And one of the things I know that the committee
20 has brought up, you may claim conservatism for a
21 particular aspect of performance, be it gee, we'll assume
22 I'll make a very simple analogy, but I'll assume the
23 temperature is always above boiling. It's very
24 conservative for my release model, which is temperature
25 dependent, and so I will assume it is always above

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1 boiling. It's conservative for that particular realist
2 model, but then if you also carry that through, and you
3 never see any water coming into contact with waste, or in
4 terms of overall performance, one could question whether
5 that truly is a conservative approach in terms of the
6 overall performance assessment.

7 Clearly, it will not be that clear cut, but we
8 will have to analyze things to make sure that indeed,
9 conservative assumptions are confirmed with respect to the
10 overall performance measure of dose. In this area, it's
11 certainly possible that we can use DTO process models in
12 addition to the TPA Code.

13 As you saw today, we used the code to look at
14 sensitivities and uncertainties in the code. And the
15 performance assessment code is a very complicated model.
16 There's a lot of parameters.

17 I know Dave Esh asked me to make a statement
18 and it's true, that even though our TPA Code is simple in
19 respects to the real system, we have spent a lot of time
20 and all the technical disciplines have contributed to each
21 of the modules. And a lot of thinking and effort have
22 gone in. These models, while being simple in nature and
23 computational requirements, incorporate a lot of thinking
24 that is brought into the development. It's interesting
25 that when you do the performance assessment overall, you

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1 find that there aren't that many things that it's really
2 that sensitive to.

3 There are some particular aspects of
4 performance that dominate the calculation of overall
5 performance.

6 In a proactive sense, clearly, we've been doing
7 our sensitivity analyses, to look at what's important. I
8 think that's important, both licensing and pre-licensing.

9 When we go to these KTI meetings for issuer
10 resolution, we look at some of -- in some of the KTI's.
11 We look at well, do we really need to know this
12 information, how important is it to us? How important is
13 it in our calculation? How important is it in the DOE
14 calculation?

15 You don't want to sit there and put demands on
16 learning information that isn't going to have a
17 significant impact on performance. And then ultimately,
18 in the reactive sense, we want to understand, well, why
19 does DOE have such importance to the waste package failure
20 in their neutralization analyses. As we've talked about,
21 I think it's the cladding credit and the diffusional
22 release.

23 But there's -- we want to look at things, and
24 react in terms of being able to use our code to analyze
25 these types of things.

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1 And also, in the reactive sense, I have the
2 performance confirmation program. Certainly
3 understanding, what are the important grammars and
4 variables that should feed into performance confirmation.
5 What do we think are the candidates that DOE should be
6 looking at, when they design their performance
7 confirmation program.

8 Integration and coupling of processes and
9 models. Once again, the DOE performance assessment is
10 required to include those features, events, and processes
11 that are going to effect performance.

12 That includes coupled processes. In a
13 proactive sense, we're looking at the types of things, the
14 chemistry is very important to us, in terms -- and the
15 temperature, in terms of the release rates. Generally,
16 we're doing detailed process models, as I indicated, in
17 trying to incorporate the effects as needed into the TPA
18 Code, but it's very important to make sure that all the
19 appropriate degradation mechanisms are considered by the
20 DOE.

21 Certainly in the reactive sense, we're not
22 expecting DOE to include all coupled processes, all
23 phenomena. There will be things that will be screened
24 out, we'll need to verify their assertions. We did not
25 include this particular process, this particular coupling

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1 for these reasons.

2 We'll use, I believe, a combination of the TPA
3 Code, in addition to detailed process models, to help us
4 decide whether we agree with the DOE assertions.

5 Evaluation of uncertainty. Once again, DOE's
6 performance assessment is required to evaluate uncertainty
7 in the calculative, proactively. As you've seen, we're
8 looking at uncertainty. It's an independent calculation;
9 looking for timing, magnitude of the doses.

10 In our code, we have a variety of different
11 models and assumptions we can use, be it the chemistry,
12 the reflux, the saturated zone, the flow field, release
13 rates. There are many different combinations that we can
14 test to see if we're -- what seems to be effecting the
15 performance the most.

16 Reactively, we'll look at how DOE has estimated
17 overall performance, what they've included in their
18 calculation, including subsystem performance, to see if
19 they captured the uncertainty inherent in their
20 calculation.

21 There's also the issue of completeness in any
22 performance assessment. Do you have everything you need
23 to have? Proactively, once again, we're looking at the
24 effects, and looking how that effects the dose, et cetera.

25 Alternative assumptions. Once again, DOE

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1 reactively, they will certainly screen out particular
2 FEP's, some will be screened out because they don't have a
3 significant effect on performance.

4 We'll have the ability in our code, hopefully,
5 to capture some of these, and verify at least with our
6 code, does it truly not have a significant impact. And
7 our code is another vehicle for looking at the impact of
8 some of these things that have been excluded from the
9 analyses.

10 And, you know, in summary, our applications are
11 both proactively and reactively to what's going on. We
12 have a variety of quantitative evaluations, as I
13 indicated. I think we need to -- I think Dave Esh's words
14 were or a nice way of saying, tear apart the DOE analyses,
15 the code gives us that ability. And I realize I think one
16 of the things brought up, clearly, if you don't have it in
17 your total system code, it's hard to get sensitivity to
18 it.

19 And you know, clearly we agree with that, but I
20 think you'll see from some of the presentations later on
21 the program with coupled processes, we are looking at some
22 of these difficult aspects of the repository, be it the
23 chemistry, be it the non-exothermal flow to get a sense of
24 -- trying to get our hands around the uncertainty, where
25 could we be wrong; what could be its impact.

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1 And that's very important. I think those off-
2 line analyses are just as important as the overall PA.
3 You need to understand what you've got included, what it's
4 potential impact is, and certainly when we talk about TPA,
5 we talk about not only the code itself, the supporting
6 bases, and these other process models that are used to
7 assist.

8 With that, I'll stop. I'll be happy to answer
9 any questions.

10 MR. GARRICK: Okay. Committee, any questions?

11 MR. LEVENSON: I have one. Just to protect my
12 reputation, too.

13 MR. MCCARTIN: I'd be disappointed if you
14 didn't have any questions.

15 MR. LEVENSON: You've emphasized the importance
16 of treating the uncertainties when you do the assessments
17 or evaluations. How do you treat generally an uncertainty
18 of a best estimate is more or less symmetric about the
19 value?

20 How do you differentiate, in how you treat an
21 uncertainty around the best estimate, compared to the
22 uncertainty around a conservative or pessimistic estimate,
23 where the only uncertainty is entirely on the safe side,
24 therefore has a different connotation?

25 MR. MCCARTIN: Well, there's certainly the --

1 we hope -- we try to be realistic in most cases. There
2 are some areas where --

3 MR. LEVENSON: But you're assessing somebody
4 else's work?

5 MR. MCCARTIN: Sure. Sure. And most likely in
6 the DOE analysis, the lower speed conditions that could be
7 a little worse and things that could be better. Be it,
8 alternative conceptual models, et cetera.

9 And I think it gets to the use of alternative
10 models, more so than a little jiggle around parameter,
11 what if conditions are much different and some of the one-
12 off analyses and the neutralization analyses -- well, not
13 neutralization, degradation under performance analyses
14 that Dave was talking about.

15 But I think you try to get a sense of what if
16 we're wrong in particular areas. But you're right. In
17 some areas, if "no credit is taken," then there really
18 isn't anything worse, per se. You need to be certain that
19 it isn't detracting from something else. I don't know if
20 that answers you.

21 MR. LEVENSON: Your comment was, it's fairly
22 important that you assess the uncertainty in the DOE
23 estimates. What I'm saying is, that becomes complex,
24 unless you had some idea as to what conservative or
25 pessimistic estimate is.

1 From the first principles, if somebody gives
2 you a value and say, well, it couldn't have measured that
3 to better than plus or minus 50 percent, that's the
4 uncertainty. But if they think of a measuring value and
5 multiplied it by four to use it in the analysis, --

6 MR. MCCARTIN: I see, yeah.

7 MR. LEVENSON: -- that, if you attribute an
8 uncertainty to that, you're doing a disservice.

9 MR. MCCARTIN: Yeah. Yeah. You're right.
10 It's a complicated process, in terms of trying to get your
11 hands around it.

12 I still believe ultimately, you'll go to a
13 simple set of, for lack of a better word, I'll say
14 performance measures.

15 MR. LEVENSON: That's --

16 MR. MCCARTIN: Well, how much infiltration is
17 getting down, how many waste packages are getting wet, and
18 I would prefer to -- well, let's -- I think current
19 estimates I think DOE has 11 percent, I'll say of waste
20 packages experiencing drips. Why do I believe that? What
21 kind of assumptions are tied to that? Could it be twice
22 that? Could it be much less than that? And try to get a
23 handle on some of those intermediate outputs going down
24 the system.

25 MR. GARRICK: I think we're going to have to

1 move on. Are there any other questions from the
2 committee?

3 MR. WYMER: I have one.

4 MR. GARRICK: Okay.

5 MR. WYMER: Do you have any sort of general
6 framework or methodology or a set of criteria for which
7 you can evaluate DOE's uncertainty analysis with respect
8 to the propagation throughout the entire system?

9 MR. MCCARTIN: Well, we're looking at in
10 developing some procedures for the review plan that we've
11 talked to. What kinds of things we need to in reviewing.
12 It's still at an early stage. Other than -- we need to
13 understand what their uncertainty represents; be it the
14 parameters, be it conceptual models, and how they've
15 accounted for it.

16 MR. WYMER: That's sort of an internalist, the
17 overall approach.

18 MR. MCCARTIN: Well --

19 MR. WYMER: The thought that occurs to me, is
20 that there's an unevenness in the uncertainty, in the
21 various stages of the model. And in some cases, they're
22 introduced deliberately, in other cases, they're bedded in
23 the data, and other cases, they're kind of guessed at.

24 MR. MCCARTIN: Sure. Yeah. Yeah.

25 MR. GARRICK: So an uncertainty tracking

1 scheme.

2 MR. MCCARTIN: Yeah, right. That's
3 interesting. That's an interesting thought. I'm not
4 aware that we've gone down that path to try to bend the
5 uncertainties, if you will. Here's an uncertainty that
6 they've done for -- they simply reasons of conceptual
7 modeling uncertainty versus they elected to be
8 conservative versus a parameter. We haven't --

9 MR. GARRICK: Consultants, any questions?

10 MR. CLARK: Just a quick one. This reflects
11 more than a little personal bias, but I think you're -- I
12 think we have a little bit of a difficult situation, in
13 that you're running a model, and you're relying on other
14 people for the data. Are you comfortable you've got a
15 real good communication there, your folks? And I'm a firm
16 believer that the modeler actually even gets the data, if
17 that's possible. Is that a concern to you at all?

18 MR. MCCARTIN: Well, I guess you'd always, as a
19 person making a model, you'd always like to have some data
20 collection on your side.

21 MR. CLARK: I know, but are your folks out
22 there in the field?

23 MR. MCCARTIN: Oh, absolutely.

24 MR. CLARK: Okay.

25 MR. MCCARTIN: I mean, the job is really -- DOE

1 has the budget to develop the characterization and the
2 technical basis supporting the models. And certainly
3 between NRC and Center staff, we have Appendix 7 means,
4 where we go out and look at what's being done.

5 MR. CLARK: There's no substitute for that.

6 MR. MCCARTIN: Oh, absolutely. There's been a
7 lot of visits by NRC Center staff to various laboratories,
8 to Yucca Mountain. And in certain particular areas, we
9 actually have gotten core samples, et cetera, that the
10 Center does some laboratory work.

11 In previous years, when the research budget was
12 a little higher at NRC, there was field work done on
13 natural analogs, et cetera. But generally, we rely on
14 DOE.

15 MR. CLARK: Okay. I don't want to belabor
16 that. I just wanted to raise that.

17 MR. GARRICK: Good point. Andy? I want to
18 thank the speakers today. It was a lot of ground to
19 cover. We've got to decide what we want to do with it,
20 but we appreciate the effort that we're all going through.

21 I think now, unless there's some a question on
22 the prior, somebody, that they'd like to raise at this
23 point, we will adjourn for lunch and expect everybody back
24 here at 1:35 by that clock.

25 (Lunch recess.)

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1 MR. GARRICK: The meeting will come to order.
2 The next topic on our agenda is preclosure safety analysis
3 tool, and to lead us through, from a member standpoint,
4 this discussion will be Milt Levenson.

5 MR. LEVENSON: Thank you, John. It seems to me
6 that the people doing this have really an easier job than
7 the people we heard this morning and yesterday. You don't
8 have the uncertainties of 10,000 or 100,000 years. You
9 can only deal with the certainties in the next 100 years,
10 which should make it somewhat easier maybe.

11 I think I personally view this as really
12 consisting of two parts. And I've been hearing how
13 they're treated, in a sense that the -- essentially
14 everything that's above ground, at the repository, has
15 been done elsewhere before; the handling of fuel, whether
16 it's loading dry cast or pools or unloading reactor
17 containers of all kinds. The low ground activities are
18 new, first of a kind. And I hope during the -- some time
19 during the first couple of these presentations, we will
20 understand whether some of the experience in the past has
21 been blended in to this package for this new undertaking.

22 With that -- can you hear us? Can you hear us?

23 MR. JAGANNATH: Yes.

24 MR. LEVENSON: The floor is all yours.

25 (Reporter's Note: Speaker has accent that is

1 indiscernible at times.)

2 MR. JAGANNATH: Good afternoon. I'm Banad
3 Jagannath from the (indiscernible). I'll briefly present
4 an overview and status of the preclosure safety analysis
5 tool, which we're working on.

6 At this point, I would like to acknowledge the
7 preclosure team here, consists of Mr. Nataraja, Dancer,
8 Ahn, Galvin and Johnson.

9 A brief overview of the presentation.
10 Basically I will set up the background and give you basis
11 of doing the preclosure safety analysis, and part of the
12 tool that is part of that -- the actual presentation of
13 the tool were done by --

14 First I'll talk about the focus on NRC review.
15 What would be the basis of the review safety analysis and
16 then we'll talk about the level of risk.

17 (Indiscernible) contrary to reactor
18 (indiscernible). I'll talk about the preclosure safety
19 analysis required for the regulations, and what NRC review
20 and then (indiscernible) is expected to (indiscernible)
21 and how they're going about it.

22 The focus of the NRC review is basically based
23 on directions from the Commission, (indiscernible) and the
24 strategy plan of the (indiscernible) performance based.

25 (Indiscernible) regulation, particularly the

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1 (indiscernible) complying with performance requirements,
2 (indiscernible) in 63. (indiscernible).

3 The NRC performs a pre-safety (indiscernible)
4 of the site structures, facility hazards (indiscernible)
5 and lately even consequences. In demonstrating the safety
6 case.

7 So (indiscernible) the list components and the
8 consequent components, and performance of those as
9 (indiscernible) the perform base regulation.

10 NRC, we look into these things from the same
11 prospective, and they're looking at what they've done in
12 demonstrating the safety case.

13 NRC's purpose will be basically learning how
14 DOE (indiscernible) the structures, systems, and
15 components that are (indiscernible) safety in the safety
16 case. And (indiscernible) is part of the safety review,
17 to look at the design and other things for (indiscernible)
18 the (indiscernible) -- in this renovation.

19 The next one is a slide on the level of risk,
20 compared to a (indiscernible) --

21 (Indiscernible)

22 NRC, in their review, ... perform focus of
23 these how we the important components, and we may do
24 focus and studies to go deep into that. ... analyses
25 to check the ... is correct. ... focus review for DOE's

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1 work. DOE has to make a case and we ... that.

2 NRC duty review. We are developing a software
3 base to This is basically to help NRC ... work. ...
4 the tool has a lot of ... Each ... represents the
5 components which are listed in the safety analysis like a
6 slide ... structure, hazards, ... scenarios, or those
7 types of information. Each of those have components. ...
8 the next presentation ... that. The ... had authority to
9 ... look at the portion of the DOE's analyses, using any
10 margins they want, to be able to extract ... from that ...
11 module to see whether DOE's performing adequate analyses,
12 ...

13 Also, this is like a ... thing. Most of the
14 ... tool. And that can be used later on by the staff in
15 ... because when you have ... based on any subject, the
16 ... and those conclusions are ...

17 So when it's ... to ... we can extract them
18 from that. It's just a bookkeeping function of this one.

19 Actual tool and it's used by Dr. Dasgupta,
20 will be the next presentation. This is an introduction of
21 the ...

22

23 MR. LEVENSON: Thank you. John, do you have
24 any questions?

25 MR. GARRICK: I don't think so. I think maybe

1 in the next section maybe.

2 MR. LEVENSON: I have a couple, which are a
3 matter of scoping. Where does the preclosure safety
4 analysis start? What I mean by that is, the fuel is being
5 shipped, it arrives on site, it's unloaded, then it moves
6 into the facility. When -- where does this program start
7 being responsible for safety?

8 MR. JAGANNATH: When it comes to the site, from
9 that point onwards, the ... project, and the safety of ...

10 MR. LEVENSON: So as soon as the fuel arrives
11 on site, --

12 MR. JAGANNATH: On site.

13 MR. LEVENSON: Okay. Where --

14 MR. JAGANNATH: Yes?

15 MR. LEVENSON: Where does it end? Does it
16 cover backfilling the repository at the end of the
17 operational time, or does it just stop at the end of the
18 operational time?

19 MR. JAGANNATH: ... by definition of preclosure
20 ... starts. So when ... decides to close it, but
21 operation ... in placing the waste, 25 or 30 years,
22 and beyond that, exists a matter of DOE ... And the ...
23 it can still be part of the very last item of the
24 preclosure.

25 MR. LEVENSON: Okay. I think maybe we can just

1 go on. Thank you. The next presentation, Dr. Dasgupta.
2 Go ahead.

3 MR. DASGUPTA: I'm making a ... safety analysis
4 to ... --

5 MR. LEVENSON: Well, introduce yourself for the
6 court reporter.

7 MR. DASGUPTA: I'm base director from the
8 Center, the Center of ... I'll be talking regarding the
9 preclosure safety analysis tool, part two presentation.

10 First of all, I would like to thank the team
11 ... participated in this work, who are listed over here,
12 and the people that ... at NRC.

13 The ... is Mr. ..., which consists of a brief
14 overview of ... project, preclosure safety analysis
15 methodology, tool demonstration, application of the tool,
16 future work, and conclusion.

17 The ... demonstration that you see over here
18 will be done tomorrow morning at 8:30 over here, so we
19 would ... during this presentation here.

20 A brief overview of the operations of the YMP
21 project. I would like to ... and walk through the
22 operations of the project and then we will comment ...

23 This picture shows the design of the
24 repository. The ... coming from the distant operations
25 that ... north ... area, this is where the surface ... is,

1 and then ... to the underground facility, where the ... is
2 ...

3 In the north portal, this shows the north
4 portal review ... The facility surface is ... in cast, --
5 (Indiscernible)

6 ... the entire facility can be divided into
7 several functional areas. For example, the ... or ...
8 building will be one functional area. The underground
9 testing ... function area, or it could be divided into
10 processes, like ... to the transportation surface
11 transportation or the underground transportation or the
12 fire hazards, anything.

13 So that ... analyze. For example, over here we
14 have listed ... operation in the risk handling building,
15 in which we want the design informations, the process ...,
16 the mechanical ... background, the description of the
17 operations of that ... transfer system, we need to review
18 that. And that information naturally goes down to this
19 box over here down below.

20 Before that, we liked to identify the natural
21 events and ... external events. These natural events are
22 ... specificity with tornado, flood, and things like that.
23 And the human ... external ... raised as the aircraft
24 crash or ... from the nearby military facilities.

25 These hazard analysis -- these are all special

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1 subjects, and ... is going to provide the analysis for all
2 these. These analysis are reviewed ... and only the
3 information of the review information are put inside the
4 tool, primarily the ... of the ... and towards the
5 mitigating features that we have.

6 So this -- these are the information that are
7 stored inside the tool.

8 The next process is identification of human
9 induced internal events. Over here is primary ... the
10 hazard analysis. description of -- based on
11 information that we had accumulated from the canister
12 transfer system. We did try to find out the sequence of
13 operations. The equipment that are used in there, in that
14 system, and the ..., that was to be passing through that
15 area.

16 After that, we gave -- ... or analysis. And
17 primarily to identify the ... that we see here, which
18 means that the ... potential ... there's a potential of
19 radiological dose release.

20 To help us do a ... that --

21 (Indiscernible)

22 MR. LEVENSON: One second, let me go back a
23 minute.

24 MR. DASGUPTA: Sure.

25 MR. LEVENSON: The scenario assumption, you

1 drop the fuel from one meter, and then the next thing we
2 see is a consequence, 11 kilometers away. What are the
3 mechanisms involved, what are the assumptions for ... term
4 for releases? It sounds like you're assuming you dropped
5 the fuel from one meter, it all splits wide open and all
6 becomes airborne or something.

7 MR. DASGUPTA: No, I don't think it's a drop.

8 MR. LEVENSON: Well, what sort of tools are
9 being used for this?

10 MR. DASGUPTA: ...

11 MR. BENKE: This is Roland Benke, from the
12 Center of Consequence and Analysis.

13 What we did, is we used new Reg 15, 36 and
14 1567, to give us release fractions for impact rupture. So
15 typically, something for particulates would be like two
16 particles released in every million of this drop.

17 The release height is assumed to be one meter,
18 let's say a canister on the ground; however, the drop
19 height could've been higher. The assumption is that reach
20 curves so that maybe, you know, the crane was at six
21 meters or three meters, something like that.

22 MR. LEVENSON: So you mean this consequence
23 doesn't follow from the scenario?

24 MR. BENKE: The release --

25 MR. LEVENSON: The scenario is one meter drop?

1 MR. BENKE: No, that's the release height.
2 That's assuming that the Hepa vents from the waste
3 handling building would be at a one meter height. It
4 might not be realistic, but it's assumed for this example.

5 So if a stack is used, maybe the release height
6 would be 10 meters or 20.

7 MR. LEVENSON: Oh. This isn't the drop?

8 MR. BENKE: Correct.

9 MR. LEVENSON: Because that -- what confused me
10 is the term instantaneous release. Okay. So you're
11 assuming the instant it's dropped, everything that comes
12 out of it, is going out the stack?

13 MR. BENKE: Correct.

14 MR. LEVENSON: Is that what the word
15 instantaneous means?

16 MR. BENKE: Yes.

17 MR. LEVENSON: Do you have any estimate as to
18 what the conservatism is in that?

19 MR. BENKE: That kind of follows on to our
20 future work, where we're be using Melcor code, to
21 determine the amount of this release material from the
22 canisters, and determine how long it takes for it to go
23 through the ventilation system, and then how much is
24 retained within the building, due to gravitational
25 settling and et cetera. So more detail will be added at a

1 later date.

