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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON NUCLEAR WASTE (ACNW)

133RD MEETING

+ + + + +

TUESDAY,

MARCH 19, 2002

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ROCKVILLE, MARYLAND

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The meeting commenced at 10:00 a.m. in
Room T2B3, Two White Flint North, Rockville,
Maryland, George M. Hornberger, Chairman, presiding.

COMMITTEE MEMBERS PRESENT:

GEORGE M. HORNBERGER, Chairman

RAYMOND G. WYMER, Vice Chair

B. JOHN GARRICK, Member

MILTON N. LEVENSON, Member

1 STAFF PRESENT:

2 JOHN T. LARKINS, Executive Director, ACRS-ACNW

3 SHER BADAHUR, Association Director, ACRS-ACNW

4 HOWARD J. LARSON, Special Assistant, ACRS-ACNW

5 LYNN DEERING, ACNW Staff

6 LATIF HAMDAN, ACNW Staff

7 MICHAEL LEE, ACNW Staff

8 RICHARD K. MAJOR, ACNW Staff

9 WILLIAM HINZE, ACNW Staff

10 CAROL A. HARRIS, ACRW/ACNW Staff

11 RICHARD P. SANVIO, ACRS/ACNW Staff

12

13 Also Present:

14 CAROL HANLON, DOE

15 PETER SWIFT, Bechtel SAIC

16 WILLIAM BOYLE, DOE

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I-N-D-E-X

Opening Statement 3

ACNW Planning and Procedures

Update on DOE Performance Assessment

 Program (BJG/MPL) 6

 Carol Hanlon 6

 Peter Swift 14

 Bill Boyle 46

Adjourn 116

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

(10:05 a.m.)

CHAIRMAN HORNBERGER: The meeting will come to order. This is the first day of the 133rd meeting of the Advisory Committee on Nuclear Waste. My name is George Hornberger, Chairman of the ACNW. Other Members of the Committee present are Raymond Wyner, Vice Chairman, John Garrick and Milton Levenson. And also present we have a consultant with us today, Bill Hinze.

During today's meeting, following the planning and procedures session the Committee will (1) hear an update from DOE on its performance assessment program; (2) finalize the annual research report to the Commission, and (3) discuss preparations for tomorrow's meeting with the Commissioner.

John Larkins is the designated federal official for today's initial session.

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

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1 written comment from Mr. Mel Silberberg, on the
2 research program. His letter will be inserted into
3 the record at this meeting.

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

8 Before proceeding, I would like to cover
9 some brief items of current interest. Items of
10 interest, (1) Dr. Victor Ransom has been appointed as
11 the eleventh Member of the ACRS. He is a Professor
12 Emeritus of Nuclear Engineering, Purdue University.
13 Prior to this, he was a Scientific and Engineering
14 Fellow at the Idaho National Engineering and
15 Environmental Laboratory. Mr. Timothy Cobetz and Mr.
16 Robert Elliott have been selected the ACRS/ACNW
17 Technical Staffs. Rob, who returns to the ACRS staff
18 having previously served on a rotational assignment
19 comes from NRR and will replace Noel Dudley on the
20 ACRS staff. Tim, who joins the Staff from the Spent
21 Fuel Project Office, will assist both Committees as
22 the work load dictates.

23 Dr. Margaret Chu has been approved by the
24 Senate as Director, Office of Civilian Radioactive
25 Waste Management. She comes to DOE from Sandia

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1 National Laboratories where she has been in charge of
2 the Nuclear Waste Management Program. Prior to that
3 she was Deputy Manager for WIP.

4 The attached, at least attached in our
5 book here, February 13, 2002, a paper by Commissioner
6 Dicus, "The Future of Environmental Protection, a U.S.
7 Regulator's Perspective" provides a most interesting
8 perspective on this topic and I'm sure that anyone who
9 wants it can get a copy of this document.

10 Any other items? Okay, good. We are
11 going to move to our first topic which is an update on
12 DOE performance assessment and John Garrick will chair
13 this section of the meeting.

14 MEMBER GARRICK: I'm going to waive any
15 opening remarks for the benefit of having the time to
16 ask questions and what have you and I think we have
17 three people that we're going to hear from: Carol
18 Hanlon, Peter Swift and Bill Boyle. And I would ask
19 each of them to give us a quick statement of their
20 assignment or their role for the benefit of the record
21 and the Committee and those in attendance.

22 So Carol?

23 MS. HANLON: Thanks, Dr. Garrick. Is this
24 on? Can you hear me? Good morning. I am Carol
25 Hanlon with the Department of Energy. I'd like to

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1 introduce to you my colleagues, Dr. William Boyle and
2 Dr. Peter Swift and ask them to join us up here. They
3 will be giving the main presentations.

4 Peter is with the Sandia National Labs,
5 Performance Assessment, and he has had a very main
6 role in helping us with our performance assessment
7 activities as well as the prioritization effort going
8 forward.

9 Dr. Boyle, as you know, is a Technical
10 Advisor, with Yucca Mountain and has strong
11 underground geotechnical expertise.

12 So the gentlemen will be making the
13 presentations.

14 You know that the Committee has been
15 carefully following our process and are particularly
16 concerned both with the technical aspects as well as
17 the performance assessment. We've briefed you many
18 times and especially last year on several of these
19 topics, including the Supplemental Science and
20 Performance Analysis Document, the Preliminary Site
21 Suitability Sites and Engineering Report and I know
22 you've been at many of the key technical issue
23 technical exchanges. So you're very familiar with
24 these issues.

25 We're also familiar with and we have

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1 carefully considered the letters that you provided,
2 especially the letter on performance assessment and
3 we're hoping that you will see some of your
4 recommendations included in our path forward.

5 So I'm pleased to be able to speak with
6 you today and give you an update on some of the
7 information that has come out, some of the reports
8 that have come out since last summer.

9 I've introduced Dr. Boyle and Dr. Swift
10 and if I may just briefly cover some of the
11 information as an introduction.

12 This is our snapshot on our home page
13 which is available at [www.yuccamountain](http://www.yuccamountain.com) --
14 www.ymp.com and it pretty nicely captures the major
15 efforts, the major accomplishments we have had during
16 the last year or so, the release of the Yucca Mountain
17 Site Suitability Evaluation, Rev. 1 of the Science and
18 Engineering Report, the SR Comment Summary Document,
19 Supplemental Comment Summary Document, those
20 responding to and summarizing comments that we
21 received during our comments period; the final
22 environmental impact statement and some other
23 information as well as the state and county impact
24 reports.

25 CHAIRMAN HORNBERGER: In the spirit of

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1 engelbrecht, you did say ynp.com and I didn't know
2 that DOE had become a dot com.

3 (Laughter.)

4 MS. HANLON: Thank you very much for
5 helping me. Did I say dot com? Thank you.

6 Everyone will correct me. YMP.gov. And
7 I will never use an acronym again.

8 (Laughter.)

9 So the presentations that follow address
10 these technical updates and comments on preliminary
11 site suitability evaluation. There are two types of
12 them. One that evaluates the evaluation, the impacts
13 of the final regulatory standards including the
14 Environmental Protection Agency Standard 40 CFR Part
15 197 as well as Nuclear Regulatory Commission's 10 CFR
16 Part 9, excuse me, 63.

17 In addition, the technical updates
18 consider the evaluations of additional information
19 which was available since release of the supplemental
20 science report and analysis, the science and
21 engineering report and the preliminary site
22 suitability evaluation report, that information that
23 was continuing to be collected and analyzed over the
24 summer.

25 Another topic that we will discuss is the

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1 treatment of uncertainty in the total system
2 performance assessment for the license application,
3 both the uncertainty analysis and strategy and
4 discussion of treatment forward of uncertainty and
5 finally, the path forward for the Yucca Mountain
6 performance assessment focusing on uncertainty that
7 matters and risk-informed prioritization for
8 performance assessment.

9 And you have in your book and in the
10 presentation again these major developments, on-going
11 technical exchanges with the staff during the year and
12 we had another technical exchange last week in San
13 Antonio; the release in May of the Science and
14 Engineering Report which was based on the total system
15 performance assessment in July; in August, releasing
16 supplemental science and performance analyses as well
17 as a preliminary site suitability evaluation; and
18 including the updates later to total system
19 performance assessment, staff recommendation and the
20 technical basis which Peter will say something about.

21 CHAIRMAN HORNBERGER: Carol, what was the
22 technical exchange last week?

23 MS. HANLON: It was on -- what was the
24 title again?

25 DR. BOYLE: Laboratory design.

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1 MS. HANLON: And the final regulatory
2 standards not in July, but in June, 40 CFR 197 which
3 was finalized in November, 63 -- 10 CFR Part 63 was
4 finalized and also in November, the Department's 10
5 CFR 963 was released.

6 In December 2002, we had -- I think that's
7 an error -- 2001, additional information documented
8 was presented in four Letter of Reports which we'll
9 discuss with you today and in February, the site
10 recommendation went forward from the President. So
11 we're in the process of realigning our science and
12 performance assessment activities within BSC and
13 moving forward with a consistent direction on
14 treatment of uncertainty as well as focusing on the
15 risk-informed performance-based approach.

16 So with, unless you have any questions on
17 that brief introduction, I'd like to turn the
18 microphone over to Dr. Swift.

19 CHAIRMAN HORNBERGER: Just a quick one,
20 Carol. What's BSC?

21 MS. HANLON: Bechtel.

22 DR. SWIFT: BSC is Bechtel SAIC Company.
23 It's the management operating contractor and this
24 first presentation is the four letter reports that
25 Carol mentioned. I'll go through them, fairly

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1 quickly, but just summarize what new information there
2 is relevant to performance assessment since the major
3 documents of last summer.

4 I should credit many other people, Jerry
5 McNish, the manager of the Total System Performance
6 Assessment Department, in particular; and Mike DeLugo,
7 who was the lead on one of the four letter reports,
8 the largest, that Update Impact letter report.

9 And just to clarify, there was one mention
10 made there on Carol's side on realigning science and
11 performance assessment activities within Bechtel SAIC
12 and what has been done is that the Post-closure
13 Science Programs have been brought together with
14 performance assessment into a single organization
15 called the Performance Assessment Project. Bob
16 Andrews is the manager of that.

17 And the performance assessment
18 calculations, the TSPA, Total Systems Performance
19 Assessment, is one department within that larger
20 Performance Assessment Project. In fact, there are
21 several subprojects. TSPA now actually reports to me
22 in this group called Performance Assessment Strategy
23 and Scope.

24 The science programs we're familiar with
25 for years also now report directly to Bob Andrews

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1 within Performance Assessment.

2 A couple of overview slides here, just to
3 go through quickly. What we have here first, there's
4 a body of information that is the Total System
5 Performance Assessment for the Site Recommendation,
6 TSPASR, documentation and with that I'm including the
7 Supplemental Science Performance Analyses from last
8 summer, last spring and summer.

9 This, the SSPA and the other documents
10 that are associated with that, I believe have already
11 been presented to this group, so what I'm focusing on
12 are things that follow that, that's this page and the
13 next one in the handout. A Letter Report in
14 September, completed in September, looking at the
15 impacts of the final EPA rule and also supporting the
16 final environmental impact statement and then a Letter
17 Report in December on the impacts of the NRC's final
18 rule which was, we felt, there are enough things in
19 that to run traditional analyses.

20 And then this technical update impact
21 Letter Report, known by its acronym as the TUILR.
22 These, so you can -- a graphic showing you what the
23 documentation is, two pages of this. First page is
24 performance assessment documents, going all the way
25 back to September of 2000, a document called the TSPA,

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1 SR-Rev 0 and it's updated. ICN stands for Interim
2 Change Notice. That's basically the revision.
3 Updated in December, that's the version which people
4 are most familiar with. That supported the site
5 recommendation and the upper-tier documents that were
6 released that spring and summer, but it was also
7 updated in the spring, the supplementary analyses were
8 published in July in something called the
9 Supplementary Science Performance Analyses Volume 2,
10 SSPA Volume 2.

11 Then September and December, new results
12 that you probably have not seen yet. The Part 197
13 update and the Part 63 update.

14 MEMBER GARRICK: Peter, when you get
15 around to doing the TSPA-LA, will it integrate all of
16 these documents into the TSPA-LA?

17 DR. SWIFT: The TSPA-LA will be stand
18 alone in the sense that it will be a complete
19 documentation of its own set of analyses. It will
20 probably most closely resemble the models used in
21 these ones, but does that answer your question?

22 We don't have to keep sending you back to
23 a lower tier or older documents.

24 MEMBER GARRICK: Okay, thank you.

25 DR. SWIFT: This talk is about TSPA, but

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1 it's worth keeping tracking of the non-TSPA documents
2 also, the upper tier documents of the science
3 documents.

4 I've lumped them both together on this
5 side. Go back to 2000, you have the Process Model
6 Reports and the Analysis Model Reports prior to the
7 scientific basis or TSPA-SR. They fed into an upper
8 tier DOE document released last May, the Yucca
9 Mountain Science and Engineering Report. These were
10 contract reports. This is a DOC document. This is a
11 primary technical basis for site recommendation, a
12 thing called the Science and Engineering Report,
13 published in early May 2001.

14 The scientific basis was updated again in
15 the spring of 2001 in this Supplementary Science and
16 Performance Analyses by one which was a scientific
17 basis. This document, published in July as a DOE
18 document, I believe, has new science that was not in
19 this one. And also in Volume 2 it has new TSPA
20 analysis.

21 Together, these two supported the
22 preliminary site suitability evaluation. This is the
23 document that actually makes the site recommendation
24 case. That was a DOE document published in August.
25 The cover date is July, but wasn't released until August.

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1 And this is all material you've seen or
2 was available. This is the new part over here, the
3 November 2001, Technical Update Impact Letter Report.

4 (Slide change.)

5 DR. SWIFT: Now the Letter Report on the
6 Final EPA Rule and it's worth actually noting the
7 footnote. If you try to do a search in any records,
8 data base, looking for that document, you'll discover
9 that the title of it says it's input to the final
10 environmental impact statement. That's correct.
11 Informally, we think of it as the update report on the
12 EPA rule and it was originally planned prior to the
13 completion of the EPA rule. It was originally planned
14 as an EIS update.

15 So the TSPA was modified to meet
16 specifications in Part 197. We went from the average
17 member of the critical group to the reasonably
18 maximally exposed individual. We went from 20
19 kilometers to 18 kilometers, both for groundwater
20 release and for the volcanic disruption scenario and
21 ashfall. And the EPA rules specified 3000 acre/feet
22 per year for groundwater protection. So we ran those.

23 (Slide change.)

24 DR. SWIFT: We also, these were the ones
25 that were aspects of the analysis that was planned for

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1 the EIS, looked at both the base case waste policy act
2 inventory and a possible expanded inventory. And that
3 was the main point of the EIS.