2 MR. DASGUPTA: Yes. And over here, back to the
3 future work, we would ... we would also the worker dose
4 calculation. ... database, we would ... documents. And we
5 would have interactions with DOE. So far we have very
6 limited interactions with DOE, but it's been planned for
7 the next year, February.

8 The conclusions from this topic is ... the tool
9 is intended to assist the NRC to review DOE's ... safety
10 analysis for the preconclusion period quickly and
11 systematically to important to safety.

12 The tool is ... using visual ... and we have
13 incorporated some ... in our software. The tool has the
14 capability to perform safety analysis for the entire
15 operations ... selected operations.

16 ... talk here, so if you have questions, please
17 ...

18 MR. WYMER: A couple of small things occur to
19 me. I think they're safety related. I couldn't tell from
20 the drawings, the plan of the facility, what about there's
21 any surge capacity? By that, I mean there will be
22 shipments coming in containers, but if something shuts
23 down with respect to getting -- hitting the repository
24 canister, then things will be stacking up.

25 Is there a place to put them?

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1 MR. DASGUPTA: We, so far, from the design -- I
2 think the information that so far what we had
3 information were very little. And as you saw, the
4 drawings that we have, is almost like cartoon drawings.

5 But to answer your question, we did not ...
6 very large stacking of the material, but there will be ...
7 stacked outside, and there are some ... for the canisters
8 to be stacked inside, but we do not know what's the amount
9 of those storage facilities.

10 MR. WYMER: Okay. There will be safety
11 considerations associated with those.

12 MR. DASGUPTA: That's correct. And if -- I
13 agree with you, and especially if there is aircraft crash
14 probability is higher ... than it can ... for safety.

15 MR. WYMER: All right. My second point is,
16 what about things like ventilation failure, especially
17 associated with releases activity, and I didn't see that
18 in there.

19 MR. DASGUPTA: Right. And I think they do have
20 an escape for the ventilation, and I think fairly recent
21 ... back shows that they have two or three levels of
22 ventilation in the primary -- secondary levels.

23 The ventilation is -- they have -- you know,
24 it's a differential pressure that it's been sucked inside
25 the ... and then from there, it comes out of the heat

1 pump.

2 MR. WYMER: And there's no pressure
3 differential.

4 MR. DASGUPTA: Right.

5 MR. WYMER: Then unrelated to that, after the
6 fuel shipments stop storage, there still is quite a while
7 before closure.

8 MR. DASGUPTA: Correct.

9 MR. WYMER: Is it your responsibility to
10 evaluate the safety of the ventilation system after
11 storage is completed before closure?

12 MR. DASGUPTA: I think so. I have not gone
13 that far to ... but if anyone can address that issue, yes.

14 MR. GARRICK: Well, certainly anything that's
15 related to public health and safety would be an issue
16 before us, ventilation --

17 MR. DASGUPTA: ...

18 MR. GARRICK: ... could some leakage from the
19 waste package could get to -- that's an issue, and --

20 MR. WYMER: Yeah. The question is really,
21 whether it's explicitly recognized in the safety analysis.

22 MR. GARRICK: Oh, yeah.

23 MR. LEVENSON: George? John?

24 MR. GARRICK: Yeah. The NRC has a legacy of
25 safety analysis tools that go way back, and you know, from

1 safety analysis reports to SER's to PRA, to integrated
2 safety analysis, and probably others, and now this.

3 What's the difference between what you're
4 trying to develop here, for example, and the integrated
5 safety analysis method that they employ on such things as
6 fuel cycle facilities, et cetera?

7 MR. DASGUPTA: Well, this methodology is no
8 different than any other methodologies that you have seen
9 that we have the same ... over here. And as you saw, we
10 are using ...

11 MR. GARRICK: Right.

12 MR. DASGUPTA: ... has been used by PRA. But
13 what we have tried to bring together in one place, under
14 one umbrella, which we did not see. Say for example, as
15 with ..., that using the same tool and the same file, we
16 could keep -- be able to keep track of their facility.
17 Either we do the safety analysis or DOE does, and we
18 accept that, and we divide that into functional area, and
19 then keep the information.

20 Now, this tool is not only for this coming
21 license application, which is the construction
22 authorization, which during this time, we will not have
23 much to ..., but this tool is for way beyond that ... DOE
24 is going to present again the safety analysis to
25 possession of waste. And during that time, the design

1 will be much more detailed, and a lot of information will
2 be there.

3 So this tool keeps -- gives us a ... of the ...
4 that means today while we are looking at the canister
5 transfer system and we have ... and we find out that DOE
6 has -- well, is going to take care of ... with certain
7 safeguard, and that's why this event is no longer a ...
8 event. We would then again check to ... the final design
9 that such safeguards are in place ...

10 So this one gives -- it keeps track of the
11 holding, so it's not just for this part of the license
12 application ... it should be designed to take way beyond
13 that.

14 MR. GARRICK: Yeah. Well, the question was,
15 with all the safety analysis tools you have, and there's
16 others like the PRA that's being done on dry storage
17 facilities, I was just curious as to why there is a need
18 for another one.

19 Is the strategy here the same as for the TPA,
20 that is, to say have an independent safety analysis tool
21 to independently check, if you wish, the results of DOE's
22 PESCA?

23 MR. DASGUPTA: That's correct. I mean, we ...
24 if we were required, we will do an independent analysis of
25 that, that's correct. I mean, because this is a review

1 tool. This is -- while reviewing, we may have to do the
2 analysis. We might ... that their hazards are that
3 they have identified all the hazards, we might want to do
4 that.

5 If you're satisfied with that, we might just
6 want to check into their or the sequence of events
7 they have ... calculated or evaluated currently or not.
8 And bringing all that together, but I believe -- I mean,
9 we looked at and didn't find any tool that encompasses the
10 entirety together, what -- this is, as you saw, there are
11 different tools we brought together and put under one
12 umbrella.

13 And it's just a bookkeeping and it's not any --

14 MR. GARRICK: Yeah. One of the things that I'm
15 just curious and may be concerned about. Is this problem
16 may be able -- you may be able to confine this problem to
17 just a couple of operations with your cut-off criteria
18 that you've adopted. And as you've already said, the
19 canister is the biggest worry, the handling of the
20 canister.

21 And I guess that the thing that one would
22 wonder about here, is not over complicating it. It looks
23 like a pretty simple analysis and the people aren't used
24 to me saying this, but it would seem that abouting an
25 analysis would eliminate most of the scenarios that you

1 could imagine, except for maybe the on-site canister
2 handling scenarios, or a few -- and even there, you could
3 probably bound it.

4 And I'm very suspicious of this result at 11
5 kilometers. It seems like for a falling accident, that
6 seems awfully high, especially given the results that I
7 recall from the transportation studies at SanDio, where
8 they literally beat up on containers and cast, and what
9 have you, and hardly got any release, or never got any
10 release from train crashes and truck crashes and what have
11 you.

12 So I guess one of the things that it seems to
13 me, is there might be an opportunity here to narrow that
14 problem down to just a couple of scenarios. And I assume
15 that if that's possible, that's something you'll do. It
16 just doesn't seem like it's that big a deal.

17 MR. DASGUPTA: I agree with you, in some cases
18 we could do that. But our problem is, when we get into
19 the next phase, I think you will see a lot of details, and
20 maybe we are preparing for the next phase of the analyses.

21 MR. GARRICK: Yeah. I'm sure you're aware of
22 this, but one of the things you have to be a little
23 concerned about when you assign cut-off frequencies, is
24 how many scenarios you're going to end up with. Just
25 pushing it to the limit, if you have 10 to the minus 6

1 cut-off and you have a million scenarios, you know, you're
2 going to have an accident a year.

3 So these cut-off things on unbounded numbers of
4 scenarios is something that you have to be very careful
5 with. In a reactor, it's not uncommon to have a million
6 scenarios, for example, you know, because of the
7 combinations of permutations are really amplified because
8 of all of the mitigation features that you have.

9 Now, in this case, you know, you're not talking
10 about anything like that. But a 10 to the minus 6 cut-off
11 criteria in a reactor, would be totally unacceptable. I
12 expect here, it's probably okay.

13 MR. LEVENSON: Tim?

14 MR. MCCARTIN: Yeah. One quick thing, Dr.
15 Dasgupta, and I would read generally the operations are --
16 seem to be relatively simple, and there should be a huge
17 scenario that could capture how worried should we be.

18 However, as easily said, what -- over the last
19 year or so, what we realized, is we really don't have --
20 haven't analyzed the problem to any degree of -- well, to
21 any detail to allow us to really defend that gut feeling.
22 And this is an attempt to -- to using other tools that are
23 out there, but let's do a systematic look at this, and
24 make sure that gut feeling is right.

25 And you want to make sure those cases where

1 there possibly could be a fire or an explosion, what's
2 going to happen, what could happen, and just
3 systematically go through it, just to make sure.

4 MR. GARRICK: Yeah.

5 MR. PATRICK: If I could, Wes Patrick with the
6 Center. Wes Patrick of the Center.

7 Just to clarify, there are a couple of things
8 in these presentation that look like there's a slight
9 misunderstanding.

10 The Sandia work, what I think you're referring
11 to, Dr. Garrick, was cast --

12 MR. GARRICK: Yeah, I know.

13 MR. PATRICK: These were baskets of their fuel
14 assemblies. So it's a very different thing, their fuel
15 assemblies.

16 MR. GARRICK: Yeah.

17 MR. PATRICK: So it isn't like a fragile
18 system.

19 MR. GARRICK: But the violence of the tests
20 were ever so much greater, too, with 70 mile an hour train
21 crashes and truck crashes.

22 MR. LEVENSON: Okay. I think that a couple of
23 speakers ago, there was a discussion of the desirable
24 philosophy of analysis. It seems to me, this is a very
25 good one to start practicing that, and do only a best

1 estimate analysis, rather than doing very pessimistic and
2 ultra-conservative. Because unlike reactors, there's no
3 issues of stored energy, there's no issues of sudden
4 energy release. It's orders of magnitude differ from
5 potential, and so I think that it's a good place to start
6 doing only best estimate.

7 I'll ask one question on your slide 20, you
8 identified continued development of failure rate database.
9 What does that mean?

10 MR. DASGUPTA: This is equipment failure.

11 MR. LEVENSON: I know, yeah. But I mean --

12 MR. DASGUPTA: Well, we have started looking
13 into different figure rates, because --

14 MR. LEVENSON: This is just collecting the data
15 because --

16 MR. DASGUPTA: That's right.

17 MR. LEVENSON: -- the NRC has, you know, for
18 the most of the things that are of interest to, crane
19 failures, all of those sorts of things. There's a huge
20 database that already exists.

21 MR. DASGUPTA: Right. And those are the ones
22 that we're collecting. It's primarily based on the
23 nuclear ... industries. But we also have to ... addressed
24 your ... and we have not ... this stuff, but that is our
25 next aim to see what happens underground. And we have to

1 look into -- in the underground part of the
2 transportation, we are looking at the mining. We are
3 looking into the -- you know, the metro rail and what are
4 the accident scenarios over there that would cause this
5 sort of thing.

6 So we have to eventually ... as well. And we
7 have to continue for those data in the next year.

8 MR. LEVENSON: I would hope in this nature of
9 doing best estimates, you wouldn't just take mining data.
10 I think --

11 MR. DASGUPTA: Yeah.

12 MR. LEVENSON: -- but actually experience of
13 the Department of Energy shipping transportation system is
14 significantly different than the trucking industry at
15 large, because of all of the additional requirements,
16 everything from training and equipment and safety. Of
17 course, I would hope that --

18 MR. DASGUPTA: Sure, yes.

19 MR. LEVENSON: -- you similarly --

20 MR. DASGUPTA: Right. We --

21 MR. LEVENSON: -- strive for best --

22 MR. DASGUPTA: Sure.

23 MR. LEVENSON: Anyone else have any questions?

24 MR. GARRICK: John Larkins.

25 MR. LARKINS: Just for my information, one area

1 where you can't potentially get a somewhat energetic
2 release, would be fires, and the risk methods that are
3 currently being used for reactors might not be totally
4 applicable with these scenarios. Particularly if you have
5 a canister that can break open and it could air oxidation,
6 so that might be an area that you want to --

7 MR. LEVENSON: That's been looked at for dry
8 cast storage?

9 MR. LARKINS: Not very well. Not very well. I
10 don't think all these issues are totally addressed.

11 And I have a second question for information.
12 On the decision on the performance objectives for SSC's,
13 has that been already defined?

14 MR. DASGUPTA: No. I think that's the job of
15 the next year or I think NRC's looking into that ... or,
16 Tim, do you want to address that question?

17 MR. LARKINS: And we can talk about it off line
18 to save time. You mentioned a decision on SSC's important
19 safety, and performance objectives for those.

20 MR. MCCARTIN: Well, I assume, you know, those
21 things that are needed to meet the performance objectives
22 for preclosure are things that mesh. ... and now there are
23 discussions, and I don't know if Raj wants to talk, that
24 in terms of integrated QA and things of that issue that
25 are ongoing with DOE.

1 MR. LARKINS: The last time we talked about it,
2 if these were still being developed to discuss, and I was
3 just curious as to whether or not some criteria
4 performance objectives had been developed for those SSC's
5 and safety.

6 MR. MCCARTIN: Other than what's --

7 MR. JAGANNATH: No. We are not developing any
8 new criteria. Basically compliance with the ... and
9 category of the ... based on the frequency to ... we had
10 to make a decision on ... safety, in terms of those
11 or in terms of frequency ..., ... to make sure that
12 classification number is correct. But the decision ... we
13 are not ... yet, but basically looking at the data, we ...
14 systems are ... safety. If not ... if it is not function,
15 we ... those ... pick it up. It's not final as yet, but
16 we're working towards it.

17 MR. LEVENSON: Any other questions, comments?
18 Back to you, John.

19 MR. GARRICK: Thank you. Yeah, you've done a
20 wonderful job with that, and now I'm going to rule on
21 that. Not really.

22 I wanted to announce that we're making an
23 agenda change or a schedule change of the agenda for
24 tomorrow. And you might want to make a note of it.

25 Because one of our members is having to leave

1 earlier, we, through the cooperative effort of the Center
2 and other presenters, we have moved the agenda item
3 tomorrow that's labeled investigation and importance of
4 coupled processes related to repository design to be first
5 at 8:30, and it'll go from 8:30 to 10:00, and there will
6 be a break from 10:00 to 10:15, and then from 10:15 on
7 until noon, we'll have our tour.

8 So that also facilitates the court reporter
9 requirement, because we only need the court reporter for
10 these session -- the first session that'll go from 8:30 to
11 10:00. I hope that doesn't create any problems for
12 others.

13 Okay. With that, we'll take our break.

14 (A break was held at this time.)

15 MR. GARRICK: This is going to be the sessions
16 on alloy C-22 studies, and the chemist member of our
17 committee will lead the discussions.

18 MR. WYMER: Well, we finally got now to the
19 nitty gritty. Or at least the nitty.

20 And this afternoon we have two presentations,
21 one from the Center and one by DOE, in that order. And
22 there are two important features which I hope with respect
23 to dwell on; one is the nature of the fabricated alloy
24 that -- C-22 which goes in to making the outer layer of
25 the waste package. And the second is the nature of the

1 dissolving solutions, the corrosion -- discussed that's
2 carried out, and what -- how suitable is J-13 as a
3 material -- as the base solvent.

4 And finally, I hope something will be said
5 about the need for a better understanding of the
6 mechanisms of corrosion of C-22, which in my mind, is
7 needed if we intend to make the great extrapolations that
8 are necessary to go from 5, 10 or 20 years to 10,000 years
9 with respect to the corrosion.

10 So with those grand expectations, we'll have
11 Tip come forward. The first presenter -- well, introduce
12 yourself and your affiliation, if you will, for the
13 committee.

14 MR. SRIDHAR: Okay. Narasi Sridhar from the
15 Center. Thank you, Ray. I pushed the wrong button here,
16 didn't I?

17 Okay. In the topics that I'm going to cover in
18 my presentation, I'm going to talk very briefly about
19 historical viewpoint on allow 22, how it came to be, and
20 then going to talk about first insights, and especially
21 focus on localized solution and strip corrosion cracking,
22 what are the predicted methodologies that we are using and
23 DOE's using; hone in on the effect of fabrication and
24 thermal treatment and what our concerns are.

25 And as I briefly mentioned, the effect of minor

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1 acuties in the ground water, then proper -- a little bit
2 about uniform dissolution, because that dictates a lot of
3 the performance in our performance assessment codes.

4 And then finally, I'll briefly mention the
5 status of the subissue resolution.

6 The alloy C-22 which is really a family of C-
7 type alloys. The first origin of the alloys was by Edward
8 Haynes and other independently in the UK discovered Ni-Cr
9 alloys in 1898.

10 Edward Haynes really discovered it to satisfy
11 his wife, who was complaining that all the kitchen knives
12 were routing to corrosion, and so he -- a better alloy to
13 hold the edge.

14 Later on, alloy C was developed by Union
15 Carbine in the 30's. The problem with alloy C was that it
16 had very high carbide and silicon and ... used as
17 castings, which of course, many of the chemical plants and
18 users didn't like, because they wanted ... products to be
19 used as blades and sheaves for more practical uses.

20 So -- many people were investigating how to
21 make these alloys into broad shapes, and be ... from
22 Germany, using the newly discovered at the time, argon
23 oxygen carbonization process, double up the low carbon
24 version of alloy C, which is called alloy C-276. I don't
25 know why where that 276 came from. I've never found out

1 after all these years.

2 C-276 was okay to make materials, and in fact,
3 was the work horse of the chemical process industry for a
4 number of years, and continues to be today. But it had
5 some thermal stability problems, especially ... the
6 material, so alloy C-4 was developed in 1973.

7 C-4, one of the interesting things about it, is
8 it was also tried out as a candidate alloy by the Germany
9 ... program for the sole repository. And so there is some
10 data available for C-4 in soft text. And in a way -- the
11 reason I'm mentioning this history, is also to say that
12 even though these alloys are relatively new compared to
13 iron and other -- and copper, for example, there is some
14 industrial experience. And we could use that experience,
15 if we can build a framework to ... that experience to
16 determine whether the models that we're using in our
17 performance assessment code are -- provide data confidence
18 in our models, basically.

19 So C-4, the recent data available, and we have
20 done some analysis back in '95 of the data that the
21 Germans had developed and showed that the models that
22 we're using in terms of ... potential are consistent with
23 what they found in terms of C-4 performance.

24 Alloy C-22 was developed in '81, because the C-
25 276 and C-4-type alloys were not very useful in highly

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1 oxidizing environment, such as nitric acid and so on.
2 They didn't have enough chromium, so C-22 was developed in
3 '81. But surprisingly, C-22 was found to be highly
4 resistant to chloride-containing environments also.

5 So C-22 was really the place ... C-276 in many
6 applications, and later on, of course, the late '80s,
7 other ... alloys, such as alloy 59 by the German company
8 ... and 622 by the ... were commercialized.

9 So a lot of these alloys are now being used in
10 ... they test very high in chloride concentration, very
11 highly oxidizing conditions, plus ... gas, which provides
12 acidity.

13 In chemical process ..., which are all these
14 unpredictable mixtures of environment, ... also has very
15 high concentration of ... in some cases. And, of course,
16 both ... systems which have chloride has an oxidating
17 agent.

18 So there is quite a bit of history, and one
19 needs to put these various experiences in a map to gain
20 confidence, in order to perform our assessment model.

21 In terms of what are the issues of, you know,
22 from a performance assessment standpoint for the
23 application of these alloys and containers.

24 Well, it turns out that because alloy 22 is so
25 highly resistant to localized corrosion, the container

1 life now is dictated by uniform dissolution. And so one
2 needs to understand what the rate of dissolution is, and
3 how to gain a better -- make an ... understanding of this
4 dissolution process, we'll have confidence in the long-
5 term prediction.

6 The other thing is that effect of fabrication
7 process. What we find is that, especially in the DOE's
8 safety case that I'm going to talk about a little bit
9 earlier, the compressive zone by the thermal treatments to
10 overcome the residue of ... from the ... creates a zone of
11 compressive stresses. The width of this compressive zone
12 becomes an important parameter, to determine the life of a
13 container.

14 In other words, corrosion has to go through
15 these compressive zone and then stress corrosion cracking
16 takes place, ... data show the width of the compressive
17 zone needs to be ... a little bit better, in terms of the
18 effect of fabrication processes.

19 And then, of course, the thermal treatments to
20 overcome the problems in fabrication process, changes the
21 microstructure and that may have a ... effect on the
22 corrosion.

23 And, of course, the importance of near field
24 chemistry is always there, and that's going to be
25 discussed substantially tomorrow, and I'm not going to do

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1 ... as much today.

2 Okay. In terms of the design features. 825
3 was originally specified in the design, and then later on,
4 625 was thought about briefly, and then C-22 is currently
5 being used, and it has a ... effect on container life as
6 shown here.

7 Basically it shows that the percentage of the
8 fraction of the waste package failed for alloy C-22 is a
9 quite bit lower for a given time period, then that of 825
10 and 625.

11 Well, why is this the case? If you look at the
12 ... potential as a function of chloride concentration,
13 again, our performance assessment code, the conceptual
14 model is that if the corrosion potential of a given alloy
15 exceeds the repassivation potential of that alloy, then
16 localized corrosion takes place. And once localized
17 corrosion starts, the corrosion penetration is very rapid.
18 So ... starts pretty soon after.

19 So for a given chloride concentration and a
20 given corrosion potential, if the repassivation potential
21 of a particular material is higher than it is more
22 resistant to localized corrosion and so it lasts longer.

23 So, for example, the corrosion potential and
24 the repository condition is roughly 0 to minus 200 mV. So
25 if you draw a band from 0 to 200 mV, you can see that ...

1 extremely low chloride concentrations, roughly the minus 3
2 order.

3 625 is a little bit better, roughly about one
4 more, and C-22 is quite a bit better. You almost have to
5 go to saturation of sodium chloride before localized
6 corrosion occurs.

7 So that's the reason why the performance
8 assessment calculation shows that the percentage of this
9 package failure due to corrosion is much lower for C-22
10 than for 825.

11 Now, of course, we have done a lot of studies.
12 Some of you will say ... lab door, to show that the
13 repassivation potential is a good parameter to predict the
14 occurrence of localized corrosion for these types of
15 materials.

16 Well, how does the effect of fabrication come
17 in? Well, if you look at the repassivation potential,
18 again I'm shown the zone of danger, that is the zone of
19 corrosion potential. In this case, for the higher -- this
20 is for the ... chloride concentration, so the corrosion
21 potential should get to a lower value, come back a lower
22 chloride concentration, because the oxygen solubility is
23 lower at higher chloride concentration ... of it.