4 We also ran some updated igneous activity
5 scenarios. We reran human intrusion which we had not
6 run since December of 2000 and we looked at two
7 different times for human intrusion.

8 (Slide change.)

9 DR. SWIFT: So far those changes were all
10 driven by regulation or assumption. We also did make
11 changes in the model itself since the model used in
12 the spring of 2001. I listed the most important one
13 here first. Waste-package corrosion calculations for
14 the results of that show -- used a general corrosion
15 model that was independent of temperature.

16 In the SSPA, the supplementary results
17 from next spring, we had used a temperature
18 independent corrosion model which basically showed
19 corrosion slowing at lower temperatures. We felt
20 there was insufficient technical basis to support that
21 for the site recommendation. You know it was already
22 published in the SSPA, so we took it back out and that
23 one change there counts for most of what you're going
24 to see in these slides.

25 We found an error in our in-drift

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1 thermal-hydrology work which we omitted heat transfer.
2 It made a whole lot of difference. So we put it back
3 in and got it right.

4 We had omitted portal transport from the
5 portal due to intrusion. We corrected that. We had
6 an updated version of a waste package degradation
7 model. And we modified the inventory slightly at the
8 request of the Naval programs to treat their fuel as
9 part of the commercial inventory, whether it's a DOE
10 inventory. It's a small fraction anyway and would
11 make no difference.

12 (Slide change.)

13 DR. SWIFT: Results. These are mean
14 annual doses and millirems per year. I'm not showing
15 the complete panel of the doses that generated that,
16 but these are means drawn from 300 realizations. The
17 black curve here is the mean from TSPA-SR in December
18 of 2000. The red here is a single curve shown from
19 SSPA June-July of 2001. And this happens to be for
20 the high temperature operating mode that we looked.
21 This was only the high temperature mode here. In
22 SSPA, we looked at high and low. And then here, blue
23 and green, you can hardly tell the difference between
24 them, this new modified model run for both high and
25 low temperature for the updated model.

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1 MEMBER GARRICK: Has the red curve not
2 reached its peak yet?

3 DR. SWIFT: That is correct, the red curve
4 -- unless that is its peak. We don't know that. But
5 in the actual highest point on the curve is here.
6 That's due a climate spike. By inference, we believe
7 that -- we can't rule out the possibility it might
8 have achieved a higher peak if it ran longer, but
9 there actually is a peak in there.

10 Taking out the temperature-dependent
11 corrosion, basically moves the time of large scale
12 package failure from here to 740,000 years and what
13 that has done is basically it leaves the -- in the red
14 curve corrosion rates slowed as temperature dropped
15 later and the green and blue curves, they do not.
16 They stay at a higher corrosion rate throughout.

17 CHAIRMAN HORNBERGER: What's the change to
18 explain the differences at early times?

19 DR. SWIFT: It'll come to me in a minute.

20 CHAIRMAN HORNBERGER: Is it an assumption
21 on juvenile failures or is it igneous activity or what
22 is it?

23 DR. SWIFT: No, it's juvenile failure.
24 For the SR, we had input from our waste package
25 engineers, but they saw no credible mechanism for

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1 juvenile failures, so we had none. This is the
2 earliest general corrosion failure showing up here on
3 the black curve.

4 For the updates for both SSPA and the more
5 recent work early last fall, we have the first general
6 corrosion failures later. They're out in here. But
7 we do now have a model for juvenile failures, early
8 failures, due to improper heat treatment of lid wells.
9 The number of failures, in about a quarter of our
10 realizations, we had one or two packages out of 11,000
11 failing. So it's a very small failure rate, but it
12 produces a non-zero dose. It gives you small numbers.
13 This is a non-zero dose out to there that is largely
14 driven by igneous iodine and Carbon 14 in groundwater
15 transport.

16 MEMBER GARRICK: Are you going to later
17 get into a little more detail about impact of the
18 changes in this -- in the model in relation to the
19 difference in the assumptions between the TSPA-SR and
20 these results? I'm thinking of things like if you've
21 introduced this corrosion model now, has that brought
22 seepage back into the picture as an important
23 phenomena because in the TSPA-SR it was not an
24 important phenomena.

25 DR. SWIFT: It's still not particularly

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1 important here. It matters for transport away from a
2 package, but the corrosion model is still independent
3 of water saturation. As long as you have humidity,
4 you have corrosion.

5 MEMBER GARRICK: And you still have the
6 same model inside the waste package of the saturated
7 water environment, those kinds of things?

8 DR. SWIFT: Uh-huh. Yes. The end package
9 transport model, I think is when --

10 MEMBER GARRICK: So it's still diffusive
11 transport that's the main?

12 DR. SWIFT: Yes. One significant
13 difference between and this applies for both the red
14 and blue-green here. A significant difference between
15 these two curves and this one is that the -- in an
16 attempt to put a little more realism in that diffusive
17 transport pathway of the package, we now split the
18 transporting waste that are transported by diffusive
19 properties when they reach the drift wall, the rock.
20 We put the diffusive transport fraction into the
21 matrix of the rock and we put the effective, if there
22 is effective, transport and that would that synchrony.

23 We put that fraction and it fractures.
24 Previously, we put it all into the fractures, this
25 curve, put all the waste and the fractures and that

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1 didn't seem realistic, simply based on the surface
2 area available for diffusive transport, most of it is
3 going to go into the largest part of the surface area
4 which is matrix.

5 So that's the only change that I think
6 comes to mind for me anyway, between -- for the in-
7 drift transport model, between this, these curves and
8 that one. Probably more realistic with the splitting
9 of the diffusive.

10 Ask questions as I go. The time and the
11 fact that I'm only one person, I wasn't planning to go
12 out for a lot of detail in this stuff, so go ahead and
13 ask question.

14 VICE CHAIRMAN WYMER: I have a question.
15 How important was the microbiological corrosion? Was
16 it important at all?

17 DR. SWIFT: Bill, do you want to field
18 that one?

19 DR. BOYLE: I'm sorry, I don't have the
20 answer.

21 VICE CHAIRMAN WYMER: Is it a minor
22 player?

23 DR. SWIFT: No, I don't think it's a
24 player at all.

25 VICE CHAIRMAN WYMER: The other question

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1 is what is meant by aging multipliers of inside out
2 corrosion?

3 DR. SWIFT: Aging multipliers for inside
4 out corrosion. That is pretty cryptic. The model
5 does not have an explosive treatment of the behavior
6 of alloy 22 as it ages. Instead, we apply a
7 multiplier to the corrosion rate to account for aging,
8 changes in the alloy aging. I don't know what the
9 update was, but someone felt, I suspect that in the
10 SRR model we had an aging multiplier only on outside
11 in corrosion.

12 Somebody pointed out we should have it on
13 the inside out corrosion also. But it's an uncertain
14 parameter. It's a parameter that has a range on it to
15 account for our uncertainty in the effects of aging
16 and corrosion.

17 VICE CHAIRMAN WYMER: So the multiplier
18 then --

19 DR. SWIFT: Accelerates the rate.

20 VICE CHAIRMAN WYMER: Accelerates the
21 corrosion, in some arbitrarily decided way?

22 DR. SWIFT: Uh-huh. In some -- I hope
23 it's more than arbitrary, but it's not physics based.

24 MEMBER LEVENSON: Is the uncertainty ever
25 symmetrical? It's always in a more dangerous

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1 direction?

2 DR. SWIFT: We'll come to that in the next
3 set of talks. For these analyses, I believe it is
4 asymmetrical in many cases. I would like to see more
5 symmetry.

6 MEMBER GARRICK: Generally, more of a log
7 normal than a uniform?

8 DR. SWIFT: I know where you're headed
9 with the question. Keep asking it.

10 (Slide change.)

11 DR. SWIFT: The igneous activity results.
12 I think that's the next -- yeah. This same
13 presentation or say similar presentation was given by
14 Jerry McNish to the Review Board in January and this
15 figure drew quite a lot of attention from the Board
16 who were displeased with the lack of prominence given
17 to the word "probability weighted" here. I want to
18 make clear of that right now. These are probability
19 weighted mean annual doses. This is consistent with
20 what's in Part 63. This is not being included with
21 obvious dose you'd expect to see, but it is -- I'll go
22 through that in a couple of slides here, what it
23 really is.

24 This is the regulatory dose of volcanic
25 activity. The black curve here is what was shown in

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1 TSPA-SR in December of 2000 and the blue and red and
2 curves here were updated in September and these, by
3 the way are essentially identical. I was also updated
4 in the SSPA in June and July.

5 The red and blue were a perfect overlay
6 here for high temperature and low temperature
7 operating modes. The volcanos are pretty insensitive
8 to temperature of the depository.

9 Changes here, recent updates, since SSPA,
10 specifically for this analysis, we move the location
11 from 20 kilometers to 18 kilometers and we updated the
12 biosphere dose conversion factors. We also made all
13 the changes I just talked about in the nominal model.
14 That's the other feature that's here.

15 There are a series of other changes not
16 described here which were updated as part of SSPA in
17 the spring. They are what account for this vector of
18 25 increase from here to here, interruptive dose and
19 the decrease over here at later times.

20 The smooth curve to here or all the way
21 out to here is driven by the volcanic ashfall dose and
22 the irregular curve here and here is from the
23 groundwater release from damaged packages and at some
24 point in the future the basic weight, probability
25 weighted dose from the groundwater pathway from

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1 packages damaged by igneous activity will cross over
2 and exceed the corruptive ones. If you put edging for
3 the black line, you adjust the eruptive half, we have
4 a curve that kept on going out like that where it's a
5 groundwater curve, goes like that. So at the
6 crossover point, you see that the curve changed from
7 being smooth to being irregular.

8 The sharpness here is due to a long term
9 climate change in the model, it's spiking here. These
10 are glacial climates.

11 The other major changes here between
12 basically we -- at suggestions from the center and the
13 NRC staff, we looked at a different wind speed data
14 set which led to an increase of about, a factor of 2.5
15 from here to here. We updated our biosphere dose
16 conversation factors --

17 MEMBER GARRICK: Does that mean you will
18 look more at a wind row than a --

19 DR. SWIFT: No, the wind direction is
20 still assumed to be fixed towards the location of the
21 REMI for these. So that would have to be a factor of
22 4 or 5.

23 MEMBER GARRICK: Yes.

24 DR. SWIFT: It's not a huge player, but
25 yeah --

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1 MEMBER GARRICK: It is quite a huge
2 player.

3 DR. SWIFT: The 4 or 5 add up.

4 MEMBER GARRICK: Yes.

5 DR. SWIFT: We looked at wind from a
6 higher altitude. They had pointed out that we had a
7 data set that went to higher altitude than we could
8 have used and we used that and that was part of the
9 difference here.

10 As a matter of fact, we unrealistically
11 used only the highest altitude, the 300 millibar data
12 only went into that, whereas for this one, we used a
13 somewhat lower altitude data set against the full
14 column of wind speeds and got the elevation up.

15 This also has an increase in the number of
16 packages involved in the eruption, due to a
17 recalculation of how we did that. Has increased dose
18 conversion factors due to reconsideration of the nasal
19 ingestion pathway. That's the larger particles lodged
20 in the nose. We ended up putting in the long --

21 MEMBER GARRICK: But you continued to use
22 the assumption that all the waste packages were
23 degraded that were in the intersect?

24 DR. SWIFT: Yes. All packages in the --
25 we were conceptualizing the volcano as a conduit, a

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1 cylinder that rises up through it. It's also got an
2 intrusive dike, a tabular body that may cross many
3 drifts, but the portion that erupts, we're assuming is
4 a cylinder with a mean diameter of about 50 meters of
5 - or medium diameter.

6 Yes, all packages in that cutout by the
7 cylinder are assumed to be fully destroyed. The
8 phrase is damaged sufficiently to provide no further
9 protection. And the waste within them is produced to
10 the grain size of the particles which is by-products.

11 MEMBER LEVENSON: Is there any
12 significant, for this type analysis, is there any
13 significant difference in the footprint of the high
14 level versus the low level?

15 DR. SWIFT: The high-temperature/low-
16 temperature?

17 MEMBER LEVENSON: Yes.

18 DR. SWIFT: It's a simple scaling. It
19 affects the probability that the event will hit it at
20 all. And if you need to have a larger footprint for
21 a lower temperature operating mode, then the
22 probability of the event scales -- it's not precisely
23 linear because -- it's close enough. If you double
24 the footprint, you're going to double the probability.

25 MEMBER LEVENSON: I would have expected to

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1 see a little difference between the high temperature
2 --

3 DR. SWIFT: Oh, thank you. Thank you. We
4 didn't do it. We said that and that's a caveat that
5 is in the text and I should say that. We simply used
6 the one footprint for this and in text we discuss how
7 to use the weighting factor if you want to.

8 It's not clear that we will have different
9 footprints. One of the options was for low
10 temperature, was to use the same footprint and a
11 longer and more rapid ventilation period.

12 So we weren't quite sure what to do with
13 that and it was going to be a nuisance to --

14 MEMBER GARRICK: How about the erosion
15 time of the 1000-year erosion time for the 15
16 centimeter layer? You're still using that?

17 DR. SWIFT: No. Let me explain what we
18 actually did here. This is -- this is a good slide to
19 do it with.

20 This is the -- what we call the
21 conditional dose, the dose that you would get -- this
22 is a figure that we probably should have showed them
23 ERB in January, but didn't.

24 If an event happened at 100 years and
25 these were calculated by the way it would be SR

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1 modeled, black being the curve on the previous page.
2 If an event were to happen at 100 years, a person
3 living after that would receive a dose as shown here.
4 So a person alive at 2000 years might receive a dose
5 somewhere in this bandwidth here, the mean being red,
6 so that would be 95th shown, both shown in black.

7 Clearly, the dose would be worse if you
8 were alive at the year of the volcano. There's no
9 probability weighting shown here. The uncertainty
10 between the lowest and the highest curves reflects
11 uncertainty basically in the inputs to our ASHPLUME or
12 transport model, things like windspeed and the conduit
13 diameter. That's basically how many packages are
14 effective. And also in our biosphere conversion
15 factors.

16 The slope of the curve, how fast it drops
17 off through time is a factor of two things. One is
18 there's radioactive decay and the other is how quickly
19 that contaminated ash layer erodes away. And -- all
20 right, that's the top figure.

21 The bottom figure down here is just mean
22 curves. The red here. Now it's just the mean curve
23 shown for condition events at different times at 100,
24 500, 1,000, 5,000 years.

25 This, if you were to draw a curve,

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1 connects the dots through the tops of them, that's the
2 radioactive decay curve. So these curves then are our
3 soil removal factor. That's the rate at which soil
4 will be contaminated and ash layers being eroded away.

5 However, our treatment is not quite as
6 simple, John, as the way you describe it. What we're
7 doing is we are assuming that the top layer of top
8 soil erodes at a rate of 6 to 8 millimeters per year.
9 I believe that's right. However, we're assuming that
10 soil is plowed annually, so it's constantly being
11 remixed to 15 centimeters, so that any way -- how
12 thick the ash layer is, the radionuclides get mixed in
13 to a 15 millimeter soil layer every year and the top
14 of it gets skimmed off every year. So it's an
15 exponential decay in our soil removal rather than a
16 simple decay. There's always some still left there.

17 And so if we weren't mixing, we would take
18 off that 15 centimeters in several hundreds of years.
19 It would be relatively rapid. We are mixing, so that
20 we're always creating a -- we've always moving
21 radionuclides deeper down in that soil layer with each
22 year's plowing and erosion.

23 Clearly, we are fairly sensitive to the
24 way we treat erosion. If we had zero erosion, if the
25 soil layer stayed there forever, this curve would look

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1 like the connecting the dots from the top of there,
2 simply go out like that. Would be a radioactive decay
3 curve.

4 CHAIRMAN HORNBERGER: This is a pretty
5 critical part of the model for the first few thousand
6 years?

7 DR. SWIFT: Yes, it is.

8 MEMBER GARRICK: And it struck me as an
9 extremely conservative assumption.

10 DR. SWIFT: The assumptions that go into
11 that have to do with whether you think we're dealing
12 with agricultural land or stable desert soil. If
13 we're dealing with agricultural land that really is
14 being plowed every year, this may not be that
15 unrealistic. We have a fairly high, compared to what,
16 for example, the NRC staff has recommended, we have a
17 relatively rate at which stuff blows off, but because
18 we're plowing and mixing, that is consistent with what
19 you'd expect to see on crop land.

20 On the other hand, if we didn't have this
21 plowing and mixing going on, we had stable desert
22 soil, we shouldn't have such air mass loading or such
23 rapid erosion. We have pretty high air mass loading
24 in our BACS. It's dusty air people are breathing in,
25 consistent with agricultural land. It's blowing

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1 around.

2 It's what we did anyway. I just want to
3 show one other slide here.

4 (Slide change.)

5 DR. SWIFT: This is how you get from those
6 conditional doses to dose mean doses because this is
7 something that it's not intuitive and this is just a
8 question of probability space rather than a real
9 phenomenon. This is what the role asks for and I
10 believe it makes sense.

11 Think of these as mean doses from the
12 previous curve, the mean conventional dose. If an
13 eruption happened, Volcano 1 happened in Time 1 and
14 you dropped the time axis here, this is dose/time, a
15 person alive in the future could get in the Year T-1,
16 they would get that dose. If they were in Year T-5,
17 but the eruption was in Year T-1, they would get this
18 dose here off that curve there.

19 If, on the other hand, they were in Year
20 T-5 and an eruption happened in Year T-6 out here,
21 they'd get a zero dose. The eruption hasn't happened
22 yet.

23 Now put it into probability weighting, the
24 probability that a person living out here in the Year
25 T-5 could get a dose from an eruption that already

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1 happened back in Year 1, Year 2, 3, 4 and so on, well,
2 the probabilities of those were all the same, similar
3 to the process that has a time constant probability
4 and so the probability weighted mean dose we'd get out
5 here is simply the sum of the probability of all the
6 events in the time interval of interest, 0 to 1,000
7 years times the doses associated with each one of
8 those events at the time you're interested in.

9 So at Time 5, this person living here
10 could be getting a dose from this event, from this
11 event, this event, or that event. That one is a zero.
12 And each one of them has equal probability and you
13 multiply them and sum them up. And what you get when
14 you do this, this is actually what we do, but a little
15 thought experiment suggests that at early times,
16 although the consequences are highest, the probability
17 that the event happens in that year or has already
18 happened, the probability is low. As you go out in
19 time, the probability accumulates.

20 So the probability if you're living out
21 here at the Year 10,000, the probability that the
22 event has already happened is 10,000 times the
23 probability in the first year. So in this sum here,
24 the doses go down at later times, but the
25 probabilities accumulate and you'd expect to see a

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1 mean curve that starts out low and climbs to some
2 intermediate peak and then falls off again as doses
3 decay from radioactive decay.

4 And that actually is what -- that's what
5 the blue curve is here or the black one. The peak is
6 around 3000 years and after that radioactive decay
7 takes over and starts to drop off.

8 So that's -- the point of that explanation
9 is just to say, show how we got from things that look
10 like this to the probability of weighted sum that the
11 regulation asks for.

12 I've got to speed up here.

13 (Slide change.)

14 DR. SWIFT: Human intrusion scenarios.
15 This is the forced assumption that a driller drills
16 through the waste package. Part 197 says one waste
17 package, made a pathway to the borehole pathway to the
18 saturated zone and assume it occurs at a time when the
19 waste package is degraded enough that the grower would
20 not recognize it. And this then is -- we picked
21 30,000 years. And this is an intrusion of 30,000
22 years as our annual doses, a full set of 300 of them
23 with a mean shown.

24 And these are -- we also reran it for the
25 proposed NRC rules, was prior to finalization of 197.

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1 We used the 100-year time. What you see here, for
2 example, from 100 out to the first arrivals coming in,
3 this is basically your minimum saturated zone
4 transport time. The spread of arrival is out from
5 time after that show the spread and saturated zone of
6 transport. So some realizations showed first arrivals
7 here. Some didn't have them arriving too well out
8 there.

9 (Slide change.)

10 DR. SWIFT: The December Report looked at
11 the impact of Part -- final Part 63. The main
12 difference here was the rule now requires us to use
13 3000 acre/feet per year for individual protection
14 which is something the EPA has not clarified in their
15 rule. So now we were using a sample value previously.
16 We also in this report, if you get a hold of the
17 report and read it, will discover we ran a couple of
18 cases that are now moot following clarification of the
19 word "unlikely" and the new proposed rule.

20 We went ahead and ran a case with an
21 igneous intrusion eruption for the groundwater
22 protection standard and also for the human intrusion.
23 And with a clarification of the rule in those cases
24 are moot.

25 What happened with the 3,000 acre/feet.

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1 The result was to scale those by approximately two
2 thirds.

3 CHAIRMAN HORNBERGER: Two thirds or three
4 halves?

5 DR. SWIFT: Two thirds. We're diluting
6 them.

7 CHAIRMAN HORNBERGER: Oh, that's dilution.

8 DR. SWIFT: This was a sample value.
9 There's the range given, with a mean of about 3,000
10 acre/feet in our -- this is what we found from our
11 survey of these in the region. Well, this just pushed
12 us to the upper portion of the range in the rule and
13 produces a little more dilution.

14 These -- the numbers shown here are the
15 nominal performance only. These are the numbers of
16 the doses due to the juvenile failures of nominal
17 performance. We took the volcano out to show that.

18 CHAIRMAN HORNBERGER: It's two-thirds
19 because you put everything into the volume.

20 DR. SWIFT: The larger volume.

21 CHAIRMAN HORNBERGER: Rather than have a
22 concentration?

23 DR. SWIFT: Yes.

24 (Slide change.)

25 DR. SWIFT: The Technical Update Impact

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1 Letter Report, this is the fourth of them. I said a
2 letter report. This is -- this report is underlying
3 science rather than TSPA. I had a much smaller role
4 in this report, but Mike DeLugo is the person who did
5 most of the coordinating of it.

6 The point here was documenting additional
7 information since completion of the underlying science
8 for the Science and Engineering Report and the Yucca
9 Mountain Preliminary Site Suitability Evaluation. So
10 this updates in science since roughly the spring of
11 2001. In some cases it goes back a little further
12 than that. But this was a new work that was going on
13 last summer and early fall in experimental programs.
14 And then the impacts of this work were evaluated on
15 TSPA and preclosure, basically to make sure there
16 weren't any -- wasn't any new information that would
17 necessitate a re-evaluation of the said
18 recommendation.

19 It's a thick report. It's almost 400
20 pages long. It includes 11 White Papers in each of
21 the topical areas where the technical staff was sent
22 back to just document what is their new information.
23 Then we had a rapid series of workshops where we
24 looked at the impacts. To do this, we got the
25 technical experts who wrote those White Papers

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1 together with TSPA analysts and we had our workshop
2 setting. We went through each topic and on the spot
3 estimated elicited impacts on total systems.

4 A couple of pages here of examples of the
5 sorts of things. This isn't a very complete list.
6 Just the sorts of information that was available:
7 fracture data, seepage data. These were things that
8 were written up and then people were asked how would
9 this affect the input for models and the modelers were
10 asked would this have an effect. And so on, the high
11 profile one here, the discovery of high concentrations
12 of chloride in seepage waters at low temperatures.

13 VICE CHAIRMAN WYMER: In your technical
14 update, you didn't include a couple of processes.

15 DR. SWIFT: To the extent that they're
16 captured in the on-going work related to the --
17 usually the air field environment and the engineered
18 barrier system, yes, we did. It was structured around
19 the existing science programs. We didn't force a
20 White Paper on a couple of processes.

21 You want to deal with that?

22 DR. BOYLE: That fluoride example is
23 actually -- falls within the realm of a couple of
24 processes. As it turns out the flourine came from the
25 materials that were introduced by jackets, but it was

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1 postulated that it could have been coming from the
2 fluoride. That's the small amount of fluoride that's
3 present in the rocks.

4 VICE CHAIRMAN WYMER: So to that extent
5 you put it in.

6 DR. SWIFT: Yes. There were some portions
7 of this were entirely preclosure, for example, updated
8 data on aircraft activity. We have a new survey of
9 aircraft traffic in the area, know that that would
10 change the risk of accidental airplane crash, which
11 seems moot now.

12 (Slide change.)

13 DR. SWIFT: So what were the results of
14 this and if you've got a copy of the technical update,
15 the TUILR, I recommend you go straight to the very
16 back end of it on pages 350 on where there's an
17 appendix that discusses impacts on post closure
18 assessment and there are a series of chapters in that
19 appendix, a weight for each of the various measures of
20 the components. And here's the conclusion. All
21 impacts of all the new work are insignificant, except
22 for these two.

23 First, the Transport Team believes that
24 they're now able to show a reduction of nominal dose,
25 igneous dose, but the nominal performance. They thing

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1 it may show a more delayed retardation in unsaturated
2 zone perhaps lowering the 10,000 year dose up to one
3 order of magnitude. This is lowering, but it's also
4 just pushing it up further in time. It's slowing the
5 transport.

6 VICE CHAIRMAN WYMER: What's that due to?

7 DR. SWIFT: Excuse me?

8 VICE CHAIRMAN WYMER: What slows it down?

9 DR. SWIFT: It's a change in the way
10 they've been treating diffusion near the matrix and
11 this is not my field. It's out of the realistic case
12 AMR and so-called realistic case AMR and that it was
13 a change -- actually, I believe a numerical treatment
14 in the model of the -- I believe it added more cells
15 in the matrix, so you -- instead of having the matrix
16 represented by a single cell and diffusion occurring
17 all the way to the center at once and way back out
18 again in a single step, I believe in the numerical
19 model there, so it takes longer for the diffusion to
20 get in and out. And it's the back out part where
21 we're seeing the benefit.

22 The model probably will not be permitted
23 in the TSPA because it's numerical intensive. But
24 anyway, and also we weren't too excited about a
25 possible one order of magnitude reduction in a dose

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1 that's already 10^{-5} . But it's worth knowing anyway.
2 It may be there.

3 Possible increases in the eruptive dose.
4 Basically, we looked at the impacts of the Center's
5 model and the conclusion of our staff was that no more
6 than one order of magnitude increase there. That's
7 based simply on looking at the total number of
8 packages that might be involved. The largest
9 difference is between -- from a performance point of
10 view, the largest difference is between the Center's
11 model and the one we're using as the Center's proposed
12 mechanism has more packages.

13 MR. HINZE: Peter, if I may, Bill Hinze.
14 You have eruptive there. What about intrusive? Is
15 that considered in that?

16 DR. SWIFT: Yes. The effective is only on
17 the eruptive side here. That's deliberate to say
18 eruptive in the dose there.

19 The Center's model that basically we're
20 concerned about here, we worry about, is the one that
21 calls for what I call a dog-leg eruption where magma
22 rises, hits a drift, flows down a drift and goes back
23 up again. Ours goes straight through and they
24 proposed, and we can't rule out the possibility it
25 would go a dog-leg path and sweep the entire drift and

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1 of course, the eruption. And if so, more packages
2 will be involved.

3 MR. HINZE: Are you considering it at all
4 in terms of the intrusive? Is that going to be coming
5 along?

6 DR. SWIFT: We are reevaluating our model
7 for the intrusive effects. We don't see a big impact
8 there on dose. We believe our model needs more work
9 to be ready for the LA, but we don't think that's
10 going to change much.

11 MR. HINZE: Are you eliminating the zones
12 that you had in terms of disruption of the canisters?

13 DR. SWIFT: That may be modified for LA.
14 It may not. We're working on that right now. Some
15 version of that is likely to stay at the Zone 1 of
16 extreme damage and Zone 2, lesser damage, but in fact,
17 there are igneous geniuses are working on that
18 question right now.

19 MR. HINZE: Thank you.

20 MEMBER GARRICK: If the new data that's
21 being talked about now on igneous activity results in
22 an increase in the likelihood term, what is that going
23 to do to your results?

24 DR. SWIFT: In terms of increasing the
25 probability of a volcanic event or an eruption, those

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1 are separate probabilities.

2 MEMBER GARRICK: Yes.

3 DR. SWIFT: Increasing the probability of
4 either of those at the site is pretty much a direct
5 scaler on the probability, the way it goes.

6 MEMBER GARRICK: Right.

7 DR. SWIFT: There is a question about the
8 air magnetic data and whether or not that will change
9 the probability.

10 MEMBER GARRICK: So if the cases increases
11 that a 10^{-7} number is not even justified on the basis
12 of the supporting evidence and it may be more like
13 10^{-6} , if that happens it's going to be pretty much a
14 linear effect?

15 DR. SWIFT: Yes. We don't think that's
16 going to happen. Our of our impact assessment, we
17 don't think that probability is changing much.

18 And I think that does it. No, I've got
19 the summary slide.

20 (Slide change.)

21 DR. SWIFT: Just for completeness, to note
22 that we did look at impacts on pre-closure performance
23 of new data. Also, we didn't see anything there.

24 I think that's simply a summary side.
25 Let's me sit down.

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1 The analyses that I've just summarized
2 here, basically provide confidence in the adequacy,
3 appropriateness of the SR.

4 MEMBER GARRICK: I know we're running a
5 little behind and I want to give the Committee a
6 chance to ask questions, but you'll be hanging around,
7 will you not?