24 So the corrosion concentration is sort that of
25 all orangish-band of minus 200 to minus 300 mV, if I could

1 read the numbers from here.

2 And what it shows is, if you have non ...
3 material, just a base metal, as shown by the open
4 triangles, the repassivation potential is quite a bit
5 higher than the corrosion potential, so localized
6 corrosion at the 4 ... sodium chloride, at this
7 temperature is not likely for alloy 22.

8 If you ... it, then you have diffused ...,
9 which is quite a bit higher than the corrosion potential.
10 So ... in this particular case, this is of course, ... of
11 the a thin sample, not a thick container, so there may be
12 differences between the two.

13 But at least in this case, the ... does not
14 produce tremendous -- it lowers the repassivation
15 potential, but it does not ... into the zone. Of course,
16 we don't have an update to really show the distribution in
17 the repassivation potential. That needs to be generated.

18 But the most important thing is if you age the
19 material at 870 centigrade for even half an hour, the
20 repassivation potential moves into the danger zone for the
21 alloy.

22 What this means is that any thermal treatment
23 ... that exposes the alloy to this temperature and this
24 time range, the alloy can be effected adversely in doses
25 of low corrosion.

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1 So this is the concern we have in terms of any
2 post ... fabrication that one would perform on this alloy,
3 and how that could effect the behavior of the alloy.

4 Well, why is this post ... fabrication a
5 concern? Let's look at stress corrosion cracking as to
6 the other failure mode.

7 That ... sort of ... streams of investigation.
8 And I sort of tried to put this into kind of a flow chart
9 here.

10 If you look at the DOE investigation so far,
11 investigation done by Peter Andresen at GE and Lawrence
12 Livermore, have shown that relatively rapid crack growth
13 can occur if you initiate the cracking by some sort of
14 cyclic loading. Dave Stahl is going to present some of
15 that information later on.

16 The crack growth rates of the order of 10 minus
17 8 to 10 minus 9 millimeter per second. So if you
18 translate it, then that penetration through ... wall is a
19 decade or so.

20 So in order to overcome this potential problem
21 identified by a stress growth cracking test, post-weld
22 annealing has been proposed by DOE to create compressive
23 zone, because stress growth cracking ... stresses to open
24 the ... for them to drill.

25 So if you have compressive stresses, then

1 stress corrosion cracking can be prevented.

2 So our concern really is that what would be the
3 deleterious effect of this post-weld annealing. What
4 would subject the material to the thermal regime, under
5 which you can enhance localized corrosion behavior.

6 What will be the range of this discompressive
7 zone? Would it be 2 millimeters, 3, millimeters 5
8 millimeters, 1 millimeters, we don't know with this
9 material with this limited data. So that is the one
10 stream of activity.

11 The State of Nevada ... showed some very
12 deleterious effects of minor impurities and ... in the
13 next line. And showed that lead and sulphur and mercury
14 in the solution can cause increased stress corrosion and
15 cracking ... corrosion.

16 Our concern really is that the data as
17 currently generated by them is not really relevant to ...,
18 but what we need to do is put this in perspective of the
19 ... susceptibility, and I'll talk a little bit about that,
20 what I mean.

21 Our long work at the center have not shown
22 stress corrosion cracking of C-22, as long as the
23 potential is below the repassivation potential.

24 Of course, we are not use cyclic stresses, we
25 have used static loading, because that's what we

1 anticipate to be the loading condition in the ...

2 What we need to do is also do some confirmatory
3 testing to look at ... and look at the minor impurities.

4 Coming back to the effect of minor impurity.
5 The Catholic University data as it stands now, as I
6 understand it, is that if you add that and in their case,
7 they added lead acetate, ... 1000 ppm concentration, and
8 if the temperature is above 400 degrees centigrade, then
9 ... conditions at pH .5, a tremendously fast stress
10 corrosion cracking can occur in C-22, even under that
11 condition.

12 They didn't find any cracking at room
13 temperature, or without lead.

14 They did not establish a critical potential for
15 SCC. That means if you have conditions that the potential
16 of the alloy is below critical potential, would SCC occur
17 or not, is not known, so the true ... of susceptibility of
18 this alloy is not known. And one needs to know this
19 window of susceptibility, in order to find out whether
20 this window falls within the window of anticipated ...
21 field and environmental conditions.

22 Now, the cracking of lead and alloys, this type
23 of alloy is not new. It's been known since '65, alloy
24 600. The activation energy is very high, at least very
25 limited data shows that. So test ... centigrade to

1 translate to anticipated ... environments, I don't know
2 what the crack velocity would be. And crack in the alloy
3 22 has been shown to occur at these kinds of pH's in --
4 even without lead. So we, at this point, don't know
5 whether lead is a ... agent or just the pH.

6 So again, the ... of susceptibility for this
7 alloy needs to be established for these kinds of
8 impurities.

9 So we ... what needs to be done is, the test
10 temperature at this point is much higher than anticipated
11 for wet conditions, 2 ... centigrade that the ... is not
12 going to produce a wet environment.

13 So the effect of anticipated temperature at the
14 ... stress corrosion cracking needs to be established.
15 The effective anticipated pH of water on the stress
16 corrosion cracking needs to be established. As I
17 mentioned before, stress corrosion cracking has been
18 observed at low pH, even without lead.

19 The range of lead and other minute impurity
20 concentrations that need to enhance SCC and localized
21 corrosion needs to be established. And the ... of lead in
22 evaporated water is a question. Lead was added as lead
23 acetate, most of it is soluble in the environment, that
24 the test was conducted, but wasn't ... near field
25 conditions. Some preliminary calculation we have done

1 here showed that when you have that much lead, most of it
2 precipitates out as, you know, various lead compounds, and
3 the only soluble species that is predominantly present is
4 lead carbonate, ... carbonate, and that concentration is
5 quite low.

6 And how does the range of cracking for
7 stability, the potential for cracking correspond to the
8 range of anticipated potential of the ... is another
9 question that needs to be answered.

10 Okay. Now, going back to the topic of SCC
11 mitigation. Because the stress corrosion cracking tests
12 that are being conducted by DOE, leads to very high crack
13 growth rate.

14 DOE has proposed that they would remove the ...
15 stresses through local annealing. The laser shot peening
16 is produced for the inner lead and the induction annealing
17 is proposed for the outer lead.

18 Basically these subjective material to create a
19 high temperature, it will create a compressive zone.

20 So the temperature profile near the pre-cut
21 zone is something that needs to be determined.

22 The container life then is determined by the
23 uniform penetration rate of the alloy 22 through this
24 compressive zone. And then once it's penetrated, a rapid
25 failure occurs.

1 Now, we looked at the uniform corrosion rate,
2 because even in our performance assessment calculations,
3 the uniform dissolution rate of alloy chemicals becomes
4 ..., because of the localized corrosion assistance of the
5 alloy.

6 And these are the kinds of ranges of uniform
7 corrosion rates that we have observed. We measured the
8 uniform corrosion rate by monitoring the current density,
9 the anodic current density, because you can monitor
10 current density much more accurately into the grade of a
11 solution, than measure weight loss, and calculate the end
12 ... corrosion rate.

13 And you can see that rates of uniform corrosion
14 rate can lead to very high lifetime. If a concentrate of
15 this solution is assumed. And we have shown the rates
16 that are assumed at the TPA Code.

17 The assumed rates of uniform dissolution for
18 DOE is roughly a ... 92 lower.

19 We have measured the uniform dissolution rate
20 as a function of ... potential. And what you can see is
21 that the -- on the right-hand side, the dissolution rate
22 increases, but it accurately ... with these very high
23 potentials are not likely, but possibly, because you don't
24 have transpassive conditions.

25 The corrosion potential is more likely to be in

1 the minus 200, because ... minimal range at which the
2 passive dissolution rate is relatively constant, with
3 respect to potential, because you're getting a leakage
4 through an ... and the corrosion rate is essentially
5 independent of a chloride concentration.

6 So the growth and rate is not a great function
7 of the ... field chemistry, as long as you maintain human
8 form dissolution rate ... localized corrosion.

9 But the uniform corrosion rate depends on the
10 microstructural conditions; that is, the thermal treatment
11 that the material is subjected to.

12 What we have shown here, is that both in the
13 as-received condition and the welded condition, that is
14 when you weld it using the appropriate procedures for the
15 alloy, the uniform dissolution rate is pretty low, and is
16 not a function of fabrication.

17 But if you thermally treat it, in this case, we
18 have exposed it for four hours at 800 degrees centigrade,
19 which is just a mimic of possible thermal explosion and
20 doing treatment. You can get extremely high
21 corrosion rate ... corrosion constant of intergranular.

22 So the question really is, who would get the
23 material into this condition, to have very high corrosion
24 rates.

25 The next thing we wanted to do was get a better

1 understanding of the uniform dissolution behavior of the
2 alloy. Because most of the lab estimates are pretty
3 short-term, and we want to find out what would be the
4 processes that ... uniform dissolution of this alloy.

5 One of the proposed models has been ... model
6 called the ... defect model.

7 Basically, the model assumes that you have an
8 alloy on the left-hand side, and then you have a passive
9 ... that's essentially chromium oxide ... in this case, we
10 assume it's a crystalline filament of chromium oxide. And
11 then the right-hand side is the ... solution.

12 And the dissolution occurs by the movement of
13 point defects within the chromium oxide. You have similar
14 types of point defects. You have, of course, the oxygen
15 in position that move from the left to right, and you have
16 the vacancies where there is not a chromium presence, so
17 these are negatively charged species that move from right
18 to left, and especially, if there is chloride in that
19 environment, they will move faster, because of their
20 having force of the charges, and then you have other ...
21 defects of ... of nickel, and chromium and ... that move
22 from left to right.

23 So the net dissolution rate, that is the
24 capital I in the bottom is the effect of these various
25 movements of these charges within these outside ...

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1 That's what the model proposes.

2 Unfortunately, the problem with this model is
3 that you don't have a very good idea of what all are the
4 ... are. They are not easily determined independently.

5 So what we have done, I should say me, I should
6 say a ... in our group who did more on the calculation is
7 ... going back to the -- we know that capital I through
8 experimental measurements and by estimating various K
9 values, we can play with what will be the proportion of
10 contributions from the different processes to the net I.

11 And one of the main concerns for us is really
12 that the net movement of these point defects creates
13 vacancies in the metal. Here the picture is the worst of
14 the previous line. The oxide film is on the left, and the
15 alloy is on the right. And what happens is, due to the
16 net movement of these point defects, you inject vacancies
17 into the metal.

18 So the first thing is really that, for the
19 short time period, these don't matter because the
20 injection of the -- the rate of injection of vacancies is
21 very small, so we won't even see it.

22 But over 10,000 years, these may be quite
23 substantial. So would it have a negative effect on the
24 performance of the material is a question we're trying to
25 answer.

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1 Again, this falls into the category of have you
2 thought of processes that, you know, basically people
3 haven't thought about that ... that have a ... effect.

4 So this is one of the concerns that we have is,
5 what we have in vacancies injected into the alloy to
6 increase the dissolution rate of the material.

7 And what the calculations show and here I've --
8 I don't want to go into the detail, but we have sort of a
9 number of different cases we have evaluated, based on
10 different K values that we have assumed. And you can see
11 that failure of ... anywhere from 30,000 years to an
12 extremely high number.

13 And what needs to happen is, this model needs
14 verification. Basically, what we are trying to do here
15 is, we pulled the one level further in terms of
16 understanding the dissolution behavior, and this is one of
17 the models that look promising, in terms of explaining the
18 uniform dissolution behavior of this type of alloy. But
19 it raises some questions on the generation of point
20 defects within the alloy that need some ... experimental
21 verification.

22 Of course, experimental verification of this
23 model is not easy, because the rate of generation of these
24 point defects, and the rate of injection are extremely
25 small. And so very sensitive measurements need to be

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1 made. And that's something that we have grappling with on
2 how we're going to do that.

3 Okay. Finally, issue resolution, we had a ...
4 exchange as mentioned before on container life and source
5 term, and all the subissues are, at this point, closed
6 pending. The back-up slides, I've provided some details
7 on the agreements.

8 The one thing I want to note is that on slide
9 22, that ... I mention that it's a document that was to be
10 supplied in ... yeah, the document that was going to be
11 supplied in January 2001 is really going to be supplied by
12 a later time frame. That's the chemistry, especially
13 effect of minor constituents.

14 That's the end of my presentation. Are there
15 any questions?

16 MR. WYMER: John, do you have any?

17 MR. GARRICK: Well, it seems that everything
18 hinges on the ability to control metallurgical conditions,
19 and how are we going to evaluate that?

20 MR. SRIDHAR: At this point, DOE's making some
21 mock-ups of different scale containers with ... and
22 different post ... treatments. And our hope is that we
23 will follow what they're doing, and we would like to do
24 some conformity studies. Ideally, we would like to take
25 some materials from their desk and perform a ... studies.

1 And the two things that we would like to
2 examine are one is the microstructure of the material is
3 stationed, how the microstructure changes around the weld
4 and the ... treated barriers. And secondly, what effect
5 does this have on the corrosion performance. Those are
6 the two things we would like to evaluate. Of course, we
7 would like to follow DOE's evaluations in those areas.
8 And we have scheduled a series of meetings in the coming
9 year, to examine. These are some of the items that we
10 have as part of our agreement, this information that DOE
11 will be generating.

12 MR. GARRICK: Are there any other materials
13 under consideration that you're aware of?

14 MR. SRIDHAR: No. I think C-22 is the --

15 MR. GARRICK: Is the chosen?

16 MR. SRIDHAR: Is the chosen candidate, and DOE
17 will --

18 MR. STAHL: I'll address it.

19 MR. SRIDHAR: Okay.

20 MR. HORNBERGER: First of all, just a quick
21 question, following up on what you just said.

22 How do you propose to look at the
23 microstructure surrounding welds?

24 MR. SRIDHAR: Either just by optical
25 metalography or --

1 MR. HORNBERGER: Oh, okay.

2 MR. SRIDHAR: You know, depending on the need,
3 we can also do some ... electronic ... which we have done
4 in the past for ... characterizing the -- essentially when
5 you have ... you get depletion of chromium next to the ...
6 boundaries, and that's something we could characterize,
7 DOE would like to.

8 MR. HORNBERGER: So I -- the way I heard
9 correctly from what you said, that the center does have
10 plans to look further at the effects of both stress
11 corrosion and cracking, and the influence of trace
12 materials?

13 MR. SRIDHAR: Right. We would like to look at
14 that. But we would like to look at that in light of
15 possible near field conditions.

16 MR. HORNBERGER: Right. And -- but these are
17 planned experiments and not ongoing?

18 MR. SRIDHAR: They are -- will be started
19 pretty soon. That's -- they are planned for this fiscal
20 year, but we haven't started experiments yet.

21 MR. HORNBERGER: Okay. And how long do you
22 anticipate these will run? For several years?

23 MR. SRIDHAR: I hope so. But it depends on the
24 particular test results, you know, the cracking, of
25 course, is very fast, the test will be over soon, but I

1 think that leaves for ... we haven't planned for the
2 future, so I can make a commitment for ...

3 MR. HORNBERGER: And can you -- you plan that
4 these results would feed back into your mechanistic model?

5 MR. SRIDHAR: We would -- we are hoping to do
6 these tests as a function of potential.

7 MR. HORNBERGER: Uh-huh.

8 MR. SRIDHAR: And what we want to say is, we
9 want our data ... back into our picture conceptual model
10 of repassivation potential being that ... So if -- it
11 would treat back into the performance assessment model
12 into that parameter. That is our hope at this point.

13 The experiments dictate otherwise, then we have
14 to reconsider our conceptual model.

15 MR. HORNBERGER: Yes. And do you have an
16 anticipation as to what you might see under the conditions
17 more near repository conditions?

18 MR. SRIDHAR: My feeling is that I don't think
19 they would see the ... effect of ... in stress corrosion
20 cracking on ..., I may be wrong. As far as the effect of
21 sulphur, we had looked at in the case of alloy 825, we had
22 looked at sulphur compounds, and they did have a
23 deleterious effect on ... concentrations.

24 So that's ... area of interest that it's not
25 stressful from cracking, but that localized

1 corrosion. So we would look at ... sulphur. And, in
2 fact, that may tie with the effect of microbial organisms,
3 because one of the concerns we have is whether microbial
4 -- microbiological organisms can cause localized corrosion
5 of this alloy. And one mechanism may be local generation
6 or these sulphur or subflax fusions.

7 And so we can again tie that effect through our
8 conceptual model as well in repassivation eventually.

9 MR. HORNBERGER: Has there been work by -- I
10 don't think ... the Center on MIC, but have other people
11 done work on MIC for --

12 MR. SRIDHAR: We have actually done quite a bit
13 of work on MIC at the Center. We put it in obeyance
14 because that based on our earlier studies, especially for
15 alloy 22, it was not as great a concern as other. So we
16 had to prioritize our work. And so we had put that as a
17 lower priority, and we had ... to follow what DOE's doing.
18 And Lawrence Livermore is doing quite a bit of microbial
19 work.

20 What they are finding is, that the microbial
21 qualities increase a general corrosion rate, and our
22 concern is really is that we investigate the effect on
23 microbial organisms of localized corrosion.

24 MR. HORNBERGER: Thank you.

25 MR. LEVENSON: I just have one question. You

1 indicated the aging phenomena at 840 degrees. Is there
2 any indication that that occurs at lower temperature, at
3 much lower rates?

4 MR. SRIDHAR: It does. There is a C-shaped
5 curve for these things, as many other ... transformation.
6 And that ... which is essentially a metallic phase called
7 new phase, precipitates, and we chose 870, because 870 is
8 the nose of that transformation curve, so it occurs in a
9 very short time. So in a way, it's sort of accelerating
10 the process.

11 But it cannot ... centigrade over a hundred
12 hours and at lower temperature for a much longer time.

13 MR. LEVENSON: Well, how low a temperature?
14 Would it be occurring at repository temperatures?

15 MR. SRIDHAR: That new phase is not likely to
16 ... temperature. ... are extremely slow. What is likely
17 to occur at repository temperature may be longer in ...
18 provided you have ... the material. If you have a
19 completely new material that even long range ... is too
20 slow, ... repository temperatures. So it has a
21 combination of circumstances for ...

22 MR. LEVENSON: It seems pretty slow over a lot
23 of years.

24 MR. SRIDHAR: Yeah.

25 MR. LEVENSON: 10,000 years.

1 MR. SRIDHAR: The long range study has been
2 done both by Lawrence Livermore and by ..., looking at
3 these alloys in that ... condition, to show that it's not
4 likely to occur.

5 But in terms of the localized corrosion
6 phenomena, what is of concern is the higher temperature
7 phase.

8 MR. WYMER: I have a couple of questions. They
9 go mainly to the nature of the dissolving solution that
10 will be used in the test and the first ... evidence such
11 as it is for trace elements on the ... of the solution,
12 the corrosion. Maybe it's dissolution at that range

13 First, are you planning to do any additional
14 extensive mountain water characterization, what is likely
15 to be really in there, as opposed to J-13, which may or
16 may not be typical of what's in there?

17 MR. SRIDHAR: I think that's something ... are
18 more likely to ... but we are ... to look at that.

19 MR. BRENT: This is Brent from the Washington,
20 D.C. office, NRC staff. In effect, if you get a chance to
21 review the thermal test, I believe the lower ... unit is
22 being used in the most recent thermal test. And the
23 Center has incorporated that rock with water and they are
24 going to be running the chemistry on it, including the
25 trace elements.

1 MR. WYMER: Okay, great. And the a
2 suggestion at least ... very short concentrations can have
3 a very large ... Now, are you getting any consideration to
4 the -- this is a topic you all discussed at the break, to
5 artificially introduce materials into the repository and
6 one of the examples that's mentioned, is the possible use
7 of ... labs which might break or maybe the insulation on
8 electrical wires that might provide the source of organic
9 treatment of ... those materials that you wouldn't really
10 expect to be there, but they will be there. Are these
11 kinds of things being ...?

12 MR. SRIDHAR: We haven't talked about the
13 sources of these ... Obviously, we would like to include
14 the effect of lead, sulphur and mercury in our tests to
15 see what effect ... concentrations. But we haven't really
16 thought about what sources and how they would ... And
17 that's something we are working with and ... KDI to really
18 determine what the ... issue would be, you know, what are
19 we really having ... solution with these species.

20 Now, as far as organics, we haven't really
21 looked at it. My feeling would be that a lot of the
22 organics are also corrosion inhibitors. So --

23 MR. WYMER: You don't

24 MR. SRIDHAR: Yeah.

25 MR. WYMER: ... mechanistic studies, how deep

1 are you going to go in that direction? How much are you
2 going to try to understand the effect of corrosion? You
3 have one model that you're working on, how far are you
4 going to go?

5 MR. SRIDHAR: Well, I don't know, to be honest
6 at this point. I think what we are concentrating on, and
7 over the last few months, and this year, ... on issue
8 resolution and prioritizing where we make the ... you
9 know, especially this minor element effects and so on.

10 In terms of going further with the modeling, my
11 feeling is that we need to do some critical experiments to
12 verify some basic assumptions that the model is making, in
13 terms of the ... defect movement.

14 And we have talked about what experiments we
15 will do, but we haven't really gone into depth in terms of
16 what type of resolution we need, in terms of measuring
17 capabilities, and what really will be the type of
18 experiment we will do to create these conditions. That
19 some things we have talked about, but we haven't planned
20 it.

21 MR. WYMER: Okay. Any other questions? Jim or
22 Rod, do you have any --

23 MR. EWING: Maybe just a follow-up on your
24 question.

25 In the experiments you've done or that you

1 envision for developing the model, do you look or do you
2 use cross-sectional transmission electron microscopy to
3 look at this thin layer? It would be maybe ten microns
4 thick if I'm calculating correctly, and so it should show
5 up very prominent.

6 MR. SRIDHAR: That's one thing we have thought
7 about. One of the problems with that will be the act of
8 making the sample would disturb it, because you have to do
9 at a ... to get the thin layer for transmission of
10 electron microscopy, so the act of preparing the sample
11 may actually disturb the phenomena that we're observing.

12 MR. EWING: Yeah.

13 MR. SRIDHAR: The other possibility is to look
14 at ... changes. For example, the ... is extremely
15 sensitive to foreign defects. So if you're injecting
16 vacancies to the metal, and if we can measure ... very
17 sensitively, for example, a very high frequency of ...
18 measurements, you can possibly detect additional point
19 defects.

20 But concentration upon defects injected is very
21 small with short time periods, so it makes a big
22 difference in long time periods. So we have talked about
23 different ways of measuring the sensitivity changes, and
24 that's something we haven't come to a, you know, decision
25 on.