8 DR. SWIFT: Actually, I should have said
9 that right off. No, I have a 2:55 flight to catch.

10 MEMBER GARRICK: Oh, I see. Well, then
11 let's give the Committee the benefit of your presence
12 and see if there are any questions.

13 DR. SWIFT: Bill and I are your speakers
14 until 12:30.

15 MEMBER GARRICK: And you have to leave --
16 yes. Okay.

17 Ray, go ahead.

18 VICE CHAIRMAN WYMER: In your backup slide
19 24, you indicate that Carbon-14 is rated Class C.

20 DR. SWIFT: Yes.

21 VICE CHAIRMAN WYMER: Why did you put that
22 in there?

23 DR. SWIFT: I don't actually know where
24 that came from, Class C. So I guess I can't answer
25 your question. I realize it was likely to come. I

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1 don't know.

2 VICE CHAIRMAN WYMER: That's the first
3 time I really heard it talked about the Carbon-14
4 being rated Class C.

5 DR. SWIFT: I can say that we do not have
6 a realistic model for groundwater transport. This is
7 based on the assumption that Carbon-14, carbon, in
8 general, is a nonreactive species for groundwater
9 transport, our groundwater chemists just don't like
10 that.

11 (Laughter.)

12 DR. SWIFT: So basically that's an upper
13 bound on Carbon-14.

14 VICE CHAIRMAN WYMER: You don't know where
15 that came from?

16 DR. SWIFT: No, I don't.

17 MR. BOYLE: Good morning. Thank you for
18 this opportunity. Peter had talked about some
19 updates, and these next two talks -- the first by me
20 and then I'll be followed by Peter -- are going to
21 deal with uncertainty analyses and what we're doing
22 with uncertainties.

23 For those of you that were present at the
24 NWTRB meeting at the end of January in Pahrump, I made
25 this presentation there, and I'm pretty much going to

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1 make the same presentation. And I think Peter will as
2 well, for the most part.

3 This report -- it's available at our
4 website, if you haven't seen it already. And it
5 represents the work of others, in particular the two
6 people whose signatures are on the report -- Kevin
7 Coppersmith of Coppersmith Consulting, and Jerry
8 McNish of BSC.

9 And Chapter 2 of the report was prepared
10 by Jerry and the various process model leads. Chapter
11 3 was prepared by Kevin, and with input from Peter and
12 Bob Andrews, comments from them. And Chapter 4 was
13 prepared by Karen Jenny and Tim Nieman of GeoMatrix.

14 Now, the overview of the next two talks --
15 the first is by me on the report itself, "Uncertainty
16 Analyses and Strategy Report," and Peter is going to
17 talk about how to -- the implementation of a
18 consistent treatment of uncertainty in the TSPA, total
19 system performance assessment, for license
20 application.

21 This is the title of Section 1 of the
22 report. It's "Introduction," and the three main goals
23 of the report are listed on page 2 of the report.
24 I've distilled them here in these three bullets. This
25 is what is done in Section 2 of the report. Summarize

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1 and discuss what we at the project have done to
2 evaluate, clarify, and improve the representation of
3 uncertainty in the total system performance
4 assessment. That's Section 2, and it also gets at
5 comments made by other groups.

6 Based on this discussion, Section 3
7 develops a strategy for how to handle uncertainties,
8 and it also proposes some improvements for the future.
9 And then, Section 4 deals specifically with how to
10 communicate uncertainties to various groups,
11 decisionmakers, technical people, and also proposes
12 some improvements for the future.

13 The next I think it's six or so -- I think
14 it's up through page 9 -- pages 4 through 9 of the
15 package you have are a table. And it's related to
16 something that's in Section 2 of the report. Here is
17 the title of Section 2 of the report, "Evaluation of
18 Uncertainty Treatment in the TSPA and the Significance
19 of Uncertainties."

20 On pages 30 and 31 of the report, there is
21 Table 2.2 and it's called "Key Remaining
22 Uncertainties," and it deals in the table with these
23 first four columns. And in the report there is in
24 that table in the report, this fifth column isn't
25 there. The information that's in the fifth column I'm

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1 showing you here is in the report, but it's in the
2 text of the report. But we had a request from people
3 at headquarters to distill down those paragraphs and
4 pages in the report and create this fifth column.

5 As I did at the NWTRB meeting in Pahrump
6 -- we'll be here all day if we go through each and
7 every item in this table. The main point that I want
8 to get across with respect to Section 2 is the various
9 technical investigators were asked to summarize the
10 state of uncertainties. What I asked them to do is I
11 asked them, how can you sleep at night knowing that
12 there was a potential at that time that a decision was
13 going to be made? How can you sleep at night with the
14 remaining uncertainties? And that's what this table
15 and those parts of the report tried to capture.

16 We got back two very common answers of why
17 these people were able to sleep at night. One is the
18 uncertainties really didn't matter. They looked at a
19 broad range, and for some of the items it didn't
20 really affect the dose at 18 or 20 kilometers.

21 MEMBER GARRICK: But, Bill, isn't that
22 dependent upon the model?

23 MR. BOYLE: Sure.

24 MEMBER GARRICK: Because in the VA, for
25 example, seepage was a very important phenomena.

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1 MR. BOYLE: Right.

2 MEMBER GARRICK: And so you changed your
3 corrosion model, so that in the site recommendation
4 report it's not an important phenomena.

5 MR. BOYLE: Right.

6 MEMBER GARRICK: And I think it's those
7 kinds of connections that are very important.

8 MR. BOYLE: Right. And that's the point
9 I would say when they -- when I say that there wasn't
10 -- it really didn't have an effect or it wasn't
11 important, it is with respect to the insights that
12 were being gained by an implementation of either the
13 TSPA itself or some subsystem.

14 But, you know, the answer is both.
15 Sometimes it was -- when carried all the way through
16 to the end of the TSPA calculation, it showed that it
17 didn't matter, which then just raises the question,
18 what if the underlying models really aren't right?

19 But those were the answers I got back from
20 the PIs. One is it really didn't matter, it seemed,
21 over a range of uncertainty. But the second answer
22 that came back quite frequently, and is represented in
23 the far right column, in various words is, "Well, I
24 was conservative." You know, I took a bound, like the
25 one that deals with the rock -- acknowledge that the

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1 analyses were very conservative.

2 Whether that's a palatable approach in the
3 end, that is what was used at this point, and that's
4 the answer that was given.

5 So with that, we can't possibly spend a
6 lot of time on all these technical items. In January
7 in Pahrump, I jumped up to slide 10. I'm going to do
8 it here today again. And it's -- we're jumping to a
9 new section of the report, and this was a very
10 important section of the report, Section 3, and that's
11 the title of it up there, "Strategy for the Future
12 Treatment of Uncertainties."

13 And Section 3.1 of the report has a
14 compilation of words from the regulation. It quotes
15 from the EPA's regulation on how uncertainties should
16 be treated. It has quotes from what at that point was
17 -- probably started with the draft of 63, and then we
18 may have stayed with the draft or perhaps we got the
19 final comments from 63. I think we did get the final
20 comments from 63, but also comments from this
21 committee, the Nuclear Waste Technical Review Board,
22 the NEA/IAEA peer review group for the TSPA, and also
23 the peer review group we had for the TSPA-VA.

24 So we synthesized all of those -- you
25 know, provided the quotes and synthesized those

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1 comments in Section 3.1. And then, in Section 3.2,
2 came up with a strategy for the future. And on these
3 next two slides, slide 10 here and 11, there were
4 eight recommended things to do. And these are the
5 quotes from those eight things. The first four are
6 shown here.

7 And if you read the report, each of the
8 eight recommendations starts off with a section in
9 bold, and that's what's reproduced here. And so they
10 are develop a total system performance assessment that
11 meets the intent of reasonable expectation. That's
12 defined in the EPA rule and also the NRC's word-for-
13 work exactly the same.

14 Quantify uncertainties in inputs to
15 performance assessment. Identify processes that
16 encourage the quantification of uncertainties and gain
17 concurrence on approaches with the Nuclear Regulatory
18 Commission. And provide the technical basis for all
19 uncertainty treatment.

20 Also, the fifth recommendation was to
21 address conceptual model uncertainty. Develop a
22 consistent set of definitions and methods for bounds
23 and conservative estimates. Develop and communicate
24 information that can be used by decisionmakers. And
25 this is dealt with more explicitly in Section 4 in the

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1 next few slides. And also, develop detailed guidance
2 and provide for its implementation.

3 After the report came out, the DOE sent a
4 technical direction letter over from our contracting
5 officer over to Bechtel SAIC and told them to develop
6 this detailed guidance based upon a strategy, either
7 this strategy or one similar to it, and incorporate
8 that strategy into the planning exercises they were
9 doing to get us out to license application. And
10 that's what Peter is going to talk about in the next
11 talk.

12 At the meeting in Pahrump of the NWTRB,
13 detailed implementation was being developed -- a
14 document. I have a copy of it here somewhere. It was
15 being developed at that time, but now it actually has
16 been developed. And Peter will talk about that.

17 Now, Chapter 4 -- or Section 4 of the
18 uncertainty analyses and strategy report -- that's the
19 title of it -- "Communication of Uncertainties." This
20 exact figure is not actually in the report. There's
21 a very similar figure in the uncertainty report. I
22 think it's -- I wrote it down. It's Figure 2-13 on
23 page F-18 that's very similar to this. But this is
24 the slide I showed in January.

25 And what I wanted to get across -- for

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1 those of you that -- you saw Peter's slide this
2 morning, slide 9, that showed the black, the blue, the
3 green, and the red curves. Carol in September showed
4 a similar such figure when she was making a
5 presentation for somebody else at a Nuclear Waste
6 Technical Review Board meeting. Tim Sullivan was
7 sick, and so Carol made that presentation with a very
8 similar figure.

9 And there were comments from Dr. Knoppman,
10 a member of the NWTRB, on the fact that that figure
11 doesn't show any uncertainty. It just shows means.
12 And so we took that comment to heart.

13 And if you go back and you look at the
14 preliminary site suitability evaluation document that
15 was out last summer, that also had figures of that
16 type which didn't show any uncertainty, where now if
17 you go and look at the final site suitability
18 evaluation documents you'll see this figure and some
19 of the other figures that I'm going to show in this
20 talk.

21 At the time of the talk in Pahrump in
22 January, the site suitability evaluation documents
23 weren't final yet, so I couldn't reference them. But
24 I was pretty sure that this figure might end up in it.
25 This figure is also -- Peter showed, I believe it was

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1 slide 10, this morning, the one that he had labeled as
2 the probability weighted dose axis.

3 There was -- you could have read about the
4 controversy about that figure even in the general
5 press. It made the Las Vegas Review-Journal, and The
6 Sun, and also some of the energy-related documents.

7 The Nuclear Waste Technical Review Board,
8 even in their most recent letter to DOE, had concerns
9 essentially that generated from this figure and the
10 one that Jerry McNish had shown in the presentation
11 before, in that -- and I'm reproducing it here exactly
12 how it was shown in January to show -- it's
13 interesting that it comes up in a talk about
14 communication of uncertainties.

15 The concern is is that it's just labeled
16 as total annual dose, with no recognition that it's
17 probability weighted. And there were some concerns
18 perhaps that things were not being communicated quite
19 clearly. But as I said at the meeting in Pahrump, if
20 you go to the uncertainty analyses report, you'll see
21 an explanation down here that does describe it as
22 probability weighted.

23 Or if you go to the SSE, the site
24 suitability evaluation document, you'll see a big
25 paragraph that explains the fact that it's probability

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1 weighted. But for a PowerPoint presentation, in order
2 to have a nice, big figure, that was stripped out.
3 So, you know, there were no ill intentions, but it
4 just shows that in communicating sometimes there can
5 be unintended consequences.

6 Now, all of these charts -- these next few
7 charts deal, as Peter has already described these
8 charts -- these have to do -- when it says "total," it
9 takes the disruptive igneous event doses and adds them
10 to the nominal. In a sense, they just look -- because
11 of the magnitude of the igneous doses, they just look
12 like the igneous doses.

13 I would much rather show the nominal
14 results. But by the time I get a few slides in you'll
15 see that in order to make meaningful graphs of some of
16 these results we have to go with something like the
17 igneous results, not the nominal results, because the
18 nominal results produce too many zero doses and they
19 don't make very meaningful graphs.

20 CHAIRMAN HORNBERGER: So I take it you've
21 solved this problem, and you now know how to
22 communicate --

23 MR. BOYLE: Yes.

24 CHAIRMAN HORNBERGER: -- clearly what a
25 convolution integral is to the lay public.

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1 MR. BOYLE: We try.

2 (Laughter.)

3 I will say the January meeting ended at
4 midday. I drove right back and met with Ken DeLugo
5 for -- he was working on the site suitability
6 evaluation documents. We went through every figure in
7 there to make sure that the Y-axis was correctly
8 labeled and that we had the big paragraph explaining
9 it.

10 So we did take the Board's comment to
11 heart. We did not want to be misrepresenting anything
12 to anyone.

13 MEMBER GARRICK: Did the Board want you to
14 continue to show all the realizations, given that --

15 MR. BOYLE: I'll get to that. But wait
16 until you get to the next slide. One of the
17 recommendations in this Section 4 of the report is,
18 with respect to communicating uncertainties, there are
19 different audiences. Some people are much more
20 comfortable with a lot of detail. And decisionmakers,
21 or those that don't have a background in mathematics,
22 or in TSPA in particular, perhaps need less.

23 This is full-blown. But even in the
24 preliminary site suitability evaluation, we never
25 showed any such thing, which led to the comment about

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1 Carol's presentation in September. So we did want to
2 show -- this shows all -- this shows probably a
3 maximum amount in terms of what you would want to show
4 in the results.

5 But since some people have difficulty with
6 the horsetail diagrams, one of the recommendations of
7 Section 4 is we'll thin it out some, if you will, you
8 know, clear it up. So these are essentially the same
9 results, but it's just shaded in between the 5th and
10 95th percentile, still showing a mean.

11 To remove some of the distractions of all
12 of the horsetails, try and get it across simpler, that
13 -- if you will, that this is an air band, if you want
14 to think of it that way, and it was shaded in to show
15 the possible range of results between the 5th and 95th
16 results. And this slide also is now labeled
17 probability.

18 CHAIRMAN HORNBERGER: Why the mean and not
19 the median?

20 MR. BOYLE: Why the mean and not the
21 median? Because it's the regulatory measure. That's
22 -- just make it simpler. You know, my wife
23 understands the difference between the mean and
24 median. She had to take a course. But many people do
25 not, so --

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1 MS. HANLON: Bill, before you go on, I
2 just want to mention, since Bill is -- has talked
3 about the fact that Dr. Knoppman, as well as Dr.
4 Cohen, mentioned several times that they were unhappy
5 with the level of treatment of uncertainty, in the
6 final site suitability evaluation we did spend a great
7 deal of time, both in the executive summary as well as
8 in Chapter 4, going into a discussion of uncertainty
9 and putting more treatment in with what Bill is
10 talking about.

11 MR. BOYLE: Yes. And we may have added
12 the first -- the two figures, the full horsetail
13 diagram, which was a change from the preliminary site
14 suitability evaluation. I believe we added this one,
15 and I believe we added this one. And this is the
16 figure that gets across why I'm showing the igneous --
17 the combined total doses rather than the nominal
18 results.

19 This represents a cumulative distribution
20 function and a relative occurrence of PDF, if you
21 will, of the 5,000 realizations for the igneous doses.
22 And we get a nice, smooth cumulative distribution
23 function based on those 5,000 realizations. It goes
24 all the way from zero to one.

25 Whereas, in the nominal, within the 10,000

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1 years, which is what the site suitability evaluation
2 dealt with, some 70 or 80 percent of all the
3 realizations for the nominal case are actually zero.
4 And it makes -- you end up with a funny-looking
5 cumulative distribution function, which I didn't want
6 to have to go into all that explanation, so we chose
7 a data set that gave a nice, smooth one.

8 And this figure is in the site suitability
9 evaluation, and what it represents is at the time of
10 the peak in this plot, at 312 years, right here, we
11 looked at all 5,000 realizations and plotted them up
12 as a cumulative distribution function and as a
13 relative occurrence of probability density function,
14 if you will.

15 And it can be seen just at first glance
16 because of the log scale, but it's a first cut. And
17 so they look approximately normal, so it's a log
18 normal result that's a first cut.

19 Then, my last slide, I ended with a quote
20 from Charles Darwin. I thought it was appropriate
21 relative to TSPA and uncertainties first, and so I
22 don't -- I haven't read this book by Darwin, but I got
23 the quote out of a book of quotes. And I don't know
24 in which -- what context he made this.

25 But it's interesting that it's by Darwin

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1 and that our TSPA has been evolving, not by natural
2 selection, but we hope by survival of the fittest --
3 you know, the better models for surviving.

4 Also, TSPA -- it relates to TSPA in that
5 we are looking at the future in a TSPA, and we also
6 must make judgments based with conflicting and vague
7 probabilities. And with that, I turned it over to
8 Peter with one last explanation.

9 I think as perhaps this committee knows
10 full well, that there apparently are perhaps two types
11 of analysts, those that are very comfortable with
12 bounding, conservative approximations, and others that
13 want a fuller representation of the uncertainties
14 involved.

15 And I had -- after I put these slides
16 together I attended a National Academy of Sciences
17 meeting, Committee on Geological and Geotechnical
18 Engineering, where that discussion came up of the
19 frustrations when the two groups collide.

20 And it had nothing to do with Yucca
21 Mountain, but it put it in perspective for me that
22 we're not the only project that deals with this choice
23 of, do we just bound it and get on with it, and remove
24 some of the information, or should we deal with the
25 uncertainties more fully?

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1 And I said at the January meeting in
2 Pahrump that the two different approaches, when viewed
3 in the extreme by the proponents of the other
4 approach, can be viewed as an unyielding rock, if you
5 will, one that doesn't yield any sort of information,
6 whereas the other can be viewed as this big whirlpool
7 that sucks in all available time and money.

8 And with that image of a rock and a
9 whirlpool, between which a path has to be charted,
10 brought to mind Odysseus sailing between Scylla and
11 Charybdis. And for us I said, "Peter is our Odysseus,
12 who is going to tell us how he was to chart a course
13 and the detailed implementation of how we were to
14 treat the uncertainties."

15 And at that point, the guidelines that I
16 showed you were in the process of being prepared, have
17 now been prepared. I think they provide a proper
18 course on how to deal with uncertainties. I'd like to
19 think that this committee would feel the same way, but
20 there's always a little caution in that, you know, the
21 answers in the implementation, you know, that the
22 guidelines are not that prescriptive in terms of
23 everybody would follow them exactly the same way.

24 So time will tell, but I'm heartened by
25 the approach that Peter and his staff have developed.

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1 And I think he will tell you about it now.

2 MEMBER GARRICK: Just to telegraph
3 something that may be for the benefit of Peter is that
4 the problem is not whether the situation lends itself
5 to a bounding analysis or a probabilistic analysis.

6 The problem is that when you do a bounding
7 type analysis and you try to embed it in a
8 probabilistic analysis with language that's very
9 confusing, an example of which is to say, "Well, I
10 don't know what the solubility is, and I don't want to
11 put a distribution on it. So I'm going to assume that
12 this is what it is, and it's an upper bound." And
13 then you later say that there's no uncertainty
14 associated with the solubility because you assumed a
15 point value and as an upper bound.

16 Now, that's where you throw the system
17 into total turmoil, and that particular flaw is very
18 evident in the TSPA-SR. It's one thing to use
19 bounding analysis in a screening capacity, and what
20 have you, but it's another thing to use bounding
21 analysis on something about -- something that's very
22 uncertain, and then, in the wrap up say that there is
23 no uncertainty associated with it because you bounded
24 it.

25 And that's the same as ignoring the

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1 uncertainty, and that's something that we have real
2 concern with.

3 MR. BOYLE: Right. And I think on that
4 same issue the Nuclear Waste Technical Review Board,
5 they used different words, but it's the same issue of
6 how --

7 MEMBER GARRICK: More elegantly, I'm sure.

8 (Laughter.)

9 MR. BOYLE: We ended up, particularly in
10 the TSPA-SR, they commented on it in a letter of
11 March 20th, 2000. We have this mix of where we've
12 incorporated uncertainties for some parts, did not for
13 other parts, and we've got this mix. The guidelines
14 that Peter is going to talk about I think will try --
15 will end up in a better situation.

16 Hopefully, at the end of the
17 implementation of those guidelines we won't have this
18 unknown mix of uncertainties. We may still have some,
19 you know, approximations and bounds in it, but
20 hopefully we'll have a better handle on it. And
21 that's what those eight bullets were supposed to get
22 at, and then Peter was to implement it.

23 MEMBER GARRICK: Okay.

24 MR. HINZE: John, can I ask a -- Bill, can
25 I get to your fifth column, a detail on your fifth

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1 column, which is kind of an ominous title. On page 9,
2 you have, "New analyses may lead to reduction of the
3 probability of explosive, eruptive phenomena." What
4 analyses are these? Could you explain that a bit to
5 us?

6 MR. BOYLE: You know, I would have to --
7 I didn't --

8 MR. SWIFT: The question is -- it goes to
9 the type of volcanic eruption. Some volcanic
10 eruptions involve violent eruption and ash pushed
11 quite a long way into the atmosphere. And those are
12 the ones we're worried about. They're called violent
13 strombolean eruptions.

14 They're relatively rare in the geologic
15 record from Yucca Mountain, but not -- they're there.
16 But they're not the most common type, which are normal
17 strombolean eruptions, which produce a cinder cone
18 directly around the point of eruption and do not
19 produce ash blankets over a large area.

20 The question is: what fraction of our
21 eruptions are actually violent? And when does the
22 violent phase occur? Is it early in the eruption or
23 late in the eruption? If it's early in the eruption,
24 then that's the time we worry about. If it's late in
25 the eruption, the waste may already have been ejected

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1 into a cinder cone close to the conduit rather than
2 being pushed out 20 kilometers.

3 For the SR and for all of the work you've
4 seen, we took the copout path of bounding it with the
5 assumption that our eruptions were, indeed, violent --
6 the strombolean ones. And so if we can justify a
7 basis for saying that some -- only, say, 10 percent,
8 20 percent, whatever -- we can justify a value, we'll
9 try to use that and produce our eruptive probability
10 that way, our probability of violent eruption.

11 MR. HINZE: Thanks.

12 MEMBER GARRICK: Any other questions for
13 Dr. Boyle before he sits down? Okay. Thank you.

14 MR. SWIFT: I wasn't completely prepared
15 for it in Pahrump when Bill introduced me as Odysseus.
16 I wasn't prepared for that. But it did occur to me
17 that at least one point was relevant, that Odysseus
18 had been on the road far too long and -- 22 years, was
19 it? And whether that was me or the project, I wasn't
20 quite sure. Also, it didn't have a happy ending
21 either.

22 (Laughter.)

23 So Odysseus is not the analog here. It's
24 Scylla and Charybdis that we're worried about.

25 You've got to start thinking about the

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1 treatment of uncertainty with this question of
2 conservatism versus realism. And these are just some
3 simple observations here that -- many reviewers of our
4 TSPA have criticized a lack of realism. There's a
5 list of them, and this group is right there.

6 Obviously, there's a common theme. People
7 are looking for something we're not providing.

8 The second bullet here is my own
9 observation that I believe in general these reviewers,
10 when they review the TSPA and find a lack of realism,
11 they are in many cases not distinguishing between the
12 TSPA and the underlying process models. For them, the
13 TSPA is a window into the process models.

14 So if our process modelers make the
15 assumption that they will bound a solubility limit
16 within a range of uncertainty, we carry that forward
17 into the TSPA. And, yes, it's a lack of realism.
18 It's actually, I believe, a lack of realism in the
19 underlying process models.

20 This is appropriate. I think a good TSPA
21 should be a window into the underlying science. It
22 should be the first place you go to look to see how
23 well we understood something. But there are
24 differences, and it's worth keeping those in mind.
25 There are some places where we may have a more

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1 realistic treatment at the underlying level, and for
2 good reasons have chosen to simplify it in the TSPA.

3 All of the reviewers' comments and
4 expectations with respect to realism -- there's a good
5 -- excellent summary of them in the Coppersmith and
6 McNish report that Bill just mentioned, Section 3.1.
7 But to me, I'm focused on what's in the rule, what has
8 the NRC asked for in the rule.

9 And this is the two clauses out of the
10 definition of "reasonable expectation" that basically
11 for me sum up the issue pretty well. And I think,
12 fortunately for the reviewers listed on the previous
13 slide, these two bullets actually do put the key
14 thoughts directly into the rule.

15 Characteristics of reasonable expectation
16 include -- do not exclude important parameters simply
17 because they are difficult to precisely quantify. And
18 this one focused on the full range of defensible and
19 reasonable parameter distributions, rather than only
20 upon extreme physical situations and parameter values.
21 These are the words out of the rule.

22 I actually take some heart in the site
23 softness of language here. It's not fully
24 prescriptive. It doesn't say focus exclusively on the
25 full range or only use a full range. Rather, it

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1 suggests to me that we're looking for some common
2 sense here, but, clearly, the goal was -- the goal is
3 a full treatment of uncertainty.

4 So what's in our -- the guidance that we
5 came up with for the project? What we're looking for
6 is some version of a realistic analysis rather than a
7 bounding one. But what's admitted right up front,
8 some conservatisms will remain. Our job is to be
9 clear about where they are, what the basis is for
10 them, and what their impact is. There are cases where
11 the applicant, I believe, is going to end up being
12 conservative and explaining why and what -- how it
13 matters.

14 Focus on a realistic treatment of
15 uncertainty. That's not the same as a full
16 understanding of realistic performance. This is a
17 sticking point within the project. Realistic
18 treatment of uncertainty sometimes gets equated with
19 a full deterministic understanding of reality. And
20 the first here is achievable -- realistic treatment of
21 uncertainty. The full understanding of realistic
22 performance is not achievable. That would be the --
23 that would require 10,000 years yet.

24 So the bullets that go along with that for
25 me -- simplified models are okay in the TSPA. Broad

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1 uncertainties are okay, if they're justified and
2 explained. This is important. Scientists generally
3 think of their job to be to reduce uncertainty. We
4 need a shift in mind-set here. Our job for TSPA is
5 not to reduce uncertainty; it's to make sure we've
6 adequately included it.

7 So broaden the range of uncertainty rather
8 than -- based on present knowledge, if you weren't
9 confident with the uncertainty bounds you've put in,
10 make them broader. If you weren't confident in them,
11 that meant they weren't broad enough. And then see if
12 they matter.

13 MEMBER GARRICK: I'm pleased to see that
14 there. That's a very important issue.

15 MR. SWIFT: These are just words so far.
16 We still have to implement these. But that thought --
17 the shifting of a scientist's mind away from 20 years
18 of experimental work driven to reduce uncertainty to
19 the simple statement "give me a broad uncertainty
20 amount," that's a difficult shift.

21 Scientists and PA analysts need to work
22 together to incorporate uncertainty in the TSPA. I'll
23 have more to say on that. But it -- it can't be done
24 by either the process scientist or the PA analyst
25 independently -- and focus on a clear explanation of

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1 what we did, mathematical/conceptual descriptions. If
2 we're talking about parameter uncertainty, you'll
3 actually be able to see the equations in which the
4 parameter was implemented and the traceability.
5 That's something to strive for.

6 This thing called the guidelines document.
7 This is -- Bill described it as having been required
8 contractually by the DOE in a direction letter in
9 December. It was delivered on March 1st. It's a
10 rather dull document. I apologize. Guidelines for
11 developing a document and alternative conceptual
12 models, model abstractions, and parameter uncertainty
13 in TSPA.

14 It's, I say, dull because we don't want to
15 call it a procedure. We are not -- it's not a quality
16 assurance procedure in that sense, but it reads like
17 a procedure. I wish I knew how to fix that.

18 It describes the -- it meets the
19 requirements of the technical direction letter by
20 implementing the strategy outlined in the report Bill
21 described. It also addresses some NRC KTI agreements,
22 and the last page of this handout is the text of those
23 agreements.

24 The important thing here is that it uses
25 a team approach for both models, the alternative

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1 conceptual models and the abstractions. And for the
2 parameters we set up a three-cornered team -- a
3 triangular team, with a lead for models, the
4 abstraction models. I use the same person as the
5 lead, he or she, same person does the lead for the
6 alternative conceptual model work. And a parameter
7 lead, and then a subject matter expert and a TSPA
8 analyst.

9 So think of it for parameters, where there
10 is one parameter team lead, but for each uncertain
11 parameter in the TSPA there will be a subject matter
12 expert and a TSPA analyst who -- the three of them
13 jointly have to agree on the distribution for that
14 parameter and actually sign off on it. Likewise, the
15 models.

16 The model abstractions -- the goal of
17 abstraction is to capture the important processes, the
18 processes that are important to system interactions,
19 and to make sure that the abstraction allows an
20 appropriate representation of uncertainty.

21 This is important. The abstraction is
22 going to use simplified parameters, often lumped
23 parameters, to capture quite a lot of things. They
24 have to be built with an eye towards, can we actually
25 assign uncertainty -- representational uncertainty to

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1 those parameters in a meaningful way?