1 MR. WYMER: Andy?

2 MR. CAMPBELL: Mr. Sridhar, have you guys done
3 a series of experiments to try and bound the kinds of
4 chemistries that will go on ... or water and salts on the
5 surface of the waste package, as opposed to a bulk water
6 chemistry cooperating with, you know, some one of the
7 layers of top rock, is you know, and that may be your
8 incoming water at some point, but it's going to cooperate
9 with the surface of the waste package with a variety of
10 things that could be there. It may have interacted with
11 some iron, you know, as it came to the drift wall and so
12 on. Have you looked at a range trying to bound that
13 environment?

14 MR. SRIDHAR: We have done only limited work in
15 that area. We are following, more or less what Lawrence
16 Livermore has done, ... what we have done. We have done
17 some work of the ... steel with the outer container and we
18 have looked at the effect of alternate wetting and drying
19 on the ... chemistry. But for the alloy 22, we have not
20 done.

21 The environments really using ..., which is
22 essentially a concentrated ..., but much more corrosive
23 than you just concentrate the dirty water, because you're
24 also concentrating inhibited species like nitrates. So we
25 feel that we are already on the conservative side on that.

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1 I don't know that if that answered your
2 question, but that's very ...

3 MR. CAMPBELL: But, you at least, or somebody's
4 looking at all these various interactions --

5 MR. SRIDHAR: Yeah.

6 MR. CAMPBELL: -- to try and nail down what
7 kind of speciation and water chemistry might occur at the
8 surface of the waste package.

9 MR. SRIDHAR: Right.

10 MR. CAMPBELL: Okay.

11 MR. SRIDHAR: And the only other thing of that
12 area we're focusing on, is the impact ... chemistry, and
13 you will see tomorrow the labs and experiments we are
14 doing.

15 What happens to the chemistry of water, once it
16 penetrates through the C-point ... and interacts with the
17 ... That's an area where we are focusing on, because we
18 feel that very little is being done in that area, and
19 modeling of that environment ... very difficult, because
20 of the number of components involved and so on.

21 MR. CAMPBELL: Do you guys have a handle on the
22 kinds of stresses that will be left on the surface of a
23 waste package, I won't say if, when chunks of rock fall
24 out of the ceiling of the drift? I mean, over time that -
25 - the drifts are going to collapse, and they're going to

1 be dropping rocks presumably on the drift shield, but
2 those may also get through and get on the waste package.
3 Do you have a feel for what those stresses are?

4 MR. SRIDHAR: Right. Those are being dealt
5 with. I think ... and Simon ... are doing some of that
6 work as part of the ... TTI. But we feel in the recent
7 performance assessment calculation, the stresses from the
8 risk ... stresses are assumed to be close to the yield
9 strength and that's what we are using for the failure, the
10 mechanical failure of the waste package.

11 MR. WYMER: Anybody else? Thank you very much.
12 Now, we're going to hear from David Stahl of --
13 representing the Department of Energy; waste package
14 materials, concerns and testing program.

15 MR. STAHL: ...

16 MR. WYMER: ... concerns first.

17 MR. STAHL: Gentlemen, thank you. I'm David
18 Stahl with the Yucca Mountain Project. Currently, as
19 indicated here, I'm a materials advisor to the program. I
20 used to be the head of the department that was involved
21 with materials testing and evaluation, and as most of you
22 know, I've retired from that position, teaching at ULNV,
23 and doing some part-time consulting work.

24 ... is now is now the lead for that effort,
25 he's in the back, and the gentleman responsible for most

1 of the corrosion testing is Dr. Gerald Gordon, also in the
2 back of the room.

3 As far as the ... is concerned, what you'll see
4 is that I have a fairly reduced sized presentation and a
5 lot of back-up material. And initially this was done
6 because the message that we got was that we only have
7 about an hour in total time, and so we said, okay, let's
8 move all of the, perhaps interesting to corrosion people,
9 information to the back-up section.

10 And now we have additional time, so what I'd
11 like to do is, as we move through, pull in some of the
12 back-up slides as they're appropriate to the presentation.
13 So with your indulgence, we'll go ahead and do that.

14 As you can see from the outline, I'm going to
15 touch on materials selection. In this regard, Dr. Sridha
16 has given a very excellent presentation that forms a very
17 good basis for what I'm going to say.

18 Talk briefly about the testing and
19 prioritization effort, get into waste package
20 environmental conditions, general corrosion, localized
21 corrosion as you can see, long-term passive film
22 stability, stress corrosion cracking.

23 For each of these subjects, I'll talk about
24 basically where we are right now, and talk about some of
25 the concerns and then for each, indicate the path forward.

1 By a way of background and materials selection,
2 we had a set of criteria that we developed early on, and
3 basically they were responsive to 10 CFR Part 60, and the
4 other criteria that we had developed as part of the
5 project, including the engineered barrier system design
6 requirements document.

7 The current criteria flow from proposed 10 CFR
8 Part 63 and we now have a project design description
9 document, and system design description documents.

10 Now, we had the first survey of materials
11 conducted a week back in 1983 by Lawrence Livermore. And
12 as most of you remember, we had a thin wall design, which
13 was a stainless steel Type 304-L. And in that survey, we
14 had four criteria; corrosion rate, mechanical properties,
15 weldability and cost.

16 And we used the similar approach for the
17 current design, except that we've enhanced and expanded a
18 number of criteria. We've included, as indicated there,
19 compatibility and predictability, fabricability, thermal
20 and neutronic performance, and industrial usage and
21 experience.

22 Lawrence Livermore conducted a lot of
23 literature in his, degradation mode surveys, and limited
24 prototypic condition tests. And the objective there was
25 to narrow the materials of interest for the waste package

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1 barrier.

2 Testing, as indicated in the second bullet was
3 concentrated for materials ultimately selected; however,
4 we have a wider range of materials that underwent both
5 long-term and short-term testing over a wide range of
6 environmental conditions. And you can see the conditions
7 there are pH from 2.7 to 13. The pH 2.7 was based on the
8 fact that we thought we might have some organic or
9 microbiological reactions that might pull us down to this
10 range, also ... crevice chemistries, and the pH 13 was
11 driven by a potential for interactions with concrete
12 material, which was the original design of the liner for
13 the drifts.

14 Temperatures as you can see anywhere from 25 to
15 120 degrees centigrade. As indicated, a last bullet, and
16 alloy 22 was selected for the waste package outer barrier
17 and titanium grade 7 was selected for the drip shield.

18 Now, as Sridhar has said, the good news about
19 alloy 22 is that it has a very low corrosion rate. The
20 bad news for alloy 22 is, it has a very low corrosion
21 rate, and so you have some uncertainty problems in being
22 able to measure that rate.

23 If we can go to 42 of the back-up, basically it
24 indicates some of the other materials that we have in the
25 test program. These included a host of corrosion

1 allowance materials, mainly, as you can see carbon and
2 alloy steels, and we had some copper and copper alloys,
3 including copper aluminum and nickel copper alloys.

4 We have a variety of different corrosion
5 resistant materials, as you see there; stainless steels,
6 nucleoid, geneloids, such as GE 3 and GE 30 and 825 and
7 nickel-based alloys 625, C-4, 22 and 59, that's mentioned
8 by Dr. Sridhar, and the titanium alloys of 27, 12 and 16.

9 And as indicated in the last bullet there, we
10 also investigated some surround-coated materials, and we
11 do have some zuchonium alloys that are also being
12 evaluated as part of a cooperative program with the Navy.

13 MR. GARRICK: What eliminated the titanium
14 alloys?

15 MR. STAHL: They weren't eliminated. Actually,
16 they had, as far as the selection is concerned, that was
17 based on cost. We felt that the titanium alloys were very
18 similar in writing to the C-22 or alloy 22, most
19 generically, and so the alloy 22 was chosen as the
20 preferred method.

21 At the time, there was also some concern about
22 the weldability of the titanium and that still is a
23 concern, so for those reasons, the alloy 22 was the
24 preferred corrosion resistant material.

25 MR. GARRICK: And those issues are not as

1 important when using it as a drift shield?

2 MR. STAHL: Correct. Going back to number
3 five. You're there.

4 MR. WYMER: Okay.

5 MR. STAHL: I thought I covered that.

6 So basically, we selected alloy 22 as Dr.
7 Sridhar noted, we started out with 625, about four or five
8 years ago, and found it had some problems with localized
9 corrosion resistance, pitting particularly. And so we
10 moved to 625, found that it too, had some problems, and
11 three years ago, moved to alloy 22. And as a result, we
12 don't have a lot of data that the program has generated,
13 but there is a significant amount of data that's out in
14 the literature that we have utilized in our analysis.

15 As indicated here, our alloy 22 is resistant to
16 general crevice, pitting and corrosion. It is resistant
17 to stress corrosion cracking under environmental
18 conditions that we expect at Yucca Mountain, and I'll show
19 you some of the test data.

20 It has an excellent face stability under low
21 temperature aging. We'll talk about that. And it's
22 easily weldable, fabricable, inspectable, using existing
23 processes.

24 And I don't know if I mentioned in here, but we
25 do have several mock-ups that we've made of alloy 22, and

1 we're continuing to make some mock-ups that are close to
2 full scale, and we will section for testing some of those
3 issues that Dr. Sridhar mentioned.

4 This is a summary of the chemical compositions
5 of the alloys. As you can see, alloy 22 is an nickel-
6 based material, roughly 22 percent chromium, 13 percent
7 molybdenum, 3 percent iron, of actually you can't
8 get rid of all of the cobalt, so there is some cobalt in
9 there; tungsten and 0.35 vanadium.

10 Dennis, when he was at the DOE noted that
11 vanadium was not in the legend box, I apologize for that.
12 The V in the first entry is vanadium.

13 You can see the differences between some of the
14 pre-cursor alloys, the C-4, for example, doesn't have the
15 tungsten, but the tungsten and moly are roughly the same
16 composition. It has a little more nickel and a little
17 less chrom.

18 And you can see in the compositions of the 825
19 and the 625. The 825, as you can see is really nickel
20 rich. It's not nickel-based. It has 30 some-odd percent
21 of iron. I've also included in the chart of compositions
22 of alloy 600 and alloy 690. These were mentioned by Dr.
23 ...'s potential ... for alloy 22. I might say it's not a
24 very good analog, but that's the best that we have, as far
25 as some long term data. We do have some others, and I'll

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1 put it up in a minute.

2 As you can see, the 600 and 690 alloys do not
3 have any molybdenum, and no molybdenum does help in
4 localized corrosion resistance.

5 The next chart indicates where we are in
6 prioritizing the effort, and basically our ongoing and
7 planned work is focused on reducing uncertainties and
8 corrosion performance with an emphasis on stress corrosion
9 cracking, and ... stability.

10 Now, we have a lot of long-term and short-term
11 tests that are under way at Lawrence Livermore lab. We
12 have other tests going on at the Alliance Research Center,
13 Atomic Energy of Canada, University of Virginia, General
14 Electric to address these key uncertainties.

15 We also have studies underway to look at stress
16 mitigation, and these are underway at Lawrence Livermore,
17 Framatome, Structural Integrity, Lambda Research and Ajax.

18 What I want to do is just to divert from the
19 program for just a minute, is to show these charts, which
20 are not in your packet, but I understood that the
21 committee has not had a chance to go to Lawrence Livermore
22 Lab. And I think the people at the NRC have seen these
23 first hand. This is a chart of the long-term corrosion
24 test facility. There are 24 tanks. They're about one
25 meter square, and about a meter and a half in height. And

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1 they have a variety of different chemical environments,
2 and I won't show the chart, but on page 44 of your back-
3 up, it does have the chemical compositions of those
4 different waters that we've tested.

5 Basically, sitting water is down to 2.7, with
6 concentrations up to 1,000 XJ 13. And on the basic side
7 up to about pH10, and we've also established some tests
8 with concrete modified water, and we will be doing some
9 additional tests with some of the more aggressive waters
10 that we'll talk about.

11 This is a rack that was taken from the test.
12 There are six rack positions in each of those tanks, and
13 you can see that we have about a hundred specimens in this
14 rack. All together in the facility, we have about 15,000
15 specimens under test.

16 You can see the gentleman there is pointing to
17 some crevice corrosion specimens. They're also over here.
18 These are weight loss coupons over here, and we have some
19 uban (phon.) specimens, both below the water line and in
20 the vapor face. So a variety of different specimens.

21 You can see there's a closer view in the next
22 picture. This shows some carbon steel specimens, before
23 and after tests, confirms the fact that carbons rust very
24 nicely, and in fact, we had very good comparison between
25 the corrosion rate that we observed, and the corrosion

1 rate that we predicted for carbon steel.

2 The next chart shows a picture of alloy 22.
3 That's one of these crevice corrosion specimens, and you
4 can see in the creviced area, just a hole of staining.
5 This was the --

6 UNIDENTIFIED: Was this a two year test?

7 MR. STAHL: This was a one year test at 90
8 degrees C in acid water.

9 This next chart was taken by the nickel
10 developed associates, and this is what analog material has
11 done to streethard (phon.) and noted, this tends to be a
12 pestoloid C and this was taken after 56 years of exposure
13 at Curry Beach, which is a salt water atmosphere. And as
14 you can see, after 56 years, we still have a nice mirror
15 finish on this particular material. So we believe we'll
16 have similar, if not better results for alloy 22.

17 Okay. Let's go on to talk about some of the
18 waste package environmental conditions. As I mentioned, a
19 large fraction of the corrosion test that we conducted to
20 date have been with concentrated solutions of J-13.
21 Basically we've got that concentration levels. This was a
22 result of a workshop that we had at Livermore, and these
23 were from geochemical experts, and they suggested using
24 10X, have a thousand XJ-13, as a waters for the testing.

25 And as I indicated, the next blow-up we do have

1 some concrete modified water, which was added later on.

2 Now, we will be starting up some additional
3 tests shortly in those long-term corrosion tests
4 facilities, with some new founding concentrated waters, as
5 our new tanks are being installed. So we will be adding,
6 it's about a half a dozen different tanks for that
7 particular facility.

8 And by the way, I do suggest that the committee
9 come to visit Livermore, and look at this facility first
10 hand. We also have other facilities that are looking at
11 microbial corrosion. I'll talk briefly about that in
12 passing, and we have some relative humidity chambers,
13 where we have some static and drip testing that's also
14 under way.

15 Now, as you know, the drift shield provides
16 protection for the waste package from direct water
17 contact, and evaporative concentrations for times greater
18 than the regulatory period as indicated by others
19 previously.

20 But you still have the potential for waste
21 package surfaces, having some dust and other deposits on
22 them. And it's possible that they could develop near
23 saturated deliquescent and salts, either directly from
24 that water, or from the dust and any salt concentrations
25 that might be part of that.

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1 The critical relative humidity, it appears to
2 be about 50 percent. When you get up to about a hundred
3 percent, as indicated in the final bullet, the surface
4 solutions tends to be more dilute.

5 Now, when we take the J-13 water, we've done
6 both some PQ36 and some direct concentration testing and
7 developed -- excuse me, the chemistry of the waters after
8 concentration.

9 (Interruption.)

10 MR. STAHL: Shall I continue, Mr. Chairman?

11 MR. GARRICK: Yes.

12 MR. STAHL: As indicated in ... bullet, we have
13 the potential for a bicarbonate base, and that basically
14 accounts for the first orders of T-13, and the pH there
15 can approach a pH at 13.

16 You also have pore waters which are non-
17 bicarbonate, and the pH there can become slightly acidic,
18 depending on the calcium and magnesium content.

19 And if you look at chart 43 in the back-up, it
20 does show you the compositions of the J-13 and the pore
21 water that we start with.

22 And if you look at chart 46, in the back-up,
23 what I've shown here is some of the work at Lawrence
24 Livermore, where they followed the concentration of the
25 remaining water, as a function of time. And what we've

1 selected as indicated here, at 90 percent water removed,
2 that's the BSW or the basic saturated water, which has a
3 pH of about 13, and is indicated there of one point of
4 about 112.

5 MR. HORNBERGER: Where does the pore water come
6 from?

7 MR. STAHL: Pore water comes from the water
8 that resides inside the unsaturated rock.

9 MR. GARRICK: How do you get it out?

10 MR. STAHL: Well, there's a great effort to try
11 to collect that water. There's a variety of different
12 techniques, such as centrifugal testing, to try to pull
13 that water out without modifying it too much.

14 And so there's a science all by itself in
15 trying to extract pore water chemistry. I don't know if
16 they're going to talk about that in tomorrow's session or
17 not.

18 MR. HORNBERGER: On your slide 43, you show a
19 chemical composition.

20 MR. STAHL: Yes.

21 MR. HORNBERGER: So that water was taken out
22 with cebtrifuge?

23 MR. STAHL: I'm not sure what the process was
24 for that particular water. Gary, do you know the answer
25 to that one?

1 GARY: I'm not sure.

2 MR. STAHL: Okay.

3 MR. LESLIE: This is Bret Leslie from the NRC.
4 These samples were taken from alcove 5 from the middle ...
5 and they struggled mildly to get water out, and there's
6 three measurements. This is one of three. I'm not sure
7 if it was done using the centrifuge method, or whether it
8 was by actual compression.

9 MR. HORNBERGER: Thanks, Bret.

10 MR. STAHL: Okay. Let's go back to -- And
11 although the State of Nevada studies are very under
12 aggressive and unexpected conditions showed some attack on
13 alloy 22, literature data at 150 degrees C and 200 degrees
14 C with 25 percent sodium chloride and 135 ppm of lead
15 chloride showed no cracking. This is the results by Juri
16 Kolts as indicated there and reported in NACE, Corrosion
17 in 1986.

18 Later on, I will show you some slow strain rate
19 tests that we've just completed last week on lead, which
20 showed that there was no impact of one percent lead
21 chloride in water. So we'll get back to that.

22 As far as the bounding water compositions.
23 Here, we show them on slide 12. As I've said, these are
24 waters that could concentrate on the warm metal surface by
25 repeated wet/dry cycles from water drips.

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1 And you can see the basic saturated water, high
2 in chloride, nitrate, sodium and potassium, of course, and
3 the pH is around 13. The simulated saturated water, which
4 is the concentrated pore water has, as you can see, high
5 potassium, and nitrate. And about the same chloride level
6 as the basic saturated water and the pH there is slightly
7 acidic at pH 6.

8 So we have a range of potential water
9 chemistries that we're already testing, but certainly the
10 concern is that we don't know what the specific water that
11 a waste package could experience, and that could lead to
12 only conservative assumptions.

13 We have some unlikely scenarios that may cause
14 enhanced corrosion, such as high concentrations of
15 biliterious trace metals, trifilaments, for example, lead
16 or brines from pore water. That is a principle concern.
17 These are the principle concerns as far as the environment
18 is concerned.

19 We have identified a path forward, and many of
20 these items were already covered or noted by Dr. Sridhar,
21 but I'll walk through them very quickly.

22 As far as the environment is concerned, we
23 certainly are going to continue to monitor and evaluate
24 the waters that are collected from the drip scale heater
25 test. We're going to determine these concentrations and

1 chemical form of the minor constituents.

2 A lot of the tests that we've done, has been
3 with synthetic J-13 water, so we're going to go back and
4 repeat some of those with real J-13, and determine or
5 confirm, I should say, the heavy metal concentrations that
6 we have in those waters.

7 I'm also going to indicate -- if you turn,
8 rather, as I indicate in the last bullet, the minor
9 species solubility and the precipitate species in the
10 minerals formed using some computer modeling.

11 So that's our situation as far as the
12 environment is concerned. I want to move on to general
13 corrosion.

14 As I indicated before, and mentioned by Dr.
15 Sridhar, corrosion rates for alloy 22 are very low. The
16 tests were done, as indicated, 10X and -- actually, at the
17 3,000X J-13 over those pH and temperature ranges. And as
18 he indicated earlier, we have an up about rate of about
19 .07 microns per year. We have a mean rate of about .01
20 microns per year.

21 And based on these observed rates, as you can
22 see, waste package failures do not occur before 10,000
23 years. And this is consistent with what Dr. Sridhar had
24 shown in his chart.

25 Now, we have a whole host of short-term

1 electro-chemical measurements, to determine basically the
2 same rate, and they're consistent. We have as well done,
3 the high volume point and the chloride saturated water,
4 and the basic saturated water, and basically, as I said,
5 we have the same passive corrosion rates.

6 Now, we do have some uncertainties accounted
7 for in the model, and as a result of microbial corrosion
8 and thermal aging effects.

9 The microbial corrosion, I can refer you to
10 chart 48. Here we have some -- I don't know if you can
11 see that very well in the chart, on the display, but you
12 can see it in your hand-out. There's two sets of symbols.
13 We have symbols for 625, alloy 22 and stainless steel.

14 The open symbols, excuse me, off of the 8
15 biotic case, and that is no bugs, and the closed symbols
16 are for the biotic case, and that is presence of a
17 synergistic colony of microbes that are representative of
18 those that we collected at Yucca Mountain. And you can
19 see in a range of two to four times the corrosion rates
20 for these materials.

21 And so for the enhancement factor, we used a
22 factor of two, and we used a sampling using a triangular
23 distribution from basically zero to four on the rates.

24 And you can see, as indicated here, that we did
25 have some chromium ions that were detected in solution,

1 when you have the microbes present, as opposed to no
2 chromium detected, particularly for the alloy 22
3 specimens.

4 The thermal aging, I don't have a back-up slide
5 for that, but basically it was a result of projections
6 that were made by Dr. Tammy Summers at Lawrence Livermore
7 Lab. She's studying the generation of secondary phases
8 and aged materials. And she's utilizing the data that's
9 available in the literature. I'll just mention, the
10 Haynes long-term data. We have a whole host of samples
11 that we have under test at a variety of different
12 temperatures, and we will be conducting some
13 microanalytical investigations of those samples, to
14 determine the precipitation of secondary phases, to try to
15 get a better handle of kinetic formation.

16 As Dr. Sridhar has indicated earlier, we do
17 have this nose of a curve for the kinetics of those
18 transformations, and we believe that the temperatures of
19 concern in the repository, that we will not have any
20 impact on secondary phases. But to be conservative, we
21 have a factor of two and a half on the corrosion rate.

22 As I mentioned, we just started some drip
23 testing on heated surfaces. We did some tests at the
24 Atlas facility, with and without backfill. And we've
25 exposed some samples at Lawrence Livermore Lab, to

1 periodic dripping water, with complete evaporation. And I
2 have some additional slides in the back-up.

3 Page 49, for example, this gives you some of
4 the background for the Atlas tests. These are quarter-
5 scale tests. We did evaporate ... water on the drip
6 shield. Various materials were tested, as indicated
7 there, the Titanium grade 7, alloy 22 and carbon steel.