2 The sections get developed by the subject
3 matter experts. These are for the scientists --
4 reviewed by the process model analysts. They're
5 developed in the scientists' reports. These are the
6 AMRs, the analysis and model reports.

7 There is no prescription on how to
8 actually do an abstraction, recognizing that they can
9 be everything from -- well, not listed -- you could
10 just put the full numerical model into the PA. You
11 could simplify it, simple functions, response
12 services, parameters.

13 The implementation in the TSPA gets back-
14 reviewed by a subject matter expert, and that
15 implementation gets documented in the TSPA's report.

16 For alternative conceptual models, there's
17 a little simple step-through process here that we're
18 asking our model developers to walk through. For each
19 process of interest in product alternatives, if any,
20 with consistent available information, there's no
21 requirement here to go out and make up alternatives.
22 In fact, there aren't any that are consistent
23 available information.

24 If only one conceptual model is consistent
25 with all the information, that's good. That means

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1 you've -- you don't have a valid viable alternative to
2 conceptual models. Instead, you have things that can
3 be screened out. And you document that at that point.
4 That basically is part of our FEP screening process.
5 Things like, for example, seismic rises in the water
6 table that might flood the repository is not an
7 alternative conceptual model because it is not
8 consistent with available information. We believe
9 that can be ruled out.

10 If you have multiple viable alternative
11 conceptual models, evaluate their impacts on subsystem
12 and component performance. That's the process model
13 or the specialist in that area. If there are
14 alternatives, if the alternatives result in the same
15 subsystem performance, i.e. the same information that
16 you delivered to the system model, then, again,
17 alternative conceptual model uncertainty is not a
18 significant source of uncertainty in the total
19 analysis. Doesn't matter which alternative we use,
20 we're getting the same result out of it.

21 If two or more show different subsystem
22 performance, develop abstractions for both and deliver
23 them to TSPA. That takes you back into the
24 abstraction process. Basically, have them reviewed by
25 TSPA and implemented.

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1 Here's a point. If the abstractions for
2 the alternatives are not straightforward, this is a
3 place where I think you're going to see some
4 conservative choices come in. I don't really have an
5 example in my head, but some -- let's suppose somebody
6 proposes an alternative conceptual model which would
7 show improved performance but is going to be a heck of
8 a chore to abstract it into the TSPA. Perhaps the
9 example I gave earlier of metrics diffusion in the
10 unsaturated zone might be one.

11 This is a place where I think the project
12 will probably take the cost effective approach and
13 explain why they're being conservative.

14 TSPA evaluates --

15 CHAIRMAN HORNBERGER: Peter?

16 MR. SWIFT: Yes.

17 CHAIRMAN HORNBERGER: On that point, it
18 strikes me that what you're -- if what you're saying
19 is that you have alternative conceptual models that
20 are consistent with information, then you don't have
21 a clear way to choose one over the other.

22 MR. SWIFT: Right. Yes.

23 CHAIRMAN HORNBERGER: And it strikes me
24 that all you're saying is that, fine, if they give
25 different performance we will use the one that shows

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1 the worst performance.

2 MR. SWIFT: Yes. Well --

3 CHAIRMAN HORNBERGER: Is that right?

4 MR. SWIFT: That will do. The question
5 is, at what level do they show the worst performance?
6 If they're showing different performance at the
7 subsystem level, that isn't -- doesn't for sure mean
8 they're going to show different performance at the
9 system level. But, yes, other than that I -- same as
10 what you just said. But the idea is to actually
11 direct people who document this process of thinking.

12 MEMBER GARRICK: It seems there's kind of
13 a corollary rule here that would apply, too, and that
14 is that if you have multiple conceptual models -- and
15 let's say that those models provide the same results
16 -- then you ought to use the simplest model as the
17 basis. This is the Copenhagen rule for the great
18 physicist.

19 CHAIRMAN HORNBERGER: It actually precedes
20 Copenhagen, because it's William of Ockham in I
21 believe it was 1674.

22 (Laughter.)

23 MEMBER GARRICK: Well, Niels Bohr picked
24 it up and --

25 (Laughter.)

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1 -- made the point very elegantly that if
2 you have multiple theories, and they give you the same
3 results, we're going to, by damn, take the simplest
4 one.

5 MR. SWIFT: The problem is when they don't
6 give you the same results.

7 MEMBER GARRICK: Yes, I understand. But
8 there is that issue that there is a tendency sometimes
9 for modelers to want to impress you with the
10 complexity rather than impress you with the
11 simplicity.

12 MR. SWIFT: If the two models give the
13 same subsystem result, my conclusion, alternative
14 conceptual model uncertainty is not significant. The
15 under bullet not stated there is that the subject
16 matter expert then has to document that as to, yes, I
17 have these multiple alternatives. They all give me
18 the same result. Therefore, I'm only going to deliver
19 the simplest one, or the one of their choosing,
20 forward in the TSPA.

21 MEMBER GARRICK: Yes.

22 MR. SWIFT: And that actually is in the
23 guidance document. That step is there.

24 VICE CHAIRMAN WYMER: Now, this is turning
25 out to be a lot of extra work, but -- and looking at

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1 various parameters. But what you haven't said is how
2 the parameters should be looked at.

3 MR. SWIFT: Let me get to that on the next
4 slide when I talk about parameters. Let's imagine
5 here that the alternative conceptual models are
6 implemented in TSPA and you actually run a full TSPA
7 or a subset of TSPA with the different alternatives in
8 it.

9 And if the options -- the impacts are
10 significant, then the options are -- there are
11 basically two options. One is you can carry the
12 multiple alternatives all the way through to the
13 regulatory dose, but then you have to weight the
14 alternatives, and then you have to be able to defend
15 those weightings in some way.

16 So that may not be the -- the first simple
17 thing, you always give them equal weight, but if they
18 -- and see if it makes a difference. If they don't
19 make a difference, then you learn something. If you
20 can't defend weights, then at that point, again, you
21 default to the more conservative one if you've gone
22 through this.

23 Parameters --

24 VICE CHAIRMAN WYMER: I'd say selecting a
25 parameter value is not the same as selecting --

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1 MR. SWIFT: Yes, I'm aware of that. The
2 assumption here that you just caught me on is we
3 already know which parameters matter. And the
4 identification of we're actually -- this is the step
5 in the process that we're in right now. It's
6 identifying the parameters we want to treat as
7 uncertainty parameters in the TSPA.

8 And we're doing that by -- the TSPA team
9 is providing a list of the parameters that were
10 treated as uncertain parameters in previous analyses
11 back to the subject matter experts in each of their
12 areas for review and updating.

13 There are parameters that have been
14 treated as uncertain parameters in past analyses that
15 actually aren't doing very much in the analysis. The
16 analysis would be insensitive to the uncertainty in
17 them. If that uncertainty was appropriate, you know,
18 justifiable, defensible, and still was doing nothing,
19 then that parameter might be a candidate for one to be
20 switched to a fixed value.

21 If, on the other hand, the subject matter
22 expert looks at that list of uncertain parameters and
23 says, "Whoa. Here's the one that really captures the
24 process. Better put a distribution on that and get it
25 in there," that will happen. But the real answer to

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1 your question is that this is -- it's human judgment,
2 and this is why an iterative analysis better, because
3 people learn things through time as to which sources
4 of uncertainty matter at the system level.

5 We've learned a lot in 10 years of TSPA
6 and interacting with the process model teams. I
7 actually do think that we have the right uncertain
8 parameters, probably more of them than we need, and
9 there isn't a unique test to make sure you've gotten
10 them all. That's, from a judgment, an iteration and
11 review.

12 But once you've got the list of uncertain
13 parameters identified, categorized, they get mapped
14 back to the subject matter experts for documentation
15 in their AMRs. And the full range of defensible and
16 reasonable distributions gets documented by the
17 subject matter experts in their AMRs in that
18 triangular model with the team lead and an analyst.

19 There are two things yet to consider in
20 building uncertainty distribution. First is the
21 available data. But, second, and this is the part
22 that typically gets missed, you have to think of how
23 the parameter is used in the model. Model scaling
24 issues, what's the cell size in the model. These are
25 numerical models, and it makes little sense to use

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1 porosity data collected at a sidewall core this big,
2 use that exactly as is in a model where you might have
3 cell blocks hundreds of meters on the side. The
4 distribution is something different.

5 So think of spatial variability, which is
6 the example I was offering there, because it affects
7 the scaling of the parameter, how it's used in the
8 model. This is the point where you want the modeler,
9 the person who actually knows what the parameter is
10 doing in the equation in the model, working with the
11 subject matter expert most familiar with the data,
12 working with the team lead who is -- will have -- the
13 statistician who is supporting them in how to apply
14 the -- how to build a defensible distribution from the
15 available data.

16 And it's typically not a matter of fitting
17 it with a normal or log normal or some specified
18 model, because nature doesn't work in statistics like
19 that. What you want is -- what we want is a
20 distribution function that doesn't add any new
21 information, honors information we have, doesn't
22 create new knowledge.

23 So the simplest example of such would be
24 a peacefulized linear distribution. If you actually
25 thought data itself was appropriate to be used in the

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1 model as was -- as is -- a peacefulized linear fit for
2 the data is better than trying to force fit a normal
3 or log normal distribution.

4 But the distribution is -- ultimately,
5 it's a subjective decision, and you want it made by
6 the right experts -- the scientist, the PA modeler,
7 and a statistician with experience in doing that. And
8 then you want it documented, and so we'll do that, and
9 then implement things through a controlled database.

10 MR. BOYLE: And also, I think in the way
11 this system is set up, it's the consideration of
12 alternative models frequently gets at which parameters
13 are under consideration. For example, if your model
14 is that the rock is elastic, well, Young's module and
15 Poisson's ratio is sufficient. If, on the other hand,
16 you assume that it is viscal plastic, well, then, that
17 generates a whole new set of parameters for which you
18 then need values.

19 MR. SWIFT: The last slide here, this one
20 actually got edited a little bit in the final review,
21 and you'll get a kick out of what came out of it here.
22 This bullet used to say that regulators and reviewers
23 are not asking for the impossible, and someone felt
24 that was a little too negative.

25 (Laughter.)

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1 But I actually believe it. And I'm
2 getting back to the idea there that if we, the DOE,
3 were to misinterpret what you're asking for as -- I
4 hope I'm going to get a head nod here. If we were to
5 misinterpret that as asking for a full, realistic,
6 deterministic solution to the future, that is
7 impossible. We're not going to do it.

8 But we can commit to a realistic treatment
9 of uncertainty. Can we actually achieve it? It will
10 be some version of it, but there will --
11 pragmatically, there will be conservatisms here and
12 there. And it's our job to explain what we did.

13 And this is the last point -- there's no
14 unique solutions. A lot of credibility comes from how
15 well we can explain it.

16 And that's it for that presentation.

17 MEMBER GARRICK: Before we go to the next,
18 any comments from members of the committee? Milt?

19 MEMBER LEVENSON: Well, I'd like to make
20 one comment. It's sort of a follow-on to the comment
21 John made earlier, and that is that it's not of major
22 importance that we reduce uncertainty. The importance
23 of uncertainty is only to make sure that the true
24 extent of some risk is not obscure, and that, as in
25 medical work, false positives are equally to be

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1 treated as false negatives. And the whole objective
2 is to make sure that you know enough so that you can
3 evaluate the risk. Now, reducing uncertainty per se
4 is certainly not an objective of mine.

5 MR. SWIFT: Others see things differently.
6 I agree with you completely, but the -- on the
7 alternative conceptual model side, for example, a
8 question I got from the ATRB was, well, where is the
9 step where you go out and design an experimental
10 program to go back and test those models and throw one
11 or the other of them out?

12 And that isn't where I actually was
13 thinking. I was thinking we're going to make a
14 decision based on information that we have now. We're
15 going to decide if the uncertainty matters. And it's
16 a different way of thinking of things.

17 MEMBER GARRICK: Ray?

18 VICE CHAIRMAN WYMER: Well, actually,
19 you're not going to make a decision based on
20 information -- based on what you have between now and
21 the time of your license application. No, I've raised
22 my questions already.

23 MEMBER GARRICK: George?

24 CHAIRMAN HORNBERGER: Again, just a
25 comment following on what you've just said, Peter. I

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1 think in part, as I read some of the TRB comments, it
2 would be that the question is whether or not there is
3 an adequate scientific base to support the models that
4 you have.

5 MEMBER GARRICK: Yes. And I like the --
6 your remarks about -- that the distributions or the
7 uncertainties need to be driven by the information or
8 the data. Too often we've seen people spending a
9 great deal of time and effort and exercise on trying
10 to choose a distribution that will work for them in
11 their model.

12 And there's enough analytical tools
13 available now that there's no reason for doing that.
14 We ought to be able to forget about whether it's log
15 normal or beta or gamma or whatever, and let the
16 information, however it comes out as a distribution,
17 be the basis of the model.

18 And even if it's a histogram, because
19 there are tools now that very effectively convolute
20 discrete probability distributions. And that is even
21 a more -- often a more accurate representation of
22 what's taking place, and very often much easier to
23 follow.

24 So these are encouraging signals that
25 you're giving in the context of guidance. I think

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1 it's very important. And I think it also addresses
2 this whole issue of the confusion that sometimes
3 exists between good science and adequate science with
4 respect to solving a problem, and we've talked about
5 that a lot in this committee.

6 We want good science, but we don't think
7 it's necessary to reduce an uncertainty between, say,
8 10^{-12} and 10^{-7} , even though it's five orders of
9 magnitude, if the risk is of the order of 10^{-3} . So
10 that's adequate, even with that wide amount of
11 uncertainty. So these are steps that are very
12 encouraging to us.

13 Any questions from the staff? Yes.

14 MR. HAMDAN: Uncertainty means different
15 things to different people. Milt and I and perhaps
16 everybody in this room understands uncertainty as has
17 been described, and Milt described it very well. And
18 on slide 11 from your first presentation --

19 MR. SWIFT: In my first presentation?

20 MR. HAMDAN: Yes. Which igneous activity
21 -- you showed us the slide about the effect of igneous
22 activity -- if you want to -- this was what obscured
23 uncertainty. This is very clear. It goes to the
24 point and evaluates the effects of igneous activity of
25 a property of one. So this has nothing to do with

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1 uncertainty.

2 But to the public and people who are on
3 the street, this is the uncertainty. You are saying
4 in this slide to them that if -- it were -- this is
5 the point that you are going to give to them, not to
6 us in this room. We evaluate the risk and then we
7 make a recommendation based on risk.

8 But to the people on the street, this is
9 uncertainty. And I think this needs to be looked at
10 and responded to and articulated to the public. So
11 this is the comment that I make.