8 This was actual J-13 water that was used, and
9 in test number four, which I'll show you in the next
10 chart, included the backfill, which was an Overton sand.

11 In the next chart, you can see the two tests,
12 test three and test four. Over here, this is the sand and
13 this is the drip shield, and this is the simulated waste
14 package.

15 The next chart shows some coupons, these were
16 Titanium and alloy 22 that were in the drip shield,
17 basically setting on top of the drip shield, and you can
18 see that we have significant staining from the blue dye
19 that was used in the water, but no interactions.

20 We did have some surface oxidation on the
21 right-hand side with the Titanium.

22 This is without the backfill. With the
23 backfill in test number four, you can see basically the
24 surface is fairly clean, but we did have some silica
25 deposits, and again, you can see it better hopefully on

1 the pictures that you have in your hand-out.

2 MR. WYMER: Now, that basically diverted the
3 water?

4 MR. STAHL: For the most case, it diverted the
5 water down to the sides, that's correct.

6 Now, on the test that we have done at the
7 Livermore Lab, I guess we can go to 53 in the back-up, has
8 the same information. Basically, we used a 100x
9 bicarbonate water, specimen temperature of 93 Centigrade,
10 system relative humidity about 60 percent, test duration
11 of about a month.

12 And looking at alternate wetting and drying of
13 those samples, as I'll show in the pictures, we have these
14 little bath-type configurations with the specimen on the
15 bottom of the surfaces, are heated from below, and we've
16 deposited both the bicarbonate and the chloride sulfate
17 base water.

18 You can see the set up in the next chart. This
19 is within that relative humidity chamber that I indicated
20 previously. And the next chart gives you a blow-up of the
21 sample I think that's on the left-hand side. You can see,
22 this happens to be a welded sample of alloy 22 at 93
23 degrees C.

24 Basically, no interactions at this stage, but
25 you can see that we have significant salt build-up. I

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1 guess I could've shown this other one first. This is a
2 clean test prior to test. You can see the thermal couple
3 over here, and there's also some thermal couples
4 underneath, and you can see the fact that there is a
5 little bath there, so we can collect the deposits. And I
6 guess this picture on the right just shows you the overall
7 view of the specimen and the heater.

8 MR. WYMER: That's a plastic set-up?

9 MR. STAHL: Yes. Let's go back to 18.

10 So these are the concerns of general corrosion.
11 Basically that we need to do some testing with
12 concentrated solutions that include a variety of different
13 Yucca Mountain waters, as indicated in some of the
14 discussion that we had Dr. Sridhar's presentation.

15 We note that the variability and uncertainty
16 are large, due to the very small values of weight loss.

17 We need an independent method to verify these
18 low rates, and certainly as indicated, by Dr. Sridhar and
19 others, we certainly have concern about extrapolating
20 those long -- those rates to very long times.

21 Basically, we're going to use these new
22 bounding test environments in the long-term corrosion test
23 facility. I've already mentioned the basic saturated
24 water, the simulated saturated water.

25 We're going to continue tests into the

1 performance confirmation period, with periodic
2 evaluations, and we'll perform some insitu monitoring and
3 coupon testing.

4 We'll study analog materials and data for
5 similar alloys. As we mentioned alloy C-4 and some of the
6 other C alloys that have been around for 50 or 60 years,
7 so there is some experience data that we might be able to
8 take advantage of, that would give us confidence in our
9 model predictions.

10 We're going to install some thinner and larger
11 surface area coupons, hopefully to reduce measurement
12 error. We are going to test different heats of material
13 and we're going to, among other things, install high
14 density -- excuse me, high sensitivity probes in some
15 vessels to permit on-line measurements.

16 There are techniques that we're going to
17 utilize as well. For example, the atomic force
18 microscope. We have initiated some of those measurements
19 already, and it's given us some data that's consistent
20 with the long term results that we've generated to date.

21 There are other techniques that we'll utilize.
22 Dr. Sridhar mentioned electrochemical impedance is a very
23 promising technique, as well as linear polarization, and
24 we plan to utilize those to corroborate these very small
25 rates that we measured in the long term corrosion tests

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1 facility.

2 Okay. I want to move on to localized
3 corrosion. As indicated, again by Dr. Sridhar and others,
4 localized corrosion is not expected, based on extensive
5 literature in the -- excuse me -- data in the literature,
6 and that collected by the Yucca Mountain Project.

7 We've done a lot of cyclic polarization
8 measurements, as has the Center for a variety of different
9 environments, as indicated here. And as I indicated
10 previously, the passive corrosion rates are similar in all
11 relevant environments.

12 I should mention in the long term corrosion
13 test facility, a good fraction, I think it's 40 percent of
14 the samples are welded. And we haven't seen any
15 preferential weld intact, but we will continue to study
16 that.

17 We have, as indicated in the last bullet, a
18 significant margin between the corrosion potential and the
19 passive film breakdown potential. So again, that's a good
20 reason why you don't see localized corrosion for those
21 materials.

22 And for those of you that are interested, I
23 have in the back-up, electrochemical potential tests.
24 These are just a couple of tests that we've performed --
25 excuse me. These are just a couple of figures of the

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1 dozens of tests that were performed, would show that for
2 alloy 22 and the simulated saturated water and for the
3 saturated acid waters that we don't see in the tech on
4 alloy 22.

5 And we've done some testing on alloy -- excuse
6 me, of stainless steel, and you get significant attack for
7 stainless steel under those conditions.

8 In 22, we show the little lolly-pop test, a
9 different technique for crevice corrosion. And you can
10 see on the left-hand side that here we have tests that ran
11 to 550 millivolts, a 100 degrees C in basic saturated
12 water. Even under those conditions, you do not see any
13 crevice attack in alloy 22.

14 In the middle chart, push that all the way up
15 to 800 millivolts and 110 C with basic saturated water,
16 again, no crevice attack, but there is some staining.

17 On the right-hand side, where we have an
18 unbuffered solution, 100 degrees 4M sodium chloride, you
19 can see that we do have a 350 millivolts after two hours,
20 you do see crevice attack.

21 These are some of the samples that were done.
22 This is a slow strain rate test. You can see the sample
23 geometry, and basically these are the ones that did not
24 show any attack. Let me see if I have -- yes, I do.

25 Now, if you look at the -- in the back-up in

1 61. Here's a test where it shows the impact of the water
2 chemistry, and the fact that this is up at 400 millivolts,
3 4M sodium chloride. You can see at the lower left, that
4 you do get crevice attack, which is what you would expect,
5 but without the crevice, you can see normal stress strain
6 behavior.

7 If you go to 63, this is one I like
8 particularly. This shows slow strain rate test, with and
9 without inhibiting ions. And you can see -- oh, this one,
10 excuse me, this was just without inhibiting ions, the next
11 one is with and without.

12 Here you can see the impact of the voltage, and
13 these over here on the right are the open circuit
14 potential, and 100, 200 millivolts. As you get up here,
15 400, 300 and 400 millivolts, which is really driving it,
16 as Dr. Sridhar said, you do see some crevice corrosion and
17 lose of ductility.

18 The inhibitor effect as shown on the next
19 chart, if you look at the extreme right, you'll see the
20 case where you have a basic saturated water at 105 degrees
21 centigrade. If you remove the nitrate, you can see you
22 get just a small deviation, a slight movement to the left.

23 Instead of the nitrate, if you remove the
24 sulfate, you get again another small decrease. But if you
25 take away both the nitrate and the sulfate, you can see

1 that you readily get crevice attack. So that's pretty
2 dramatic.

3 Now, one of the other things that we've just
4 done, and it's in your packet as a loose hand-out. This
5 is a test we just did last week. This shows alloy 22.
6 This is indeed a slightly more aggressive test, because it
7 has a lower strain rate. This was at 95 degrees C, and
8 we're comparing the room temperature air test, which is
9 the red curve, the one to the left here, with the 95
10 degree C one percent lead chloride in the ionized water.
11 So there are no buffers in that particular test, and you
12 can see there's no degradation of crevice attack.

13 So let's go on to the concerns. I think I've
14 addressed most of these, that crevice corrosion
15 susceptibility may develop over a long term, but due to
16 slowly increasing corrosion potential, coupled with the
17 potential loss of passive film protectiveness. And
18 crevice corrosion may be impacted by combinations of
19 aggressive species and concentration of heavy metals.

20 Our path forward, as we've covered I think
21 already, we're going to continue these separate effects
22 tests. We're going to look at the damaging species of
23 potentially chloride, fluoride, and possibly sulfate from
24 the potentially beneficial species, the nitrate,
25 carbonate, silicate, and possibly sulfate.

1 And also going to be looking at these different
2 waters; pore water, perched water, and ground waters have
3 somewhat different ionic ratios.

4 We're going to continue the long term
5 electrochemical potential measurements and determine the
6 critical crevice potential in these environments
7 containing the heavy metal concentrations, and you've seen
8 an example of that.

9 So that's about path forward for the localized
10 corrosion. Now, I want to get into long term passive film
11 stability and then stress corrosion cracking.

12 As noted by Dr. Sridhar, alloys, such as alloy
13 22 rely on a stable tenacious oxide film to enhance
14 corrosion resistance. Limited evaluations have been
15 conducted, as I indicated by atomic force microscopy, to
16 understand the nature of the passive film.

17 We did basically extrapolate the data that we
18 had from the two year tests in the long term corrosion
19 test facility. And we've done some limited evaluations of
20 Josephinite, which is a nickel iron alloy -- excuse me. A
21 mineral, it's a natural mineral that has survived for
22 thousands of years in stream beds.

23 The concerns here, as I've mentioned
24 previously, certainly we need to have an understanding of
25 the stability of passive films over very long times. That

1 does not exist right now, particularly the effect of
2 dissolution and diffusion processes.

3 We need to better understand the impact of
4 aggressive species and mechanical damage. And lastly, we
5 need to understand the mechanical strength and adhesion of
6 the growing film over time.

7 So how do we hope to get there from here?
8 Well, one of the first things that we'd like to do, is
9 this potential pH diagram for the multi-component, alloy
10 22 system.

11 And we'd like to do that, as indicated here, in
12 Yucca Mountain bounding environments and temperatures.
13 And the calculation is analogous to a phase diagram
14 calculation, so that we'll determine the thermodynamically
15 stable fields, which include oxides, soluble ions,
16 sulfides, et cetera.

17 And we're going to look at, in addition to
18 alloy 22, some of the other alloys, such as alloy 59 and
19 686.

20 We're going to include radiolysis effects.
21 Principally by looking at the peroxide impact and also
22 oxidized anions. And look at sulfur effects in our
23 microbial studies.

24 We're going to continue our evaluation of
25 Josephinite as a natural analogue, and we're going to

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1 utilize two computer codes, one is the FACT code, as
2 indicated here for this analysis, which we'll corroborate
3 the results obtained by our qualified THERMOCALC Code,
4 which we have been using on the project.

5 In fact, the FACT code has been utilized as
6 well by Lawrence Livermore, and they have a lot of
7 experience with that.

8 Our next chart indicates some of the testing.
9 We want to grow thicker films at higher temperatures,
10 using autoclaves, humid air, and electrochemical
11 techniques. Basically to accelerate film growth for
12 compositional and structural studies.

13 And we want to understand better the kinetics
14 of film growth. This is very critical. Is it
15 logarithmic, parabolic, or higher order? Does film growth
16 become linear as it thickens, for example? And does the
17 film become mechanically brittle and spall off?

18 So those are the things that we want to
19 determine by some of these tests.

20 We're going to use a battery of microanalytical
21 techniques as indicated here. I won't read them to you,
22 but basically, that will help us to understand the
23 properties and characteristics of the film, as a result of
24 the different environments of that we've tested them
25 under.

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1 We're also going to look at corrosion potential
2 changes from some of our corrosion tests. Look at
3 compositional changes in the film over time. Going to
4 look at the film properties of cold-worked materials, and
5 see what the impact there is.

6 As I mentioned, we're going to perform some
7 additional, but limited examination of Josephinite and
8 other natural analogues, as received and after exposing to
9 selected environments to compare that with the performance
10 of the alloy 22 films.

11 As I mentioned previously, we're also going to
12 look at some of the other engineering alloys that have
13 longer term experience, such as alloy C-4 and alloy C-625.

14 So that basically is the path forward for long
15 term constant film stability.

16 The last area is stress corrosion cracking.
17 And as noted, stress corrosion cracking needs three
18 elements basically. It has to be susceptible, the water
19 chemistry must be aggressive, and a threshold stress level
20 must be exceeded.

21 As I showed, we have significant amount of U-
22 bend tests in alloy 22, which did not show any stress
23 corrosion cracking after two years of concentrated J-13
24 waters under acidic and basic conditions.

25 We have found stress corrosion cracking in

1 laboratory tests that use aggressive solutions. And I
2 think as Dr. Staley and others have said, if you have
3 aggressive conditions, you can crack most materials. The
4 question is, is that a reasonable environmental scenario
5 for Yucca Mountain, and that's something that we're going
6 to have to show.

7 But in order to eliminate that, at least for
8 the latest total system performance assessment, we assumed
9 that aggressive solutions would develop, and then we
10 looked at stress mitigation as a way to eliminate stress
11 corrosion cracking.

12 So given the last bullet, the rates of crack
13 growth are relatively rapid, and I have I think the back-
14 ups here.

15 This shows the GE and Lawrence Livermore test
16 data that I mentioned earlier. And you can see perhaps, I
17 don't know if you can read it there, but the rate here is
18 one point four-tenths into the minus eight, and for the
19 Livermore test, it's around two to four-tenths into the
20 minus eight millimeters per second. And certainly these
21 are very low rates, but as Dr. Sridhar, when you're
22 dealing with repository time frame, these are really
23 unacceptable.

24 So what we need to do is look at stress
25 mitigation, and as we mentioned, we have two techniques

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1 that we're evaluating, laser peening and induction
2 annealing. And I'll talk a little bit about those in a
3 minute.

4 As far as the model for stress corrosion
5 cracking, we used two models in our total system
6 performance assessment. Basically in the analysis --
7 detailed in the analysis model report, the film ruptured
8 model and the critical stress intensity model.

9 And the experimental plan developed the data to
10 support these models. We have multiple test methods that
11 are needed and under way to provide this data. And just
12 as an added confirmation, both the waste package
13 degradation process model report and the stress corrosion
14 cracking analysis model report stated the importance of
15 SCC, stress corrosion cracking, as the container life-
16 limiting corrosion mode. I guess "the" needs to be
17 emphasized.

18 So we have evaluations underway to determine
19 the stress state through the weld area before and after
20 application of stress mitigation techniques. And these
21 are going on with these mock-ups. There are sections of
22 mock-ups that I mentioned.

23 Results to date indicate that compressive
24 stresses are generated to a depth of about 2 to 3
25 millimeters for the laser peening, and up to about 6

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1 millimeters with induction annealing.

2 And as Dr. Sridhar mentioned, it means that
3 this material must be corroded away by general corrosion,
4 which takes perhaps 10,000 years before you can get to a
5 material that has the tensile stresses that would be
6 required for stress corrosion cracking to be initiated.

7 We've already done 35. 36, just shows some of
8 the constant load tests. And basically, this gets to the
9 threshold stress requirement, and as you can see here,
10 that stresses that would cause stress corrosion cracking
11 in this material are significant, and much involved what
12 we've considered as a lower level of around the yield
13 strength, or below, as a criteria, so.

14 As far as our path forward for stress corrosion
15 cracking, long-term corrosion test facility will house our
16 many new stress corrosion cracking specimens. And I guess
17 we have some of those in the back-up. Page 65 shows the
18 Belleville washer test for our stress corrosion cracking.

19 And the following chart shows a rack, which is
20 basically a replacement rack as we showed previously,
21 which has some of these specimens, as well as these
22 doubled U-bins, which are over here. And we have some
23 compactential specimens here as well, and some crevice
24 specimens, in addition to our standard weight loss, but in
25 this case, thicker specimens.

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1 And so I've pretty much covered the first
2 bullet. The second bullet, environments. We'll have
3 standard environments plus the saturated water and the
4 basic saturated water up to the boiling points. That was
5 one of the reasons for the new test tanks that I
6 mentioned, because some of the tanks we had previously at
7 Lawrence Livermore Lab, it was uncertain whether they
8 could take the 112 Centigrade test that would be required.
9 So we ordered new tanks, which have a higher temperature
10 rating.

11 Metallurgical conditions as indicated there;
12 base metal, aged metal, weld metal, and welded plus aged
13 materials will be tested. We'll do periodic examinations
14 as we've done with the other long term corrosion test
15 facilities, beginning in about six months after exposure.

16 As I've mentioned, we've gotten electrochemical
17 tests that are underway. We will be determining the
18 repassivation constant needed for the film rupture, SCC
19 model. We'll continue the General Electric constant load
20 crack initiation tests in these different waters, to
21 determine the stress corrosion cracking initiation
22 threshold stress.

23 And we're going to continue the reversing DC,
24 direct current potential drop, crack propagation rate
25 determinations at GE and Lawrence Livermore, and a variety

1 of different environments and metallurgical conditions.

2 And as indicated, we'll perform some select DC
3 drop tests under electrochemically polarized conditions.

4 And as was suggested by Dr. Joe Farmer,
5 acoustic emission is a technique that might prove useful
6 in stress corrosion cracking to follow the crack growth
7 over time. I've done some experiments using that
8 technique with cracking of ceramics and it's a very useful
9 technique.

10 To summarize and conclude then, we have
11 experimental results from the current testing program.
12 These were described briefly.

13 Alloy 22 has continued to perform well, under
14 the conditions expected at Yucca Mountain. Concerns
15 regarding the environment, general and localized
16 corrosion, long term passive film stabilities, stress
17 corrosion cracking were identified. These concerns
18 address aggressive, but unlikely environmental conditions,
19 as I have shown.

20 And I've described the path forward to resolve
21 these concerns, and reduce model uncertainties. And these
22 include a sweep of new long term corrosion tests, as well
23 as short term tests, using that battery of standard
24 analytical methods that we have available at Lawrence
25 Livermore, to better understand the degradation

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1 mechanisms.

2 I'd be happy to entertain any additional
3 questions that anybody has.

4 MR. WYMER: That's a lot. Are you still --

5 MR. STAHL: Still awake?

6 MR. GARRICK: Yeah. I'm curious about, I
7 guess, the trade-off between research or tests to
8 establish the range of environmental conditions versus the
9 -- how far you need to go with the waste package corrosion
10 tests.

11 MR. STAHL: Sure. Well, we've recognized from
12 day one when we started the corrosion testing program,
13 that we were behind the eight ball, in the sense that we
14 had to come up with some environmental conditions in
15 advance of the insitu thermal tests that were evaluating
16 some of the geohydrology and water chemistry.

17 So we've done our best guesses on what we
18 thought those water chemistries could be. As we may here
19 tomorrow, there is effort underway to look at collected
20 waters that we've sampled or are sampling in the drift
21 scale, either test is a function of time.

22 And what we've seen so far, is that you do get
23 regions where the CO2 basically in the water is boiled
24 off, leaving less aggressive conditions. Some of that CO
25 then gets sucked up in cooler regimes outside of the waste

1 package, so that the pH of those region goes down to I
2 think the eight-sixish or thereabouts, and so you have
3 this halo effect around the waste package.

4 And then, of course, you have gravity that
5 works for you. Any water that gets moved out, hopefully
6 will then drain between the drifts, and that was one of
7 the reasons why the repository design was changed, to
8 expand the different -- the distance between bore holes,
9 so that you don't have overlapping thermal zones, and you
10 have regions where you can't have drainage.

11 So certainly we don't have the final answer on
12 the water chemistry if that answers your question, but
13 we've had to move forward, and of late, as you know, we've
14 had modification of the program to look at some of the
15 potential effects of the heavy metals, and you've seen
16 some preliminary results that we've obtained. We will be
17 continuing that with a variety of different waters, lead
18 and other heavy metal concentrations to determine the
19 impact on corrosion.

20 Does that get to your question?

21 MR. GARRICK: Yeah. How are you bringing your
22 results to bear on the most current performance
23 assessments?

24 MR. STAHL: Well, we continually have
25 interaction with them. We are working, as you know, on

1 the TSPA SR.

2 MR. GARRICK: Right.

3 MR. STAHL: And all of the data that we have to
4 date, has been put into the models that we have.
5 Certainly if we get some new data that's going to impact
6 the result, then that would be a reason to modify the
7 TSPA, but so far, we don't have any surprises. So that
8 would be the process for modifying the performance
9 assessment.

10 MR. GARRICK: One of the things that you've
11 covered in a lot of detail is information about getting a
12 better handle on protective films, --

13 MR. STAHL: Yes.

14 MR. GARRICK: -- layers and what have you. And
15 a couple of years ago when we had the working group, we
16 were reminded of the possible, very favorable impact of
17 secondary products, in terms of providing added
18 protection.

19 Where are you headed with that? What are you
20 on to demonstrate?

21 MR. STAHL: Well, certainly as I indicated,
22 when you have a J-13-type water, we do have inhibitor ions
23 that certainly enhance corrosion resistance. You also
24 have the silicate, which is a plus and a minus, because it
25 tends to code out some of our testing samples, and so

1 people will say, well, maybe you need to eliminate the
2 silicate. But we do have silica in J-13, and so that's
3 going to be a specie that would be present, that we need
4 to look at its effect, whether it's a positive or a
5 negative.

6 MR. HORNBERGER: First of all, can you lead me
7 through the logic that would suggest that the waters that
8 you can squeeze out of the rock are more likely to be
9 those that you should consider to be in contact with the
10 waste relative to perch waters?

11 MR. STAHL: I think frankly they are less
12 likely, but that's my opinion.

13 What happens when you dry the rock out, is
14 that, most of the species that are in that water will
15 remain in the pores. The water itself will diffuse to the
16 fractures, and then vaporize and move out to the cooler
17 regions.

18 When that water returns, it will return mainly
19 by fracture flow, that will pick up only those minerals
20 that were present in the fractures. And there's no way
21 for it to pick up the residual minerals that were in the
22 pores.

23 So my feeling is, is it will be more like a J-
24 13 than a pore water, that the package would see.

25 MR. HORNBERGER: So why are you doing

1 experiments with pore water?

2 MR. STAHL: Because, sir, those people who
3 argue that you have the potential for pore water
4 chemistry, and we have not been able to completely rule it
5 out, and hence, we rule it in, and we do some tests.

6 MR. HORNBERGER: Okay. Dave, I don't know if
7 you have your slide 36, page 36 handy, but --

8 MR. STAHL: Sure.

9 MR. HORNBERGER: -- I don't think that I follow
10 the message that you wanted me to take away from that.
11 It's on the stress corrosion cracking that caused the --

12 MR. STAHL: Yeah. This is the -- having to do
13 with the minimum thresholds stress. And Jerry Gordon's
14 back there, and perhaps to expand further on this.