12 I have another question for Peter, and
13 that is on your slide on the parameter uncertainty.
14 You probably will need to pull that out. The approach
15 is fine, and you have articulated it very well. The
16 real questions come with the -- when you want to
17 assign probability distribution to a certain
18 parameter, that's where the rubber meets the road.

19 There sometimes you don't have enough data
20 to select a distribution, and that's where the problem
21 lies. There are a lot of parameters with a
22 distribution that have validity bases, and I wonder if
23 you could extend your answers from that -- for
24 conceptual models to do alternative distributions for
25 these parameters, and satisfy yourself that, really,

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1 it does not make a difference.

2 And that will probably be needed because
3 there is simply a lot of parameters with uncertainty
4 for which we do not know what the right distribution
5 is.

6 MR. SWIFT: My own experience in analyses
7 like this is that for parameters to which the results
8 are sensitive, the form of the distribution is less
9 important than the range. What you're worried about
10 are the impacts of the tails.

11 And so the difference between a log
12 uniform distribution and a log normal distribution
13 will not be that great. The difference between a log
14 uniform and uniform distribution may be very
15 important, but I think picking distributions that span
16 a broad enough range of uncertainty that the range
17 itself is defensible -- just what the scientists
18 believe is a broad enough range -- will take quite a
19 lot of the concern off the shape of the distribution,
20 the actual form or function used to fit it.

21 MEMBER GARRICK: I see this next
22 presentation is -- yes?

23 MR. HINZE: Well, I guess wanted to
24 suggest that the most important, the most critical
25 phase of this whole thing is making the decision on

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1 when you have done sufficient sites that you have a
2 model that you can do some calculations with. It's
3 very hard to put uncertainties on that.

4 It reminds me a bit of the ore deposit at
5 Roxby Downs in south central Australia, which is the
6 most important mineral discovery since the Second
7 World War. It was found as a result of a very
8 incorrect model. The answer was just beautiful. It's
9 correct, but it was a totally incorrect model.

10 Now, if you use that incorrect model,
11 which some people have tried to use, in other parts of
12 the world to find a similar ore deposit, you're just
13 not going to get there. It seems to me that you can
14 put parameters -- the uncertainty around these
15 parameters, but it's the question of when you've done
16 sufficient science that you understand the process
17 well enough so that you can make a judgment, and that
18 judgment will have uncertainties.

19 MEMBER GARRICK: That's correct. Okay.
20 I see this next presentation is a big one.

21 MR. SWIFT: It's not as big as it looks.
22 I'll give you the fast version.

23 MEMBER GARRICK: We would like to hold, as
24 best we can, to our 12:30 recess.

25 MR. SWIFT: Me, too.

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1 So I will certainly not go through all of
2 these. I will give --

3 MEMBER GARRICK: I have an advantage. I
4 can ask all the questions and extend the time, and
5 then blame you --

6 (Laughter.)

7 -- blame you for overrunning.

8 MR. SWIFT: Can we have the lights here?
9 So we can see the screen better. Good. Thank you.

10 Since December, the project has gone
11 through a replanning exercise. You'll recall that in
12 -- starting in the summer of 2001, the project went
13 through a planning exercise for a multi-year plan
14 prepared by the M&O contractor, BSC, and then to be
15 approved by the DOE, for the work to be done to
16 support a license application.

17 And the plan, which was submitted in
18 September, produced a large body of work that was --
19 scientific work that went out to about -- an
20 application in about 2006. The dates were somewhat
21 flexible. But the DOE came back to BSC and said,
22 "Perhaps you want to replan."

23 There was not a prescribed date. However,
24 we felt it was prudent to replan with the idea of 2004
25 in mind to see if we could, in fact, identify a scope

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1 of work that would allow us to produce a docketable
2 license application in 2004. Of course, docketable is
3 the NRC's decision, not ours, but we wouldn't submit
4 an application unless we felt there was a reasonably
5 good likelihood that it would be docketed.

6 So with that in mind, we set out to
7 prioritize work in the performance assessment and
8 science activities, which we realigned the project at
9 the same time, so that the science became part of the
10 performance assessment project, and focused primarily
11 on the work that was necessary for license
12 application, identify and select an overall scope of
13 work to balance the project management risks. This is
14 not human dose risk. This is the management risk.
15 What's our risk of success or failure? And document
16 it.

17 And this, then, would be the basis for the
18 replan that was delivered to DOE March 1st. Back in
19 December, we were planning ahead. In fact, we did --
20 BSC did deliver a new multi-year plan to DOE on
21 March 1st, and that is in DOE review.

22 And that has not been released yet. Is
23 that correct? The plan B of -- anyway, it's a big fat
24 thing, work plans for the outyears, starting
25 immediately but out to 2004.

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1 And inform these decisions with input from
2 the TSPA analyses, technical staff working with the
3 science program staff, line management, project
4 management -- this will be the senior management team
5 -- and then project planning. These are the people
6 who ultimately -- they're the ones that have to
7 prepare a multi-year plan.

8 In theory, it's -- no, more than theory,
9 it is a resource-loaded schedule where you can
10 actually point to a schedule and see what things cost,
11 how long they take, and what they do. And that's the
12 -- so the process we wanted to go through here, just
13 for -- this is -- remember, we're only prioritizing
14 work within performance assessment and science.

15 This does not include design activities.
16 This does not include licensing activities, quality
17 assurance activities, the various support activities.
18 It's only a portion of BSC's budget that was developed
19 in such studies.

20 The PA team identified attributes --
21 basically, a short story here -- we're headed for a
22 multi-attribute utility analysis. And we've done it.
23 That's where this clarification is headed.

24 The PA team defined the attributes at
25 which the work scope was evaluated. The department

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1 managers of the science departments defined work
2 scopes to be considered for each model, component.
3 Think of the unsaturated zone or the saturated zone,
4 and so on. For each model component, they defined
5 alternative work scopes they wanted to have
6 considered. For each of those they should have
7 estimates of cost and time.

8 And the department managers and the TSPA
9 modelers provided initial estimates of the impact of
10 the proposed work on the attributes. Basically, an
11 attributes questionnaire. We scored each work scope
12 description.

13 There were 25 model components, and each
14 one had about -- almost each one had three work
15 scopes, so about 75 different work scope descriptions
16 were scored against these attributes. And that was
17 actually done in a workshop in January where we had
18 the key players all together in a room for three days
19 and went through scoring the -- first of all, we wrote
20 final work scope descriptions, we scored them against
21 the attributes, and I'll go through how we -- what
22 that means here in a minute.

23 And then we ran them through the utility
24 analysis tool that I'll describe in a minute, produced
25 an initial prioritization, in mid-January had a

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1 management review of it, and provided input to our
2 budget team at the end of January. And that, in turn,
3 has gone on to DOE now.

4 This is a conceptual figure that -- it's
5 important because this came out of a BSC management
6 meeting in November -- the idea that, since most of us
7 think best in only three dimensions, let's find --
8 think of it in three dimensions. What are the things
9 that matter to us in making decisions about what
10 science activities we do on the project?

11 And we came up with three axes -- a
12 quantitative performance axis. What is our calculated
13 total annual dose? And what work are we doing that
14 moves it up or down? This is, you know, basically,
15 are we in compliance with 63/113?

16 Regulatory defensibility and acceptability
17 -- in a regulatory framework, can we defend the models
18 and data used to calculate that dose? Have we met the
19 qualitative requirements of Part 63? This axis is
20 Part 63 and 197, as implemented through 63.

21 So things like multiple barrier
22 requirements to qualitative, descriptive requirement,
23 but that would live on this so-called X-axis.

24 Satisfying KTI agreements -- the NRC has
25 given us a list of what needs to be done to defend the

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1 models. We, in some form or another, need to address
2 those agreements and produce defensible models. Then
3 -- and we need, say, for example, quality assurance
4 requirements, our so-called X-axis attribute.

5 Then there are the Z -- what we call the
6 Z-axis out this way. This was a -- Y was up in this
7 coordinate system when it first appeared on our white
8 board. So the Z-axis here, qualitative acceptability,
9 internal and external defensibility, these are issues
10 that we know we care about them, yet you can't trace
11 them to anything that's in the rule.

12 So some of these are -- some of them are
13 actually quantitative as well as qualitative. But
14 qualitative things -- defensibility of models, beyond
15 what's needed for a regulatory framework, the question
16 of, can we convince people we actually understand the
17 system well?

18 Many of the Technical Review Board's
19 concerns are on this axis, not all of them. I'll
20 argue that some of the NRC staff and center's concerns
21 may be on this axis. They're valid. This is not to
22 say the Z-axis is not important, but there are
23 technical issues that don't tie directly to the rule.

24 For a quantitative one, an easy one to
25 think of is peak dose. There's no regulatory limit

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1 applied to peak dose occurring several hundreds of
2 thousands of years out. At the peak dose is a
3 quantitative Z-axis attribute.

4 So it's not three-dimensional space, and
5 those axes aren't orthogonal. And they're certainly
6 not mutually exclusive. We decided to define it as a
7 16-dimensional space for the purpose of the utility
8 analysis, and nobody can think in that, but the
9 spreadsheet does.

10 There are 16 attributes here that can be
11 coarsely lumped against those three axes, but, in
12 fact, for the utility analysis we scored things on
13 each one of these attributes without considering those
14 at X-, Y-, Z-axis. That's just there as a
15 communication tool for our own management team.

16 For each work scope, we went to the
17 technical staff and said, "Will your work, if you do
18 your Level 1, 2, or 3 scope" -- and I'll explain what
19 those are in a second here -- "will that change
20 10,000-year mean annual dose?" Which, by the way,
21 that is driven entirely by the volcano. That's the
22 10,000-year total. That's the Part 113 dose.

23 Will it change groundwater concentrations
24 or human intrusion? And that's it for quantitative
25 performance.

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1 Regulatory defensibility -- have we
2 captured all credible FEPs? Have we excluded the ones
3 that can be excluded according to the criteria? Are
4 we meeting our requirements to describe -- identify
5 and describe multiple barriers? And do they link to
6 specific KTI agreements?

7 The so-called Z-axis sorts of attributes
8 impact on conference of internal reviewers, impact on
9 conference of external reviewers, and some
10 quantitative ones have come out of the TSPA
11 calculations. Change in time to 15 millirem. Change
12 in uncertainty. This would be the distribution spread
13 from the 9th and 5th, for example. There's no
14 regulatory driver for that. It's the mean we're
15 regulating on, but we do care about that spread in the
16 uncertainty and system outputs.

17 We looked at a forced early failure case,
18 peak dose, and this -- I should say associated with
19 conditional igneous intrusion. We had a question
20 there about, will your work affect our conditional
21 igneous dose? Will your work affect a representation
22 of uncertainty at the parameter level? And our
23 ability to defend the conceptual models.

24 The actual questions themselves are shown
25 in the handout. I have time to show those a little

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1 bit. This goes pretty quick here.

2 For each model component -- there are 25
3 of them I'll show up here in a minute -- department
4 managers define three levels of work. The expectation
5 was that this would be an increase in cost and/or
6 time. Level 1 would be the quickest and cheapest.
7 Level 3 would be the longest and most expensive.

8 Level 1 -- what work would be required to
9 complete quality assurance issues and to validate the
10 existing models? That's not focusing on not
11 developing new models, but meeting our own internal
12 validation requirements for the models that we used in
13 the analyses I showed an hour ago -- the most recent
14 set of PA models, which are not -- in our own
15 terminology, they are not qualified and validated yet.

16 Level 2 scope -- take a so-called risk-
17 informed approach to going beyond Level 1. Risk-
18 informed in this sense means to us look at the impact
19 of the work before you decide if you're going to do
20 it, and, in particular, this might involve taking PA-
21 based -- system-level, performance-based approaches to
22 resolving KTI agreements rather than the literal full
23 scope of work that was anticipated when we agreed to
24 the agreement.

25 In other words, if we can show it doesn't

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1 matter, is that a sufficient way to address a
2 question?

3 Level 3 -- and these are both optional.
4 We went to the work package managers and said, "If you
5 can close everything at Level 1, don't bother to
6 define any higher levels for us." Level 3 was
7 essentially the same as that plan A work scope that
8 got us to 2006. And with respect to KTI agreements,
9 it was the full and literal completion of all
10 activities proposed.

11 Managers were -- these are the science
12 managers, department managers, provided input on how
13 well each proposed work scope meets the defined set of
14 attribute scores with respect to the defining set of
15 attributes -- better way of saying that.

16 And the -- I'm going to skip a couple of
17 slides here and just go to slide 10, because the --
18 the same word that's on the intervening slide, where
19 you've got this helpful equation here. Ignore the
20 figures. They're not all that helpful.

21 But for each one of these 16 attributes,
22 we asked questions of the technical staff, how likely
23 is your work at this level -- scope of work -- how
24 likely is it to, for example, increase confidence in
25 your treatment of parameter uncertainty? How likely

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1 is it to result in an increase in total dose? And the
2 technical staff provided answers that ranged from very
3 unlikely to very likely.

4 We then asked a management team what types
5 of -- what value they assigned to different types of
6 answers. That's this V thing here. Actually, it's a
7 relatively small player in the utility analysis. But
8 since it's up there -- if someone said their work was
9 likely to -- or, let's say, it was likely to result in
10 a change in dose, we then asked the TSPA modelers,
11 "How big a change might that produce?" These are all
12 subjective answers, but at least we're asking the
13 right experts.

14 And the TSPA modeler might say, "Oh, it
15 could increase by a factor of greater than 10, or
16 could have a small change of less than a factor of
17 10." We wanted to apply -- but this now is a
18 management decision, what value do you apply to the
19 different answers.

20 In this hypothetical example here, we gave
21 that a weight of one and a weight of zero for a
22 neutral effect, a small change in dose, and a weight
23 of .15 for an increase in dose. But that's how the
24 impact value function was used.

25 Then this weighting -- this is a

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1 subjective management decision. How important did
2 management think that question was? And these were
3 elicited from the management team in the project.

4 If I go back to that three-dimensional --
5 you know, this figure -- if our technical staff were
6 all-knowing, for any scope of work they actually
7 could, in theory, define a vector in this N-
8 dimensional space that defined where their work would
9 put us. Would their work, you know, greatly increase
10 qualitative defensibility? Would it greatly increase
11 regulatory defensibility? And so on.

12 That would be the first term of that
13 three-term sum that went into the utility analysis.
14 The other two are management questions of, where does
15 the project want to be in that -- in this
16 N-dimensional space? If the project did not care
17 about qualitative acceptability, external reviewer
18 type issues, we could truncate the Z-axis and live
19 entirely in the X/Y plane. It appears to be the bare
20 minimum needed for licensing under Part 63.

21 But the project is not willing to accept
22 that risk, and, you know, the TRB certainly
23 understands that point. I met with them -- a subgroup
24 of them, just a couple of days ago, and we talked
25 about this. Obviously, we're not going to live only

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1 on the X/Y plane.