15 But basically what we're showing here, is that
16 we don't get stress corrosion cracking until we have about
17 1.8 times the yield stress, which is much higher than what
18 we see for other materials. For example, stainless steel,
19 you see something as low as 20 to 40 percent of the yield
20 strength, where we start to see stress corrosion cracking.

21 MR. HORNBERGER: So I'm to take, for example,
22 your pink square, which is C-22 as received, that's your
23 1.8 stress ratio.

24 MR. STAHL: Uh-huh.

25 MR. HORNBERGER: And because it failed at 16:00

1 hours, that indicates --

2 MR. STAHL: No, it's unfailed.

3 MR. HORNBERGER: It's unfailed?

4 MR. STAHL: You're looking at the 1.8 at 16:00
5 hours?

6 MR. HORNBERGER: Yeah.

7 MR. STAHL: That's as received. That's
8 unfailed. That has not failed yet.

9 MR. HORNBERGER: Okay. So tell me one that
10 indicates stress corrosion cracking.

11 MR. STAHL: No, no. I'm saying this was the
12 minimum threshold, we think it's above that. We're just
13 saying because we tested at 1.8 and it did not fail there,
14 that the threshold is above that limit.

15 Anything else from that, Jerry?

16 MR. GORDON: That's the main point.

17 MR. HORNBERGER: Okay. So I'm not going to
18 look at the three plus signs up at 2.4.

19 MR. STAHL: Uh-huh.

20 MR. HORNBERGER: And it says above that, one
21 unfailed. Why are there three symbols there and the sign
22 says one unfailed?

23 MR. STAHL: Yes. These are stainless steel.

24 MR. HORNBERGER: Yeah.

25 MR. STAHL: Two of those have failed at that

1 level, and one is still ongoing.

2 MR. HORNBERGER: Oh, I see, okay. I think I
3 have it now. Sorry.

4 MR. STAHL: No problem.

5 MR. LEVENSON: Well, one question as a
6 taxpayer.

7 MR. STAHL: Sure.

8 MR. LEVENSON: Are you giving any consideration
9 to using all of the surplus nickel from dismantling the
10 diffusion plants to make these thousands of tons of
11 containers?

12 MR. STAHL: Yes, absolutely. We are looking at
13 that issue, and we presented that, I think, a light paper
14 to Lake Barrett on that subject. I'm not sure where
15 that's headed, but at least we know what it is that we
16 need to do to handle that material. Sue, do you have any
17 other comments on that?

18 UNIDENTIFIED: That's fine.

19 MR. LEVENSON: All right. If you are seriously
20 considering it, are you proceeding to make any bad sheets
21 of metal because what comes to you is not 100 percent pure
22 nickel?

23 MR. STAHL: Well, as I mentioned, we will be
24 doing heat-to-heat variations in our future corrosion
25 tests. We have no plans right now to take contaminated

1 nickel and test it until Lake Barrett or someone else
2 directs us to move forward with that.

3 MR. WYMER: As you know, the dupe of the
4 understanding you have of pluses that would lead to
5 corrosion, the more confidence will have in your
6 extrapolation to be extremely long times.

7 MR. STAHL: Yes.

8 MR. WYMER: And you mentioned several points,
9 corrosion models that you were developing. I think I
10 understood pretty well the corrosion model stress
11 corrosion repair. These other areas that you indicated,
12 like general corrosion, localized corrosion, long term
13 passive instability. Can you say a little bit about what
14 you're doing on those ... modeling?

15 MR. STAHL: On the modeling, on the general
16 localized corrosion, I think those are generally straight
17 forward, and those are detailed in the analysis and model
18 reports. Those are not like limiting the passive film
19 stability. One is one that needs development, and Dr.
20 Sridhar had indicated one model, which was dicting the ...
21 of point defect model, which we're looking at. There are
22 some other models out there. This is going to take a
23 little bit of time to evaluate and what needs to be done.

24 MR. WYMER: I was wondering if you were doing
25 something different from what the Center is doing on --

1 MR. STAHL: Basically, we're -- we have a
2 competitive or compatible approach.

3 MR. WYMER: Just one trivial point. My
4 recollections of my freshman chemistry are pretty dim at
5 this point.

6 MR. STAHL: Mine, too.

7 MR. WYMER: I wondered about the one percent
8 lead chloride concentration. It seems a little high.

9 MR. STAHL: That is high. Well, that was one
10 that we chose to test as ... mentioned earlier, that's
11 10,000 ppm. We wanted to see what happened in that
12 particular test. We will be looking at a variety of
13 different concentrations, with and without J-13, with and
14 without some of the inhibiting species, and see what the
15 impact is.

16 But 10,000 ppm is large, but if you take the J-
17 13, and concentrate it a thousand or 3,000 times, it comes
18 up to what, a couple of hundred ppm's. So a thousand is
19 still well in excess of what we'd expect from the
20 concentrated solutions.

21 MR. WYMER: You mentioned too that you are
22 planning to do some studies with water that has trace
23 impurities. That's a delicate area for you right now.

24 MR. STAHL: Yes.

25 MR. WYMER: What program do you have planned

1 for characterization of the additional characterization of
2 the water for these low concentration of things?

3 MR. STAHL: Well, we do plan to take, as I
4 indicated, some of the solutions that are made of alloy to
5 us and determine what the heavy metal content is.

6 MR. WYMER: Just the heavy metal?

7 MR. STAHL: We're going to do a whole suite of
8 analyses and see what's in there. Basically, as I
9 mentioned, a lot of the testing we had done previously was
10 with a simulated J-13, so it didn't pick up some of these
11 trace elements, so now we're going to go back and do some
12 testing with J-13, and some other natural waters, see
13 what's in there, and compare that with our simulated
14 water, excuse me, to see if there's any differences. We
15 don't expect any, but that's something we need to do.

16 MR. WYMER: -- with respect to solid phase
17 formation from some of these things that are in the water.

18 MR. STAHL: Uh-huh.

19 MR. WYMER: How much -- how hard are you
20 looking at those? What sort of film studies will you be
21 making?

22 MR. STAHL: Well, as I mentioned, some of the
23 techniques that we have at Livermore, that's available to
24 us, particularly the atomic force microscopy and some of
25 the others that we mentioned, in that -- I don't know if I

1 showed the back-up slide. I kind of went quickly through
2 that. Let me see if I can find it.

3 Each of those techniques can tell us a little
4 bit more about the character of those films.

5 MR. WYMER: Are you getting into some
6 speciation work?

7 MR. STAHL: It would be nice to do that. I'm
8 not sure. Yeah, I think there is one technique that hits
9 on that.

10 MR. GORDON: David, I think it's on the
11 microscopy, we've got to find the deposits opposition --
12 (inaudible).

13 MR. GARRICK: You're going to have to stand up.

14 MR. GORDON: I'm Jerry Gordon --

15 REPORTER: I can't hear you. I'm sorry.

16 MR. GORDON: I'm Jerry Gordon. We do plan to
17 analyze the deposits like calcide and silicates, and the
18 non-remon spectrograph is an ideal tool to do that.

19 MR. STAHL: There was a chart on that subject,
20 I went through it very briefly. I'm trying to find it.
21 I'm not being successful.

22 MR. WYMER: You've got something on 45 that
23 touches on it. That's okay, though. I got the answer
24 from Mr. Gordon back there.

25 MR. STAHL: Okay, very good. Any other

1 questions?

2 MR. EWING: Just to follow up on some of Ray's
3 comments. It's very impressive. I think you're doing
4 just about everything one could imagine doing to address
5 these problems. But I've just been reflecting on the role
6 of these heavy metals, lead, arsenic and so on, and --

7 MR. STAHL: Uh-huh.

8 MR. EWING: -- if they do have an important
9 role, then this is really a very difficult problem. The
10 PQ36 code that you mentioned using, won't have the
11 appropriate data, and even if it did, coprecipitation
12 reactions would rule that out.

13 MR. STAHL: Sure.

14 MR. EWING: The EH_pH diagrams that you would
15 systematically develop, really won't capture won't happens
16 with these trace metals. So to help me in my thinking, is
17 there some general sense of the mechanism by which these
18 heavy metals play a role? Is this just an observation
19 from a set of experiments, or is there some reason to
20 expect this to be important?

21 MR. STAHL: Well, like any of these aggressive
22 species, what we're doing for the most part is
23 interrupting the potential for the surface film to
24 naturally repassivate. Chloride is one that does that for
25 many systems, and I would expect that the lead and some of

1 these others probably play a similar role.

2 Jerry, do you have any other thoughts on that
3 as well?

4 MR. GORDON: That is the main --

5 REPORTER: I can't hear you. Could you please
6 get up to the microphone.

7 MR. GORDON: That is the potential rule of the
8 species like that, it's presumably disrupt the
9 protectiveness of the passivate, similar to chloride.
10 There are -- there's some indication that a steam
11 generator, nucleoid and vicin L-600 material steam
12 generated lead can displace the nickel in the oxide form.

13 MR. EWING: What about other heavy metals like
14 uranium, and just thinking about sources of other maybe
15 not so minor heavy metals?

16 MR. GORDON: There's no data in the literature
17 that I know of that shows ulterior effect to uranium,
18 similar to the lab.

19 MR. WYMER: The common thread is that these are
20 easily reducible.

21 MR. EWING: I was thinking about sources for
22 metals, and of course, the most apparent source is a
23 breached waste package. And so my next question is, does
24 the performance assessment look at that type of
25 connection, the breached waste package then accelerating

1 the corrosion rate of nearby packages?

2 MR. GORDON: Right now, to my knowledge,
3 (inaudible) --

4 MR. STAHL: I would anticipate that would be a
5 minor impact. We've looked at package-to-package
6 interactions, and I've not seen that it would introduce
7 any of the effects. I think most of the concern for those
8 kind of interactions have been in temperature, because the
9 packets center line or mid-plane is lower than the edges,
10 and you may set up some cells, for example, but we haven't
11 looked at anymore other --

12 MR. EWING: It may be a crazy idea, but the
13 ground water is the myer source of these heavy metals, and
14 the surrounding waste package is the major source in or I
15 hope this is not an important --

16 MR. WYMER: We're going to probably throw this
17 stuff around tomorrow morning, too.

18 MR. GORDON: It would tend to move downward
19 rather than laterally.

20 MR. STAHL: Yes.

21 MR. WYMER: Yeah, that's right.

22 MR. SRIDHAR: Nararsi Sridhar from the Center.
23 Just a point of clarification. The effect of lead is not
24 due to production of lead species to lead metal. ...
25 because based on all the tests that have been done in the

1 steam generator environment, when people have used lead
2 compounds and solutions, and as far as the solution with
3 oxygen, then you are not going to reduce lead in that
4 case.

5 The stress corrosion cracking has actually ...
6 So it is really not the electrochemical production of lead
7 compound ... lead ..., it's merely the incorporation of
8 lead in the passive ... as Jerry mentioned, as a possible
9 mechanism.

10 But what is really normally at the is
11 exactly the microscopic for that ... mechanism of lead ...
12 But if it is ... species that is effecting, then you would
13 expect oxygen will be beneficial rather than detrimental.

14 MR. WYMER: Then you would expect the ...
15 driving force for the lead to displace ...

16 MR. SRIDHAR: Correct.

17 MR. WYMER: This is a fascinating subject, but
18 maybe --

19 MR. CAMPBELL: Yeah. Have you guys been able
20 to -- I mean, one of the things about lead is it's
21 everywhere and back for many years, it was a very
22 difficult species or element to measure in the environment
23 as a contamination. If you were synthesizing J-13 type of
24 water with say, ... chemicals, I would bet a dollar to a
25 hole in a donut, that there was ... Have you gone back or

1 anticipated going back and looking at some of those
2 solutions?

3 MR. STAHL: Well, the J-13 water is fairly old
4 water, so I wouldn't expect the industrial revolution has
5 had an impact on that. But you can get lead
6 atmospherically by inborn particulate.

7 We are going to look at that as well, to see
8 what the heavy metal concentration is on some of the dust
9 particles that we've looked in and around Yucca Mountain,
10 and some of the ESF tunnels.

11 MR. CAMPBELL: That's in terms of the natural
12 environment, but what I was also thinking was in terms of
13 your experimental solutions that you use in your test
14 facility, you make those up from reaging grade chemicals,
15 as opposed to --

16 MR. STAHL: Correct.

17 MR. CAMPBELL: -- trace element pure chemicals.
18 I can guarantee they've got lead in it at some level.

19 MR. STAHL: That could very well be. I
20 understand your point.

21 MR. CAMPBELL: And if you've got archived
22 samples, you could probably go back and get some idea of
23 what those levels were, at least you can see it was an
24 effect at much lower levels than say were done at the
25 Catholic University.

1 MR. STAHL: Well, we do have the samples of J-
2 13 water that we generated for the corrosion test
3 programs. And certainly, we can look at those synthetic
4 solutions for heavy metal content.

5 MR. LESLIE: Andy, this is Bret Leslie, NRC
6 Staff. I just would like to re-emphasize that, as part of
7 the issue, resolution process for the near field, we're
8 going to be requesting from DOE exactly what you've just
9 suggested. We're going to ask them to provide those
10 analyses, to put their experiments in a better framework.

11 MR. CAMPBELL: Thank you, Bret.

12 MR. WYMER: Jim, did you have a question?

13 MR. CLARK: Just a quick question. I was
14 curious about the evolution of this whole issue. How did
15 these particular metals come on screen? Was it past
16 experience with the knowledge that they could pose a
17 problem? Is it because they're likely to be in the
18 environment, what --

19 MR. STAHL: Well, frankly, the issue was raised
20 by the state, and once an issue has been raised, and it's
21 appropriate, then we need to respond. And so we're doing
22 a series of tests.

23 MR. CLARK: And you are seeing effects?

24 MR. STAHL: They are seeing effects.

25 MR. CLARK: They are seeing effects?

1 MR. STAHL: We have not seen any effects of it
2 in testing that we've done so far. I mentioned the lead
3 chloride test that we just completed last week, plus our
4 examination of the literature. But they have seen such an
5 effect. The Catholic University, as was mentioned
6 previously, under, what we think are aggressive and
7 unlikely conditions.

8 But we still need to understand what the
9 threshold is, so that we can rule out that issue.

10 MR. AHN: This is Tae Ahn, ... In the last
11 technical exchange of NRC with DOE, DOE agreed to provide
12 the information and the ... effect. That's the basis of
13 the ... of their concern of the ... container corrosion.

14 In the last ... meeting here, we had another
15 question raised by other people on the speciation. ...
16 environment and the reactor. The ground water contains
17 carbonated bicarbonate solution. In the reactor, the
18 water is pretty pure, therefore, you could have different
19 species ... lead compared with ... that associate with the
20 ground water. That aspect also needed to be clarified. I
21 don't think we could simply ... at higher temperature in
22 pure water from the ...

23 MR. WYMER: Thank you, Tae.

24 MR. STAHL: Yes, we agree.

25 MR. WYMER: Any other comments before we leave

1 this subject?

2 MR. ENGELBRECHT VON TIESENHAUSEN: Engelbrecht
3 von Tiesenhausen with ...

4 REPORTER: I'm sorry?

5 MR. VON TIESENHAUSEN: ... I certainly applaud
6 that DOE's looking for trace elements in ground water, and
7 I ... variation in chemistry, I presume, and I just
8 wonder, is that going to include trace elements or are you
9 just going to use at major alloy ...?

10 MR. STAHL: Well, we're going to get the
11 chemistry, the complete chemistry. So we will be picking
12 up some of the trace elements as well.

13 MR. VON TIESENHAUSEN: And do an aspect
14 analysis to see what's in there or --

15 MR. STAHL: Well, I'm not sure what ... aspect
16 or atomical absorption or whatever technique we're going
17 to use, but, yes.

18 MR. VON TIESENHAUSEN: And you're also going to
19 keep track of the mechanical history on these alloys, and
20 start testing?

21 MR. STAHL: Absolutely. That's very key. As I
22 noted for some of the thermal aging studies, we're going
23 to be looking at as received yield aged worked corroded
24 samples, and follow that as a function of time, so, yes.

25 MR. VON TIESENHAUSEN: ... like to mention,

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1 that you might want to keep track of thermal chemical
2 history ... down to whatever sampling you've got.

3 MR. STAHL: Good point. I'll keep that.

4 MR. WYMER: Thank you. Is that the end of it?
5 Okay. John, it's yours.

6 MR. GARRICK: Okay. I'm going to declare an
7 unscheduled break before the night shift.

8 (A break was held at this time.)

9 MR. GARRICK: All right. Let's come to order.
10 The committee member that's in charge of research is
11 George Hornberger, so I'll let him introduce the next
12 topic.

13 MR. HORNBERGER: Okay. We're now in to prime
14 time. Bill Ott got the key spot on our agenda here.
15 Bill, I understand you're going to go through this, your
16 view graphs here on the research plan and sort of an
17 overview of the -- how you link back into the commission's
18 strategic plan and all.

19 Some of this is pretty high level, and I hope
20 that the time spent on the slides might be --

21 MR. GARRICK: Worthwhile. Is that what you're
22 intimating?

23 MR. HORNBERGER: Be suitable and brief, and not
24 all the lengthy read, but you know where we are on the
25 agenda, Bill, and we want to get to have time to ask you

1 all the questions we need to ask you.

2 MR. OTT: All right. I'm on. As a preamble,
3 let me start with, everybody's aware we're not talking
4 high level waste, if anybody's looked over from this
5 morning's discussions, isn't interested in our generic
6 radionuclide transport program. This is not the way ...
7 this time.

8 I also want to thank a few people that helped
9 in putting some of this stuff together. In particular,
10 Andy, he was up working in our staff for about six months
11 during the year, and he had the responsibility to follow
12 along and help us. I sort of stole him from you guys for
13 about a day recently to sit down and actually draft up our
14 outline for this particular program.

15 Oh, who am I? I'm Bill Ott. I'm the Assistant
16 Branch Chief of the Radiation Protection, Environmental
17 Risk and Waste Management Branch, which has the
18 distinction probably of the longest acronym of any branch
19 in the Commission.

20 I'm in the Office of Nuclear Regulatory
21 Research, and my e-mail address and phone number are on
22 the cover.

23 As a matter of fact, there are four major
24 topics in here. The first part of the first two bullets,
25 I'm going to go over the first part real quick, primarily

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1 because a lot of it is addressed to our attempt to come to
2 grips with everything in the Commission these days, has to
3 be addressed in terms of the strategic plan.

4 It is the thing that every staff member is
5 being encouraged to read and to know how their programs
6 fit into it.

7 When we got to this program planning task, it -
8 - we didn't feel we didn't have any other choice to start
9 from the strategic plan, look for the roots that would
10 justify the kind of work that we're doing and call those
11 out.

12 In addition, it is becoming very appreco with
13 any organization, to at least try and establish a vision
14 statement for what your organization is trying to do.

15 Second, the last two bullets on here, I'm going
16 to go through some brief discussions of what we've been
17 doing the last year, highlight a couple of our
18 accomplishments, and a couple of new initiatives, that I
19 think we, in the branch, find fairly exciting, and I hope
20 you will, too, in terms of what you've been doing, and
21 what we'll be doing in the future, and then some recent
22 areas, recent activities in the area of radiation
23 protection and health effects.

24 Now, the NRC has a vision. The Office of
25 Research has a vision. I'm not going to go into these. I

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1 provided them here for completeness, so we'll go on to the
2 next page.

3 I do want to say one other thing. The
4 Committee has received a copy of a predecisional plan for
5 radionuclide transport research. It was predecisional,
6 and not to be given out anywhere. I'm going to talk a
7 little bit farther about what our schedule is for letting
8 a wider audience see that.

9 It is a, I would say, a second or third round
10 working graph. It's very rough. It does not have good
11 connection between the sections, because a lot of it's
12 written by different people. I'm trying to give it to you
13 because you might be an hour trying to peruse the program
14 through the various aspects to the final analysis. But it
15 does have the substantive discussion in there of how we're
16 trying to modify the offices' prioritization system. And
17 I expect that's where we'll probably want to spend a
18 little bit of time discussing that when we get to it.

19 The other reason for our being here, is that
20 we've got some research data coming out. And we have
21 tried over the last year to increase our interactions with
22 the Committee. We've had two instances, where we brought
23 one of our staff in, in terms of whether to talk to you
24 about the slidework that we had going, and we brought in
25 Bill ... and Glenn ... from P&L to talk to you about what

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1 we're doing in the hydrology program.

2 This is sort of the third one, in terms of
3 trying to give you an overview of what else is going on.
4 We are planning on trying to bring about three more
5 presentations to you next year, again, bringing in the
6 investigators, to keep you apprised of what we're doing,
7 so that you have a better basis for making comments in the
8 research plan.

9 We wanted to give you an early glance of this
10 planning effort. We're not asking you for a letter on the
11 plan right now. It's for your information, for you to see
12 where we're going, for you to make comments about the way
13 we're going when you write your research status, we're not
14 asking for a specific letter back on it.

15 One other thing I wanted to mention, is the
16 parallel effort going on by the Office of Research right
17 now. George made a presentation of the Rogers Committee
18 in August, as did ... Powers.

19 One of the interesting aspects of that meeting,
20 was the charge at the beginning by Chairman Reserve, in
21 which he asked three questions, which had not been
22 anticipated before that.

23 Those three questions involved, are we doing
24 the right things basically; are we funded at the right
25 level; and is the research being done by the right people.

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1 It would seem to me that when you guys do your
2 research perspective, maybe some attention should be given
3 to specific answers to those questions. That was just a
4 slide ...

5 To begin at the beginning, the vision. We've
6 had this up for a long time, so you all have had a chance
7 to read it.

8 Basically it says we're trying to develop
9 technical basis and tools -- data and tools to all of the
10 licensing office to do more realistic predictions of
11 facility performance, disposal system performance.

12 So let's go on to the next one.

13 As I said to you earlier, the strategic plan
14 has been -- is the ... for the agency right now. The
15 strategic plan is a small two volume document, which
16 essentially identifies strategic goals, performance goals,
17 performance strategies, and performance measures for each
18 of the strategic arenas that the Commission has.

19 The major ones, the major strategic goals are
20 make nuclear materials safety, and bear waste safety.
21 Those are the main program areas.

22 In the Office of Research over the last year
23 and a half, or two years, they've been developing a
24 research prioritization system, which has been based
25 primarily on the major goals, which are safety, urban

1 deduction, efficiency and effectiveness and realism, and
2 public confidence. The measures that have very strongly
3 correlated to the reactor safety arena.

4 One of the things that we felt we needed to do
5 in developing a program plan, is to develop one that's
6 based on the nuclear waste arena, as opposed to nuclear
7 reactor safety arena.

8 So what you see here, is what we have extracted
9 from the strategic plan, in terms of the safety arena,
10 performance goals, strategies and measures. The main
11 performance goals that we're looking at are maintain
12 safety; make decisions more effective, efficient and
13 realistic; and increase public confidence.

14 This fourth one, which is unnecessary burden
15 reduction, but if we agreed to a better job on the first
16 two of these, the result is going to be better, in terms
17 of burden reduction.

18 I'll address public confidence a little bit
19 later, because public confidence is not so much determined
20 in what we do, as much as how we do it.

21 Strategies for maintaining safety, and these
22 you can get at -- get from looking at the plan, but these
23 are not all the strategies. These are the strategies that
24 we felt directly connected up to the reason for us doing
25 research. And I'm not going to read through these. The

1 strategies for maintain safety, the strategies for
2 effective, efficient and realistic, and on the next page,
3 the last one, is the strategies for increase public
4 confidence.

5 What's the basis for us doing research? If you
6 ask the licensing office, the primary reason for us doing
7 research is to help them get their job done. And that's
8 true. I mean, that is the reason we exist, and because of
9 that, the user office has a process that's called
10 development of user needs.

11 In the Office of Research, we give a very high
12 rate to user needs that are identified by the office. How
13 is that company from the strategic plan? Well, it comes
14 from their trying to implement their responsibility in the
15 strategic plan, and noticing programs with the licensing
16 experience through their working with other people, their
17 peers, and identify to us things where they need
18 additional work, to help them do their job better.

19 If you look at the long term, which we tend to
20 do in the Office of Research, we also tend to look at what
21 are the data that sits out there, and what the tools and
22 basis for the things, that the licensing office uses.

23 Are there gaps? Are there potential problems
24 that we see developing over the years? Not today, not
25 tomorrow, but perhaps three years from now, five years

1 from now? I think we've had some success in identifying
2 some of those issues, even to the point of time of not
3 having the user office support for doing those things.

4 We're getting very close to the point to where
5 they are starting to do a lot of these issues. I'll point
6 out a couple of those as we go further through the
7 document.

8 New information. We tried to keep a close
9 touch of what's going on. There have been four
10 significant reports out of the national cabinet just over
11 the last year.

12 One we participated in, which is one of
13 institutional control. There was another one on basic
14 research needs in the earth sciences. Both of these were
15 funded by DOE, that address issues that are very close to
16 the responsibilities of our agency. Our staff worked out
17 those things, they looked for new information and
18 processes, things that potentially effect our ability to
19 do a good job.

20 We tried to address those in the research
21 program, put them on a list of things that need to be
22 addressed further in the future, and I'll get to that list
23 as time passes as well.

24 If you look at the way we've organized the
25 program, we've talked all this morning on TPA, I was

1 fascinated to see developments and improvements that have
2 gone on over the last year.

3 (Indiscernible)

4 I'm actually thankful that I was able to come
5 down here and listen to that, because I found it very
6 interesting. We have the same problem with
7 decommissioning facilities, contaminated sites,
8 waste.

9 We have to predict performance over time. The
10 time isn't as long, the source term isn't as large. There
11 isn't that much money in the licensing, so there are a lot
12 of differences between what we do for decommission and
13 other types of contaminated sites that can be done for
14 TPA.

15 We're trying to develop a generic database,
16 look for tools that can be looked at for and develop tools
17 that can be applied broadly, ... and develop, because
18 there has been a focus in our program, in recent years, to
19 develop and some of the developments over this past year
20 have come to the point of looking for and we're looking to
21 places within other agencies, where we can magnify our
22 resources, and perhaps tap into tools that are already
23 available. I'll discuss that later today.

24 But if you look at PA and you look at how the
25 calculation develops, there are certain elements that are

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1 common in the PA source term. You have to identify what
2 kind of waste you have, what the inventory is, what the
3 chemical form is. You have to know something about what
4 you've got, before you can predict what's going to happen
5 to it over time.

6 Did I go too far? Okay. The performance
7 assessment provides a framework, which facilitates --
8 let's go on to the next one. Let's just skip this one.

9 Site storage is one of the things that came to
10 our attention after the institutional control meeting. It
11 had been a concern of ours with monitoring processes and
12 things like that, but there are more things to it than
13 monitoring. Site storage is now becoming a separate ...
14 program, which is separate from PA.

15 Site storage ... essentially involves after the
16 PA. Inputs from PA help us determine things that we need
17 to do during monitoring, but they are different kinds of
18 things, during site ... Let's go to the next one.

19 Okay. In terms of the generalized performance
20 assessment, organizational framework. We have -- in terms
21 of work that we've been doing in source term, we've had
22 work focused on solubilities and slag degradation, a very
23 small effort. But one that produced product this year was
24 the licensing office found very useful, that was the work
25 that we reported to you on ... slide work.

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1 REPORTER: Can you get her to turn your mic up
2 just a little bit. I'm having a hard time hearing you.

3 MR. OTT: Maybe if I just turn. Is that
4 better?

5 REPORTER: Yes.

6 MR. OTT: I'm sorry. I tend to be a little
7 soft spoken.

8 In terms of future efforts, they may include
9 characterization of contaminants associated with
10 entombment. Entombment is a very real issue to us right
11 now. There may be additional industrial process waste
12 forms in non-slugs. We don't know, we'll have to look at.

13 In terms of engineered systems and materials,
14 we've had a very small program going on for a number of
15 years, that's been looking at concrete. It's the main
16 material that's used in a lot of applications for creating
17 covers and creating walls and things like that. That work
18 is nearing an end. There's a model that's been developed
19 for concrete degradation called foresight ... been looking
20 at developing data sets for validation of that model.
21 We're going around the country and looking at structures
22 as old as we can, to get good data points to calibrate
23 that model over a long time frame.

24 But that's not the end. I mean, there are lots
25 of other materials besides concrete that are being

1 considered for barriers. There are things like chemical
2 barriers that are being looked at by EPA. We have to be
3 aware, in this particular instance, not only of what we
4 think might need to be looked at, but what the DOE is
5 doing and what EPA is doing.

6 But there's certainly, I think, a need for
7 additional work on the long-term performance of non-
8 concrete engineered barriers, and we need to look into
9 doing that as a future effort.

10 Transport processes. This has been sort of the
11 largest and single effort in the branch, because it
12 includes both hydrogeology work and the geochemistry work.
13 We're looking at flow through both saturated and
14 unsaturated formations, and those processes that might
15 retard and create ...

16 We have been looking at mechanistic absorption
17 modeling for, I would say, at least six years. Primarily
18 with the USGS out at Mineral Park with Jim Davis' group,
19 and at Sandie National Laboratory with Randy ... and Hank
20 Westridge.

21 That work is getting to the point now where a
22 couple of years ago, we decided to do a demonstration
23 project at Nada Rita in Colorado, which is a radium
24 recovery site, which has been remediated by DOE.
25 Everything was scraped off down to the ground table,

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1 ground water table, but they still have residual
2 contamination in the ground water table, and a complex
3 chemical environment.

4 We deliberately selected that, to see whether
5 the information that we had gathered over the years of
6 working on the natural analog at Alligator Rivers in
7 Australia, which Jim felt it provided sufficient data, to
8 be able to actually model a chemically complex site, to
9 see if that was actually possible. He felt that it was,
10 and that uranium was the one thing that he felt that he
11 could do it with at this time.

12 Sandia has been looking at a little more
13 fundamental perspective, and that lowers the materials on
14 the same problem of mechanistic absorption.

15 On the flow side, the work has been very much
16 focused on looking at uncertainties. Again, now in direct
17 response to a user need for MSS, was looking at parameter
18 uncertainty and models like REDRAD and DandD. These
19 models that are applied generically to a number of sites,
20 basically deterministic models of when we started with
21 them.

22 Many questions with regard to those models, in
23 terms of the pedigree assumption, pedigree of constant
24 that were used, we contracted with the AML, RESRAD to take
25 a very strong look at the assumptions in RESRAD. And to

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1 make certain that we had a very good pedigree on it,
2 because we wanted to put a problemistic show around the
3 RESRAD, to allow it could be used for sub-site
4 calculations for the Commission.

5 PNL essentially helped us by developing
6 distributions for parameters to allow -- provide the data
7 that was needed to run DandD and RESRAD in problemistic
8 mode. You have to have distributions on hydrology
9 parameters, some things like KD's or whatever you're going
10 to use for absorption, and other performance parameters
11 and models.

12 That work for DandD and RESRAD has been
13 completed. The user guides -- user manuals are getting
14 ready to be published now.

15 What are we going to do in the future? Okay.
16 We've also been looking in this -- I'm sorry. Conceptual
17 model uncertainties. No, that's the other one. We've
18 been looking on conceptual models ... at the University of
19 Arizona. That's work that was placed under a competitive
20 contract, addressing the question of how we can go about
21 selecting the models that we use, and then if the data --
22 the interpretation of the data is not unique, there's an
23 alternative interpretations of the model that -- of the
24 data that would lead you to different models.

25 What's the uncertainty created by taking one

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1 path, one set of models as opposed from another path.

2 Let me go on. Pathway analysis. We're not
3 doing any work on that right now. However, there's some
4 information -- well, there's information. The
5 professionals on the staff in the ... area have been
6 looking at this for a number of years, saying the data in
7 the pathway models are old.

8 A lot of that data was generated in the '70s or
9 before the '70s. And there needs to be work done to
10 update that information.

11 The first ever might do in the future is to try
12 to come to grips with that, we just go out and survey and
13 take a look at it, and see how good -- what the quality of
14 that data is, and determine whether there is a real need,
15 where we could actually measure and develop that, we can
16 ascertain that the information does need to be --

17 MR. GARRICK: Now, Bill, do you think there's
18 enough information available now to do a competent
19 atmosphere dispersion analysis for volcanic ash?

20 MR. OTT: For volcanic ash?

21 MR. GARRICK: Uh-huh. You guys brought this
22 back into an important issue.

23 MR. OTT: We? Not we. We started off there in
24 a number of years ago. In terms of -- I was here 18
25 months ago when the Center made the presentations on

1 volcanism, after we got the -- I guess you guys came down
2 with your final determination that we shouldn't do anymore
3 work on volcanism.

4 And after that, being at that presentation, and
5 seeing the levels of risks that were predicted, I couldn't
6 really argue with you, because the levels were at the
7 margin.

8 MR. GARRICK: Right.

9 MR. OTT: And to my mind, if that's the worse
10 that you can --

11 MR. GARRICK: But that's where the analysis is
12 going to come from, is --

13 MR. OTT: Is atmospheric.

14 MR. GARRICK: Yeah.

15 MR. OTT: From the volcanic event.

16 MR. GARRICK: Yeah.

17 MR. OTT: I would think that a lot of the work
18 that's been done could be adapted to do that, yeah. That
19 was your question?

20 MR. GARRICK: Yes.

21 MR. OTT: The dose assessment term I put up
22 here was primarily to describe the overall codes, the
23 RESRAD's and the DandD.

24 The biggest effort that we have had going on in
25 recent years, is development of a flexible frame wall.

1 I'm not going to say a lot about this right now, but it
2 has come to the point where we don't have the resources to
3 do that on our own anymore. And I'll talk a little bit
4 more about this, but we probably are going to stop doing
5 that by ourselves, and join with DOE and DOD and TPA in a
6 joint effort to essentially work on flexible framework.

7 That's all I want to say about that right now.

8 Site stewardship. We do have work currently
9 planned to address monitoring. We had done some work on
10 monitoring, shell monitoring, on monitoring, shadow
11 monitoring, a few years back. That work was completed,
12 and we wanted to go down and look at monitoring the
13 unsaturated zone for a deeper systems.

14 We weren't able to do it at the time. That's
15 the thing that's on the books right now.

16 In the long term, there are other things that
17 institutional controls reported to the National Academy,
18 said there are real problems with assuming long term
19 institutional control for some of the legacy sites that
20 have to be -- that can't be released for general use.

21 I think that's something that we need to
22 follow, what DOE's doing, and there may be some role in
23 there for us to do some small work, to either stay on top
24 of that, or make some kind of contribution ourselves.

25 The next one.

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1 MR. LARKINS: Bill, before you leave that.
2 Your research at one time, was doing some work -- those
3 assessment sets.

4 MR. OTT: That's what I'm talking about. We
5 can't -- don't have the resources to support that.

6 MR. LARKINS: Okay. So that's ...

7 MR. OTT: We're doing deliverable on sets
8 during this month. We were anticipating that we'd have
9 certain capability and ... will be expected, additional
10 ... and we just didn't have the resources to follow that
11 particular avenue anymore.

12 When we first began that effort, that was also
13 a multi-agency effort with both DOE and PA. Over the
14 years, they both pulled out, and we tried to shoulder the
15 entire burden ourselves, and it has become too much. We
16 can't do it anymore.

17 There's also promise that -- by changing
18 course, we may get a lot of the things that we were trying
19 to develop a lot sooner, and that's a site benefit that --
20 you always make changes like this reluctantly.

21 MR. LARKINS: The consensus is that it has more
22 of a problemistic --

23 MR. OTT: Well, there's problemistic techniques
24 in SAD's have been taken over into those RESRAD and DandD.
25 But they're problemistic versions of RESRAD and DandD

1 available right now.

2 And in terms of accomplishments, I'm going to
3 go over that in a couple of minutes.

4 Prioritization. The topic that everybody likes
5 to look for.

6 Prioritization system in the Office of Research
7 is strategic plan based. It's analytical hierarchy
8 process based. Basically that means that the analytical
9 hierarchy process was used to develop the priority system.
10 It's a rating system, developed from a analytical
11 hierarchy model.

12 Okay. The measures of the original system were
13 structured around the reactor safety arena. They included
14 measures that we had -- we are projects that we get, which
15 included things like core damage frequency and large early
16 release fracture.

17 It becomes difficult, and it's one of these
18 classic situations of comparing apples and oranges, when
19 you have to compare the apple by saying how much like an
20 apple does it taste. So it becomes difficult to compete
21 for resources, in a situation like that.

22 We're proposing to change that, to make those
23 basic measures relate to nuclear waste, so that we can
24 compare regarding safety, as it's viewed in the ... as
25 both to safety as its viewed in the reactor.

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1 We don't expect the overall system to change.
2 When we talk about and developed the changes that we're
3 proposing to make, we deliberately did it, so that we
4 wouldn't .. the ... system, primarily, because we thought
5 that was the path of least resistance.

6 Next. Now this on the left is what the Office
7 of Prioritization of the system looks like. And you'll
8 notice -- okay.

9 The first criteria here basically is a no go.
10 It says -- it does issue a credibility, or varied sources
11 of credibility, and even here, there were things to talk
12 about operating experience, and technology and ACRS, which
13 were blatantly not right, so we've got ACMW in there, all
14 right.

15 But we also said, hey, let's look at regulatory
16 -- regulators that we're talking about, about waste
17 disposal and contaminated sites, okay. The MC's are no
18 changes, we wouldn't change the rest of that.

19 Formal user needs, Commission SRM's, these are
20 things that essentially drive our existence. Use our
21 office once something, we try to be responsive for the
22 Commission says we do something, we don't try, we just do
23 it.

24 Safety significance. This is the first place
25 where we have deviated from, the office system, because if

1 you look at the way systems are evaluated, and their
2 safety significance, it doesn't leap out at you, when you
3 say it addresses new safety challenges, maintains or
4 assures current level of safety and monitors safety
5 performance. Because the measures they use to judge this
6 relative values are CDF's and work, core damage frequency
7 and large ... release ...

8 Said, well, this doesn't work for us. What are
9 the appropriate measures here. And if you go into the
10 predecisional report that I've given you, there's a
11 description of the way this is done for the waste. At
12 least now, we're looking at whether the regulatory
13 requirement within the waste agreement. And that
14 basically goes back to 20.1301 of the hundred limit that
15 you were talking about earlier today.

16 We also talked about putting in things like
17 addressing technologies to prevent degraded isolation
18 performance and addressing monitoring long-term care.

19 The scope of licensees. We didn't change that,
20 except to say, let's talk about a class of license. Let's
21 talk about decommissioning. Let's just talk about slag
22 sites, as opposed to talk about PWR's and PWR's.

23 Again, we tried to be -- go ahead. Realistic
24 decision making. ... large nuclear industry out there
25 that supports a significant amount of work themselves.

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1 The decommissioning licensee arena, is not what
2 you call a wealthy group that supports a lot of
3 independent investigation.

4 Okay. That's right. So in terms of -- I can't
5 go out there and find 50 decommissioned licensees that are
6 running a research program, including 50 percent of the
7 project, and join them for leverage. All right.

8 So in this particular case, we said, let's
9 generalize this. Let's stop talking about licensees and
10 this kind of stuff. Let's talk about partnerships. So we
11 just changed this to say, hey, if we can partnerships with
12 other federal agencies, other national governments, that
13 stuff, we ought to get some kind of credit for this
14 prioritization system. And so we just proposed doing
15 that.

16 The next one. Burden reduction. Again, the
17 ... looks at doing things like changing something out of
18 one reactor that saves \$10 million in a given reactor
19 year, and we'll save them \$100 million over that year.

20 Again, we're talking about decommissioning
21 sites, contaminated sites, sometimes we don't even know
22 who the owner is. It seems unreasonable to try and
23 justify a program, which needs to be done, based on those
24 kinds of measures.

25 We said, okay, let's look at it in terms of

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1 cumulative savings, you know, not savings per year,
2 savings -- but cumulative savings, because something's
3 going to save the decommissioning industry \$10 million, we
4 ought to get some credit for that as well.

5 Those are no public ... contributors.
6 Originally, this prioritization system had something in
7 here on corporate ... I think in the last iteration when
8 I wasn't around, it was ... office, they determined that
9 public confidence really is something that comes out of
10 how you do your work, not what you do. So it wasn't
11 determined to be the thing that -- a primary factor in
12 prioritization projects ...

13 We don't suggest changing that. And at the
14 bottom of that table, it tells how the scores are created.
15 And what the office does, is take this rating scheme and
16 evaluate projects and activities, not individual projects,
17 but projects and activities. And then within those
18 activities, there may be several projects.

19 They score them, they create a big huge list.
20 And they go down to the bottom to where the budget is, and
21 draw the line. So that tells you how it's done, and this
22 tells you what we're trying to do to change it to make the
23 process at least more reasonable for us to be looking at
24 for resources.

25 Now, this is the last page of this section.

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1 No. Implementation. All right. This is the last one.
2 How are we going to move forward from here?

3 We've got a very rough draft. We want to clean
4 that draft up and by the middle of December, essentially
5 send it down to the user office, NMSS, and over to NRR, to
6 get comments and inputs on the plan. That will include
7 Section 6.

8 I have not talked about Section 6. Section 6
9 is the detailed listing of current projects, and proposed
10 new projects that we would anticipate looking at over the
11 next five years. ... release handy right now, we've
12 gathered a lot of information from the staff but I haven't
13 had a chance to put it all there.

14 The part about current ongoing work is
15 relatively complete, and includes a brief scope and brief
16 objective and short statement scope of the projects that
17 we have ongoing. That's all included in the predecisional
18 draft that you have, as the last section of the report in
19 the plan.

20 Okay. We want to go NMSS and NRR, ACNW. We
21 would like to incorporate ACNW ideas, but we're not going
22 to ask you for a letter. I don't want to put the extra
23 burden on you guys in reviewing a report that's really in
24 draft form.

25 If you have ideas, if you want to look at

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1 Chapter 6 and say, are there things that I think they
2 ought to be doing over the last five years, we would
3 welcome a note, an e-mail, whatever from you, suggesting
4 topics that you think we ought to include in this plan.

5 I want to give you the same admonition I gave
6 to the staff, we can't approve a ... Okay. We have staff
7 that ... to put those into the plan.

8 Next page. After we get internal refunds,
9 after we get NMSS' reaction to collenate their views, put
10 ideas that they're suggesting for participatory research
11 into this, we would like to solicit information from a
12 larger audience.

13 Those are our partners in other federal
14 agencies, we have MOU's with several, and ... that's
15 fairly exciting.

16 ... comment, and we'll give people 45 to 60
17 days to suggest ideas. When we get all that stuff back,
18 we'll create a final document, we'll create a final
19 listing, and we'll go through there and we'll try and
20 develop a prioritization plan for what we would executive
21 over the next five years, in order of decreasing
22 importance, or decreasing ... rating system.

23 Now there are constraints that may be applied,
24 things like balance. You can't say that well, I've got
25 \$15 million worth of hydrology research, so I'm going to

1 throw this hydrology. It came out .01 points in the
2 rating system in geochemistry.

3 MR. HORNBERGER: It sounds fair to me.

4 MR. OTT: I don't readily agree with you,
5 George. I think we do have to maintain some balance and
6 advance along the front, to try and maintain the evolution
7 of these tools in an orderly manner, as opposed to just
8 approving one thing at a time.

9 All right, next. All right. We're done with
10 the plan. I deliberately didn't go through Section 6. I
11 didn't want to waste a lot of time going through that
12 topic.

13 What I'm going to do now is talk about -- I
14 think I'm listing six accomplishments over the last year,
15 and go into a little detail.

16 One of them I've already mentioned, a slag
17 report that we've put out in March, and you heard the
18 report on. We got very good reactions on that from NMSS.
19 We anticipate finalizing that report in the next month or
20 two, including a multi-compliment PG model.

21 We had a review of hydrogeologic programs, with
22 a lot of attendance from other people. Again, we noticed
23 it on the website, and made it a public meeting and we
24 invited everyone to come that we could, and that was the
25 one that we scheduled deliberately in conjunction with

1 your meeting, so that we could hold over the investigators
2 and talk to you.

3 But at that meeting, we had USGS, we had
4 someone from the NWTRB. We had someone from -- we had
5 numerous NMSS staff present. We had people from the
6 center there. We had DOE. We had ARS, EPA, National
7 Academy's, the State of Illinois. Okay. I mean, all
8 those people came to that meeting, and we were very happy
9 to have that participation.

10 We've been opening our program reviews. We've
11 been trying to have multi-project reviews, when we have
12 light projects, to have a program that's going to last a
13 couple of days, to get into enough depth to attract our
14 counterparts from other agencies. We've been doing this
15 for about two years now, with a big success.

16 We're very pleased with the response we have on
17 this one. Others, we've not had as much participation,
18 and we need to find ways of getting more attention for
19 that, or getting a bigger audience somehow.

20 I mean, the public ..., we attend corporational
21 meetings, we publish a period a new journals, but somehow
22 we have to engage other state ... more efficiently.

23 And primarily, the most effective engagement
24 would be for federal agencies, like DOE and UPA and the
25 Department of Defense. The Department of the Army is the

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1 one we're working with right now.

2 We have a workshop on multi-media environmental
3 models and ... in March, which was also a very large
4 success. That meeting did have participation from the
5 department, the U.S. Corps of Engineers, the Environmental
6 Protection Agency, and the U.S. Geological Survey were all
7 there, as well as the Environmental Protection Agency.

8 Next. About six weeks ago now, the EEO signed
9 the international agreement, which essentially, makes us a
10 participant in the OECD/NEA absorption project, phase two.
11 We were also a participant in phase one. We were a late
12 entrance in phase one, because we hadn't heard about the
13 projects inception.

14 We learned about that through a meeting on
15 another international project, and decided this was
16 something we needed to be a part of, we needed to keep up
17 with what's going on in the international community in
18 absorption.

19 We completed the problems ... of RESRAD and
20 DandD, which I've already mentioned to you. And we're
21 currently developing a NOMU with a research on PADO in the
22 Department of Defense, in this case, the Corps of
23 Engineers, at the Water Waste Experiment Station. USGS
24 has learned of this particular effort, and has asked if
25 they could participate as well, and we also helped to get

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1 the Agricultural Research Service in, because of their
2 expertise in the area of soils.

3 So we hope within the next two months to have
4 an NOMU in place that will facilitate both the exchange of
5 information, and the development of things like joint
6 workshops with those five other federal agencies,
7 particularly their research arms.

8 Next. I'd like to go into a little bit more
9 detail on the OECD/NEA absorption project and a little bit
10 on two of the others.

11 The objective is to demonstrate the
12 effectability of different chemical ... modeling approach
13 to support the selection of absorption parameters for
14 performance assessment.

15 The conclusion of the absorption project, phase
16 one, was that the state of science is to the point where
17 we can do a better job in KD's. It might be an informed
18 KD, one which is selected as a result of another processor
19 off to the side, which is considering things like pH and
20 eH bionitics ..., but they felt that it was time to -- it
21 was time to try applying that. And the second phase of
22 the absorption project is essentially going to do that.

23 There's an executive group that's looking at
24 test cases. Each participating country and there are 10
25 countries participating, and 13 organizations.

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1 Each country is going to supply modeling
2 changes or test cases that are developed by the technical
3 direction team.

4 The NRC is going to have three teams working on
5 the project, three modeling teams; one based here at the
6 Center; one based up in Rockville with MNSS and RES staff,
7 and one with AUSGS contractor out at Mineral Park. So
8 we're -- we're actually very pleased in this instance that
9 we went to MSS and we invited them to join and they saw a
10 value in the ... capabilities of their staff and the final
11 analysis of applying their expertise to various problems
12 ... to the results of other teams, and so we decided to
13 join with us.

14 You can go on -- I think there's two parts down
15 there. There are more details here that you can look at
16 if you want to.

17 I talked about DandD and RESRAD. DandD have
18 been a much more ... code, particularly in version one.
19 This is a set of calculations that we did to try and
20 compare RESRAD and DandD in their new versions. These are
21 now problemistic versions and one -- I think we ran a
22 thousand realizations for DandD in these calculations, and
23 500 for RESRAD. It could've been more for RESRAD, I'm not
24 certain. It was at least 500.

25 The comparison here was to go back to some

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1 published information, in terms of places where people
2 have concentrations and doses, to see whether -- how
3 RESRAD and DandD would do with those published values, and
4 in comparison with each other.

5 What applied here, and my note down at the
6 right says, "90th quantile". These are 90th quantile
7 values.

8 I deemed the Indian minus -- I'll explain that
9 in a minute, RESRAD, RESRAD*, and then DandD, RESRAD,
10 DandD, RESRAD, for U-238, ... testing and K-40. The
11 reason there's a lot more runs done for potassium 40,
12 because it turns out that fish pathway in the residential
13 scenario, tends to get a huge dose. That's because the
14 residential scenario assumes that the person residing on
15 this site has a pond, and eats something like 50 kilograms
16 of fish a year that he grows in the pond. And that pond
17 is simply contaminated by waste or things that were left
18 on site.

19 We're separately looking at that assumption, in
20 terms of consumption of fish, and whether there's anybody
21 with an agricultural ... site and ... likely to consume
22 that much fish over a year.

23 But for this exercise, we decided to run DandD
24 without ...

25 RESRAD had a similar quirk in it, and the

1 drainage area was much, much larger than the contaminated
2 area. And so we ran the RESRAD the second time, we shrank
3 down the drainage areas, the contaminated area, to try to
4 get some comparability out of it.

5 I mean, when you look at the numbers in this
6 table, potassium chlorine, ... 233 and 238, we feel that
7 they're remarkable ... in terms of the relative magnitude
8 of these projections. You wouldn't expect them to be
9 exactly the same. These models are significantly
10 different.

11 But the old problems of DandD's way over the
12 conservative; RESRAD is the greatest in there. They hover
13 around the same values on these things. Sometimes one's a
14 little higher, sometimes the other's a little higher. And
15 they're both hovering very close to what UNSCEAR reported
16 in terms of data -- in terms of doses from natural
17 concentrations of ... uranium and potassium.

18 Next. The research MOU that I talked about,
19 developing media meeting on linkages in March gave rise to
20 a lot of discussions of the participants in that meeting.
21 And the idea popped up that, you know, wouldn't it be nice
22 if these groups got together and interacted more.

23 And it also turns out that DOD, EPA and -- or
24 excuse me, DOE, EPA and the U.S. Army Corps of Engineers
25 are the primary supporters for the frame network at PNNL.

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1 That is most likely where we are going to go for large
2 site complex modeling expertise, after this. We have not
3 yet placed a contract there, but all indications indicate
4 that that's where we would go. The framework is already
5 up and running.

6 There are already significant capability both
7 with NEPA and the Corps of Engineers, and then DOE. One
8 of the things that -- when we met a couple of weeks ago to
9 essentially make certain that applications using the
10 frames model that we're currently diverging. In other
11 words, they were winding up having multiple versions of
12 frames. They didn't want that to happen. They wanted the
13 framework to converge, so if there was a single framework,
14 that all of these particular modeling applications were
15 working off of.

16 Ralph Katy and I went out to PNL and
17 participated in the meeting, and they were discussing what
18 they were going to do over the next 18 months to three
19 years. We found that to be a very exciting prospect, not
20 only from what the frames will be able to do, if the
21 capability that are brought in by places like the Water
22 Waste ... Station, ... models now, but they have an
23 extensive modeling system, that would be a great value to
24 us if we were together.

25 They also have a system that is designed to

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1 look at general calculations, and in fact, they're using
2 ... statements that proves output to satisfy the
3 requirements of those determinative impact ..., so we're
4 hoping to get access to that kind of capability through
5 this partnership.

6 We made -- we've had numerous teleconferences
7 with regard to this MIU discussions with the appropriate
8 staff at the four agencies.

9 We've had OGC review and at least three of the
10 agencies are holding ... approval from Portland, until
11 we've got the legal approvals, and we hope to be able to
12 move forward with this in the next month to two months. I
13 would like to see it happen by Christmas, but I'm not
14 certain.

15 Next. Now we're going to switch tracks. We're
16 going to leave radionuclide transport. You guys wanted to
17 hear about what's going on in the other side of the house,
18 so we're going to talk about that a little bit.

19 We'll start with the technical basis for
20 clearance. There was a contract awarded about a year ago
21 ... procurement providing technical basis for rule making
22 on the control of slightly contaminated materials.

23 Because of concerns that arose after the award,
24 the contract on conflict of interest, it was decided that
25 the contract would be rebid. That bidding process has

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1 been gone on for a while. We expect a contract award in
2 January. It's still in the procurement process, but we
3 expect to have that completed by then.

4 The National Academies effort. You made -- you
5 eluded to earlier in one of the letters that you were
6 working on yesterday. The -- it's called the Study of the
7 Alternatives for Controlling the Release of Solid
8 Materials. The contract was awarded on August 31st. The
9 duration is from September 1st, 2000 to February 28th,
10 2002, provision committee membership was posted on the web
11 on November 9th, I believe an 18-day comment period or
12 something like that.

13 We have met with the National Academy staff,
14 specifically on October 24th, to provide documents that
15 are called for in the contract. There were a number of
16 documents that were discussed, and or in this area of
17 background ... and we met with them and provided them with
18 that material.

19 There is a tentative date for the first
20 committee meeting has been proposed, for January 3rd,
21 2001. So that's the status of what's going on with the
22 National Academy right now.

23 Next. This should be dear to the heart of our
24 Center. We contracted with them to do a review of the
25 drafting of 1640. 1640 was produced by the same

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1 contractor that had won the award on the technical basis
2 contract. There was some concern that if people worried
3 about conflict of interest and maybe 1640 would be
4 tainted.

5 So we contracted with the Center to do an
6 independent technical review.

7 The bullets here are semi-quotes from their
8 report conclusions. Found that SAIC agent -- SAIC was a
9 contractor generally performed a high quality analysis;
10 the QA program was appropriate and effective; they
11 identified some minor errors that should be corrected; and
12 they proposed additional scenarios for future work.

13 1640 will be reviewed, revised appropriately
14 and then published some time in the next couple of months.

15 Publication of draft NUREG 1725, human
16 interaction with reused soil, a literature review. We
17 published a literature review, which caused no end of
18 public comment. We contracted with the Agricultural
19 Research Service as probably will be the people that would
20 know the most about soil in the country to contract ...
21 just give us an idea of what people use soil for, so that
22 someone could then assess what the impact would be, if you
23 were releasing slightly contaminated soil.

24 That's been published. It was out for comment.
25 The comment period closed November 17th. ARS and NRC

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1 staff will address the comments and decide whether to
2 include additional sources in the list of sources that was
3 provided as a result of the literature here.

4 Next. We'll move on to the health effects
5 area. One of our major efforts is BEIR VII. That's a
6 multi-agency effort with a primary funding coming from EPA
7 and DOE.

8 It was originally a 36-month study that was
9 initiated in September of '98, with a September 01
10 deliverable. It's been complicated by the fact that
11 there's an ongoing revision of the atomic bomb dosimetry
12 which won't be available until 2002. The atomic bomb
13 dosimetry is one of the bases for the report. They are
14 proposing to delay or extend the project for two years.

15 There has not been a final decision on that
16 yet, but there are proposals before the various funding
17 agencies with regard to doing that.

18 The JCCRER, which is the work that's proceeding
19 to examine the occupational exposure database for workers
20 in the Mayak production facilities in the Soviet Union.

21 We're in the third year of a four year study at
22 the present time on pulmonary effects in Mayak workers for
23 prolonged exposure to plutonium.

24 Developing an integrated database of clinical
25 and dosimetric information. They basically have 40 years

1 worth of data on about 400 workers, who were employed at
2 the Mayak facilities. So we've got both detailed clinical
3 data, and detailed exposure data from the facility itself.

4 MR. LARKINS: Bill?

5 MR. OTT: Yes.

6 MR. LARKINS: I've got a question here. How
7 come there's no ... at Chernobil information and put that
8 as part of your --

9 MR. OTT: I don't know the answer to your
10 question. This stuff was all started in the health ...
11 branch before I took over, before the two branches got
12 merged.

13 MR. LARKINS: Well, I was just curious. I
14 mean, it's an obvious --

15 MR. OTT: I think there's a lot of stuff going
16 on in Chernobil, but we're not directly involved in any of
17 it right now.

18 ISCORS Sewer Study, and this one that we would
19 like to come to you in late summer to talk about.

20 Sampling is complete, 50 percent of the samples
21 have been analyzed. They expect to be complete with all
22 of the analyses by June. We're looking at coming to AMNW
23 in late summer. ISCORS website, I've listed the website
24 here. There's a lot of information on the study under the
25 website. All you have to do is allegated it to get to it.

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1 They're basically looking at the collection of
2 radioactive materials and hospital wastes and things like
3 that and sewers, and trying to determine whether it
4 constitutes a problem.

5 Revised MARSSIM manual published, we're a
6 participant in that. That's also available on the EPA
7 website. That's it. That's it.

8 MR. HORNBERGER: Bill, I --

9 MR. OTT: ... handed in it.

10 MR. HORNBERGER: Bill, I have a couple of
11 questions and they're probably linked. Let me -- it'll be
12 a relatively long question.

13 As you know, when we commented on the research
14 effort, the Office of Research effort for the past two
15 years now, and our criticism, if you like, were sort of
16 two-fold. The first one was that we didn't see the
17 prioritization scheme that we thought was necessary, and
18 linked to that, we said that the prioritization scheme, we
19 would like to see linked into more strategic overview of
20 what needed to be done.

21 And then linked to that, we were concerned
22 about whether or not the budget was of the appropriate
23 size to really do the work, whether it was above critical
24 mass.

25 Now, I think that everyone must be really

1 impressed with what you have presented today in terms of a
2 prioritization, in terms of thank you for sharing the
3 predecisional plan that you have put together.

4 Certainly, that goes directly to the -- to what
5 we commented on. The question that I have, however, is
6 that the prioritization criteria, to really get you in the
7 game, requires the changes that you went through with us
8 that were proposed. Otherwise, a linked bit, whether or
9 not your program is above critical mass, in terms of
10 dollars really comes around.

11 So my linked question is, how -- what's your
12 score card in terms of having these proposed changes
13 approved, number one. And number two, how do you think --
14 how do you anticipate this may effect the overall budget
15 availability for waste related research?

16 MR. OTT: Okay. First, you had a copy of the
17 predecisional draft, an early copy in your notebook. You
18 weren't supposed to have that.

19 You weren't supposed to have that because we
20 haven't gotten our office director to approve it. I met
21 with the office director Wednesday before Thanksgiving and
22 went through this briefing, and got permission to give you
23 that predecisional draft. I went over the priority --
24 changes to the prioritization scheme, and his primary
25 concern was whether it would disgrunt the other party's

1 prioritization process, which is something that we had
2 anticipated and we've tried to come to grips with.

3 I think that there is going to be support at
4 the office level for that revised prioritized organization
5 scheme.

6 Now, does that mean we're going to get more
7 money? Not necessarily. It may force a decision with
8 regard to separately funding the major ... It may not, I
9 don't know. All I can do is speculate at this point. I
10 think something that's probably might be a significant
11 factor in this, when we get around to budget time this
12 year, is the kind of remarks that the advisory committee
13 has come out with.

14 Those questions that Roger's asked. I mean, is
15 the work that we're doing good work, regardless of whether
16 it's highest priority work, is it work that you think
17 needs to be done.

18 One of the things that has both the
19 Environmental Protection Agency and the Corps of Engineers
20 excited about this NOU, is access to the work that we're
21 doing on parameter and model certainty.

22 They find the work that we've been doing in
23 that area to be extremely appropriate, even for their
24 concerns.

25 It is actually kind of gratifying to go to a

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1 meeting and find out that your sister agencies are seeing
2 you doing things that gee whiz, you know, we really like
3 what you're doing there, we'd like to get access to it.

4 But to go back to the reports that come up,
5 very seldom does a clear statement come through from the
6 Commission that the work that we're doing isn't a value to
7 the program.

8 What comes through is problems with the
9 prioritization and things like that. It would be nice to
10 have clear statements with regard to, is the work that
11 you're doing viable.

12 We're coming to the -- to a near term
13 conclusion on the geochemistry work. We've actually put a
14 lot of resources into that over the last, not just six
15 years, but probably longer than that, because we started
16 doing it in the high level waste program.

17 We originally funded work at Alligator Rivers
18 as a natural analog to uranium and ... waste issues. We
19 did work at Pena Blanca with the Center for the same
20 reason in geochemistry.

21 So if you looked at the cumulative investment
22 of our knowledge over the years, we're now getting some
23 kinds of gratifying results in seeing the international
24 community coming to the same conclusions as we are. The
25 information has come to the point where it ... as usual.

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1 It's not just information. It's also the technology that
2 uses it, computationally.

3 When we first started this, it was not feasible
4 to do anything but use a constant KD. The computers --
5 the computer ... couldn't handle it, but computers have
6 increased a lot in the last ten years, their capabilities
7 now.

8 And even though it would be more complex to
9 deal with chemistry, it's something that we think is
10 computational feasible now.

11 So we're seeing gratifying results from
12 external sources, but we're not seeing as much from
13 internal sources that might help us. That's one of the
14 comments that I would make. I don't think your question
15 included the -- included level, whether I thought we were
16 at the right level.

17 MR. HORNBERGER: Right.

18 MR. OTT: If you look at what I stated -- I
19 showed you about what we are doing, there are areas that
20 we're not doing very much in at all. We're on a
21 shoestring. The work that we're doing at NIS has been
22 funded at about \$100,000 a year. The work that we've been
23 doing on slide, we've been working at Johns Hopkins
24 University. We're not doing any work at pathway analysis,
25 we should. We ought to be looking at some of those

1 issues. I would say ...

2 MR. HORNBERGER: Okay. Actually, the second
3 part of my question, and this is my final question, short
4 answer. Depending upon how we did the counting, and we
5 could never get a total agreement on how one counted, I
6 think that the program -- overall program level was
7 between 1 and \$2 million the year before last.

8 What's your budget for this fiscal year total?

9 MR. OTT: For --

10 MR. HORNBERGER: Total program. Has it gone
11 down, has it stayed the same, has it gone up?

12 MR. OTT: Well, no, what you were talking about
13 probably -- what you're talking about probably isn't total
14 level. It probably -- we adjusted the rating ... that
15 part of it?

16 MR. HORNBERGER: That's right.

17 MR. OTT: And I would've thought it would've
18 been listed at about two million. I wrote these things
19 down last year and totaled them up last night. Where's
20 that piece of paper? I thought you might ask that
21 question.

22 There is. In the waste arena, in FY 2000, the
23 funding was 2645. In 2001, it's 2177. It went down by
24 about a \$500,000. But part of the reason for that is both
25 RESRAD and DandD were completed in 2000. And there's only

1 a little bit of money going into finishing over the user
2 manuals and a little bit in training and that kind of
3 stuff.

4 So the majority of that decrease between 2000
5 and 2001, is the fact that we considered RESRAD and DandD
6 to be complete.

7 MR. HORNBERGER: Fair enough.

8 MR. OTT: In terms of materials, the 2000
9 budget was \$1.4. The 2001 budget is 485,000. The
10 difference there, and that's why it's so dangerous to give
11 out numbers. The difference there is, there's \$800,000 in
12 the 2000 budget that was awarded to the National Academy,
13 and that was essentially provided at JGER ... MNSS. Money
14 was moved around in the agency to be able to fund the
15 National Academy.

16 MR. HORNBERGER: Okay.

17 MR. OTT: So \$800,000 of that difference comes
18 from funding -- all of the fund in 2000. So not much
19 difference. There may be a couple of hundred thousand
20 dollars. And the third area is reactors, and I say
21 reactors, because that's where things like JCCERR funded,
22 the radiation protection stuff, the worker doses, and
23 occupational exposures, that was funded at \$565,000 in
24 2000, and the 2001 budget, it's \$870,000. And if I look
25 through here, there's a good reason for that increase, I

1 don't have it indicated in my notes.

2 MR. HORNBERGER: That's okay. Because I --

3 MR. OTT: It's about the same.

4 MR. HORNBERGER: It's about the same, perhaps a
5 little lower.

6 MR. OTT: Yeah, but it's about two million in
7 the waste arena. It's about a half a million in
8 materials, and about a half a million in reactors. Total,
9 about \$3 million, if you take out the fluctuations caused
10 by things like National Academy and RESRAD and DandD.

11 MR. HORNBERGER: Okay. We don't have a lot of
12 time, but we'll have a round of questions.

13 MR. WYMER: That was great.

14 MR. OTT: I felt like I kept losing myself.

15 MR. GARRICK: Well, I think I'll pass, too. I
16 just want to ask what --

17 MR. HORNBERGER: If you're going to ask
18 something, you better ask it.

19 MR. OTT: This is a mutually

20 MR. GARRICK: How far in the future do you look
21 when you do your planning for research?

22 MR. OTT: Right now, we're looking at five
23 years.

24 MR. GARRICK: Five years.

25 MR. OTT: In the past, we've looked five years

1 ahead, but as budgets shrunk, projects got stretched out,
2 instead of cutting projects, we would tend to slide
3 dollars over, and all of a sudden your planning window
4 became shorter, because you weren't able to start new
5 things. But we are deliberately, in this plan, trying to
6 look five years into the future. We're trying to do more
7 in terms of projecting and participatory needs.

8 MR. GARRICK: Okay.

9 MR. HORNBERGER: Stan? John?

10 MR. LARKINS: You said that one area that ...
11 pathway analysis, are there any other areas that you think
12 should be funded?

13 MR. OTT: Well, I think that was one of the
14 most obvious ones. To a certain extent, a lot of it is
15 going to depend on this -- the results of our
16 demonstration project at Nada Reda, and on the results of
17 the absorption project.

18 If it's true that we can do a much better job
19 with geochemistry, with making ... models, it's also true
20 that we probably don't have the right data to do it at the
21 majority of sites. If somebody goes in and pulls up a
22 soil sample and there's a KD in the laboratory, and then
23 goes back, you're not going to have the information out of
24 that sample, to then go back and say, well, I don't want
25 to do a KD, I want to do something else. We need to know

1 something about what's in that soil, in terms of the
2 primary minerals that are present, because the minerals
3 are going to be the things that are critical in
4 determining how things are absorbed.

5 So in the long run, to a certain extent, it
6 depends on certain research. And I should point out, and
7 you'll see this when you look at it. One of the things in
8 the absorption project is going to look at is costs. We
9 want to know whether we can efficiently, effectively and
10 cost effectively make these kinds of changes.

11 Part of that depends on how much of the burden
12 is assumed by regulatory agencies, and how much of its
13 assumed by the individual developers.

14 The -- we still anticipate that need for a
15 platform to do complex sites. So I expect that we will
16 continue to meet the fund work in that area. I can't
17 really identify anything more right now.

18 We've asked the staff, and they've given some
19 input, but we haven't really had a chance to collate ...
20 Sorry. I wish I could give you a better answer right now.

21 MR. HORNBERGER: Okay. We're going to move on.
22 Thanks very much, Bill. I turn it back to you, Mr.
23 Chairman.

24 MR. GARRICK: Okay. I think that in order to
25 accommodate changes and adjustments, we'll take a five

1 minute break. We no longer need the court reporter for
2 the next session. Just a short break.

3 (Conclusion of proceedings.)

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CERTIFICATION OF TRANSCRIPT

I, Ellen Walters, hereby certify that this is the transcript of the porceedings held before the U.S. Nuclear Regulatory Commission in the matter of the 123RD MEETING OF THE ADVISORY COMMITTEE ON NUCLEAR WASTE, at SAN ANTONIO, TEXAS, on November 28, 2000, and that this is a full and correct transcript of the porceedings.

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