2 So where are our decisions headed? And
3 that's the point of the -- listing the management
4 weight. And for each of the 16 attributes, for each
5 of the work scopes, you can define -- we define a
6 likelihood that the answer will be what we -- what --
7 that the likelihood of a specified answer will occur.
8 That comes from the technical staff, the scientists.
9 And these values and weights comes from managers.

10 And then, for each work scope you create
11 a spreadsheet and sum them up. And the -- you get a
12 utility. It's a dimensionless number. It's
13 associated with each work scope, and it's a
14 quantitative -- and fully comparable from one work
15 scope to the next -- measure of the utility of doing
16 that piece of work, utility defined in respect to the
17 questions we asked, what are the attributes, and the
18 weights management put on those attributes.

19 Now, caveats that come out of this --
20 first of all, like any decision analysis exercise, the
21 results of the model here means the utility model,
22 utility analysis. It's a decision-aiding tool. The
23 project had no intention of using it as a direct
24 decisionmaker. Other -- that's the most important
25 caveat. It's to inform managers who still have to

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1 make subjective human judgments.

2 The cost assumptions that went into it
3 were not always consistent. Results -- we
4 deliberately did not constrain them by schedule. We
5 didn't force people to say, "You've got to make
6 everything end by 2004." There were some differences
7 among department perspectives and the impacts of their
8 work, despite the workshop discussions. Surprisingly
9 few, actually. That workshop was as close to a
10 consensus as I've seen when people understood what it
11 was we were doing.

12 It doesn't include all work scopes. It's
13 just a -- for those who are looking for the piece of
14 the management budget or design or testing the
15 interface with design or the TSPA calculations
16 themselves. We excluded those from the exercise.

17 Some questions didn't capture what we were
18 after. We wrote some bum questions. That happens.

19 Utility rankings -- we presented utility-
20 only rankings, and they're in the packet here, and
21 also utility cost ratio rankings. Utility-only
22 rankings ignore cost. Utility cost ratios are better.
23 They're clearly what the tool was designed for.
24 You're doing a -- we are doing a utility analysis
25 because cost does matter. We don't have an unlimited

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1 budget.

2 But when you do a utility cost ratio, you
3 discover pretty quickly that not all work costs the
4 same. And very large work packages may perform more
5 poorly in the evaluation, simply because they've got
6 a big denominator -- cost -- where, obviously, if
7 you're a utility people defined their, aggregated it
8 coarsely, and produced expensive packages. You get a
9 big denominator in that fraction.

10 The examples here in the packet are
11 weights, management decision weights from two people
12 -- Bob Andrews and myself. In fact, in the back, in
13 the backup slides, there are different rankings
14 provided with weights listed from other groups of
15 people. And in the report that went with this, the
16 people are identified by name. They were the BSC
17 management team. We also listed some DOE managers but
18 did not include their results. That would have been
19 inappropriate.

20 What we discovered -- you can see when you
21 get to the back -- is that actually the management
22 weights, even though we had some -- quite a broad
23 range of management types in the exercise, we were not
24 as sensitive to the management weights as you might
25 think.

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1 And this last caveat here, that the --
2 deliberately, we didn't want to emphasize -- didn't
3 want to focus only on things that show a positive
4 benefit or a negative impact either way. Both of them
5 are important. Obviously, we need to know if our work
6 is going to show poor performance. That's -- we must
7 know that. But we also want to value work that shows
8 improved performance.

9 MEMBER GARRICK: I think we're going to
10 have to wrap up in about five minutes.

11 MR. SWIFT: Okay. I'm there.

12 Just an example here, a couple of
13 examples. Thank you, Bill. I apologize for this.

14 These were three different levels of work
15 defined for engineered barrier system flow and
16 transport. The way to read this figure -- the bars
17 here are the amount of utility associated with that
18 activity for each one of these 16 attributes over
19 here.

20 And the first thing that -- we have the
21 big blue band here -- resolution and closure of KTI
22 issues. So the experts in the engineered barrier
23 system department felt that if they did more work, the
24 Level 2 work, they had a better likelihood of closing
25 their KTI agreements. And the band is thicker here

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1 than it is here. But they were still -- I believe
2 this was a likely answer, and that was very likely.

3 Interestingly, although these two work
4 scopes are very different, they show an absolute --
5 this one costs \$2 million more, takes two years
6 longer, and in the space of these questions that we
7 asked gives you the same answer. So that's an example
8 where the management decision was pretty much a no-
9 brainer. We looked at the one that gives you the same
10 answer more cheaply.

11 CHAIRMAN HORNBERGER: Peter, you'll have
12 to forgive Raymond and I. We have another meeting we
13 have to go to.

14 VICE CHAIRMAN WYMER: I apologize.

15 MEMBER GARRICK: That's all right. We'll
16 carry on here for a while.

17 MR. SWIFT: The work scopes are sorted by
18 utility at the Level 2. This was the so-called risk-
19 informed work scope, the intermediate work scope for
20 each of these areas. Biosphere scored highest. This
21 is simply because -- a number of reasons, but
22 biosphere has a high likelihood of affecting the total
23 10,000-year dose.

24 And in the management weighting used to
25 generate this figure, Bob Andrews and I both felt that

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1 anything that was not moved -- the 10,000-year total
2 dose was the most important thing. We gave that a
3 very high weighting, and the biosphere igneous
4 activity was --

5 MEMBER GARRICK: Peter, let me comment on
6 that. Of all the things on here, the biosphere is
7 probably the most prescriptive. And so -- and one of
8 the things that prescription does is very often
9 eliminate a lot of decisionmaking and analysis,
10 because this -- the biosphere -- the regulations on
11 the biosphere are pretty binding in terms of how much
12 flexibility you have in analysis and investigation.
13 I'm surprised that that would end up on top.

14 MR. SWIFT: Well, this is a -- let me go
15 to the next -- a different slide. This one is in the
16 backups, and it's -- I'll come back to answering that
17 question.

18 MEMBER GARRICK: Yes. Okay.

19 MR. SWIFT: This is incremental utility.
20 This is --

21 MEMBER GARRICK: Yes, I understand that.
22 Yes.

23 MR. SWIFT: -- how much more you're
24 getting when you -- how much more utility you get when
25 you go from Level 1 to Level 2. And biosphere has

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1 dropped well down the list here.

2 MEMBER GARRICK: Yes.

3 MR. SWIFT: The difference there is that
4 our biosphere team felt that even at their lowest
5 level of work they were likely to show an increase in
6 the BDCFs. And that's what drove that --

7 MEMBER GARRICK: I see. Okay.

8 MR. SWIFT: And I actually -- this is all
9 subjective. This is judging by work that is not yet
10 done, and I tried to argue with Tony Smith about this
11 one in particular. I don't think shifts are going up
12 as much as he thought they were, but he's the
13 technical department lead on that. And that's where
14 his work fell out.

15 That was the -- did I just put up the
16 incremental utility plot? I did. Okay. I'm looking
17 for my summaries here.

18 MEMBER GARRICK: Are you going to tell us
19 how this has affected the outcome of the decisions?

20 MR. SWIFT: Yes, if I can find the slide.
21 Yes, that was my mistake. They're over here now.
22 It's actually 22 and 23.

23 What did we do with this? We brought the
24 spreadsheet as an electronic tool, and the types of
25 rankings you see. We brought them to a BSC management

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1 workshop where we had the senior project manager of
2 the BSC, not the corporate management, but Nancy
3 Williams, who is the project manager, and her staff --
4 I could name who they are. She had a -- has an
5 oversight -- project oversight review board. No, it's
6 just called project oversight board, POB, that is
7 people you're familiar with.

8 It would be Jack Bailey, John Beckman,
9 Gene Yonker, Nancy Williams herself chairing it.
10 Representatives from the national laboratories would
11 be Roland Carson, Joe Farmer, Andrew Worrell, Sal
12 Peterman from USGS, Tom Cotton, who is on it. These
13 people met for a fairly intensive three-day meeting to
14 go through the results of this spreadsheet, quite a
15 lot of detail.

16 And then we put the final rankings up on
17 the screen -- not final, we put the various versions
18 of the rankings up on the screen. They've been up off
19 and on for a long time, with the cost utility ratios
20 displayed and total cost. And we started drawing
21 lines in the budget where -- what can we afford? And
22 that would be an example that would be -- slide 20,
23 for example.

24 These are -- we do Level 1 scope for each
25 of them. This is what it costs in FY '02, and then we

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1 start adding in more work at the -- from Levels 2 or
2 3 at the sort of -- the highest increments of utility
3 cost ratios first. So the most bang for the buck
4 principle here.

5 What did we discover when we started
6 drawing the line in the budget? That there was not as
7 much money available as we had happened, and we were
8 able to come to the conclusion fairly quickly that, in
9 fact, the Level 1 scope was where we were looking.
10 The emphasis was going to be, based on the money
11 available, on validating the models that were already
12 available. These would be the models we showed
13 earlier today.

14 However, we could not afford to move up to
15 Level 2 and 3 across the board, so we started taking
16 those work packages apart item by item. And the
17 management team actually, in real time, went through
18 all of the work package descriptions and brought
19 things forward from Level 2 to Level 3 into the budget
20 on subject human judgment bases.

21 A primary selection criteria of moving
22 work forward was to avoid canceling any tests that
23 were ongoing. One of the lessons learned from other
24 projects is: don't cancel a test if you've already
25 paid for startup costs. Go ahead and collect the

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1 data.

2 So this is just -- this is not all PSF
3 tests. Some have PSF tests -- some tests are brought
4 forward, and other examples of testing activities were
5 brought forward.

6 And activities that were needed had to be
7 accelerated to support documentation activities that
8 could be done. Activities that were at the Level 1
9 scope of work but were planned to be done too late to
10 support license application in '04 were accelerated,
11 and that required bringing extra money forward.

12 Basically, this was a money management
13 tool that they exercised about how you use your money
14 wisely to manage your work.

15 And then this exercise with project
16 management took place in late January, and early
17 February we spent detailing work package descriptions
18 that were then delivered to DOE on March 1st.

19 And I apologize for running over. I have
20 a summary slide here. This was a decision -- the
21 multi-attribute utility analysis was a decision-aiding
22 tool, not a decisionmaking tool. We keep saying that
23 because that last slide included a lot of human
24 judgment.

25 You want both the technical and the

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1 management input. The management weights are
2 important. That's where we decide what it is -- where
3 we want to be in that X/Y/Z space.

4 Consideration given to regulatory
5 requirements, technical defensibility, and money.
6 And, yes, we will have to reevaluate it as new
7 information becomes available.

8 MEMBER GARRICK: Okay. Thank you.

9 Milt, do you have any comments?

10 MEMBER LEVENSON: No.

11 MEMBER GARRICK: Appreciate the
12 presentations. I think one of the real problems when
13 you get into this business of trying to come up with
14 utility functions that contain preference functions is
15 dealing with the different groups as you have, and
16 addressing the biases that might exist in those
17 groups, because all of us think that what we're doing
18 is the most important. So there has to be some sort
19 of normalization process.

20 But you said that this seemed to be --
21 there seemed to be a lot of harmony in this case. I'm
22 surprised at that.

23 MR. SWIFT: There was. The trick I think
24 was to focus people on giving fair questions -- fair
25 answers to questions as we asked them. When -- if you

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1 simply say, "Is my work important?" ask somebody to
2 answer that question, the answer would always be yes.
3 But if you say, "Will this specific piece of work
4 change a dose result?" or "Will this close KTI
5 agreements? And, if so, please name them and explain
6 how you're going to close them." At that level,
7 people were quite objective, and they were willing to
8 say, "No. Actually, this doesn't do anything to
9 dose."

10 We had a broad enough set of questions --

11 MEMBER GARRICK: Were they thinking in the
12 context of uncertainty when they answered the
13 question? Because --

14 MR. SWIFT: Not as much as I had hoped
15 they would be.

16 MEMBER GARRICK: Because the risk is
17 really the uncertainty. And so if what they're saying
18 is that it doesn't affect the central tendency
19 parameter, that's one thing. But if it does affect
20 the tails of the distribution, it could be very
21 significant.

22 MR. SWIFT: With respect to the dose
23 calculations, yes, they were -- they were thinking of
24 that sort of thing. But they were all thrown for a
25 curve -- thrown a curve right away by the realization

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1 that 10,000-year total dose is really a question of
2 igneous activity.

3 And as soon as people realize that, you
4 know, if you want to score on the Y-axis, the
5 quantitative axis in that, you've got to have a
6 volcano.

7 MEMBER GARRICK: Yes.

8 MR. SWIFT: A whole lot of people came
9 into the room thinking they were going to say,
10 absolutely, I've got some tail up there that's going
11 to drive dose. Actually, no, you don't. You may
12 score on time, 215 millirem. You may score on peak
13 dose. You may score on the conditional early failure
14 scenario. But those all get different weights.

15 And because we had a broad range of
16 questions, I think every technical staff person was
17 able to feel like, yes, there is a question that
18 captures my -- their personal issues. But then, they
19 didn't know how management was going to weight those
20 questions, and so they were -- the technical level of
21 agreement was surprisingly high. People always found
22 a question they could say, "Yes, that's the one I'm
23 aiming at."

24 MEMBER GARRICK: Any questions from the
25 staff?

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1 One thing I would say is that in the TSPA-
2 SR you had a couple of appendices that did a very nice
3 job of delineating the key assumptions, and then going
4 out on a limb a little bit and indicating what the
5 impact of these assumptions might be.

6 I don't know if it's the way you're doing
7 it, but I think that it would be very helpful with
8 respect to traceability and transparency for this to
9 be kind of a reference point and subsequent versions
10 be measured against this reference point. I think it
11 would make it very clear what -- which assumptions
12 have changed and what impact they've had, and which
13 assumptions are being driven by the decision to go to
14 an entirely different corrosion model, for example.

15 By just changing the model, you can end up
16 with a different set of importance rankings for
17 contributors. So I found that what you did in the SR-
18 TSPA very valuable in boiling down just exactly what
19 the team thinks is important from an assumption set
20 standpoint.

21 And I hope that something like that is
22 carried forward. I'm not saying you should do it,
23 because we don't advise you; we advise the Commission.
24 But that was -- I'm just observing that that was an
25 example of a transparency tool or a traceability tool

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1 that was very helpful. And your presentations were
2 very helpful, and we thank you very much.

3 And with that, unless Carol has --

4 MS. HANLON: Dr. Garrick, Bill has brought
5 copies of his uncertainty analysis and strategy, as
6 well as Peter's guidelines. So we're going to leave
7 these here for you. If you need additional copies,
8 let us know.

9 And I'd just like to thank Bill and Peter
10 again for working around very difficult schedules,
11 including technical exchanges and Peter's out of the
12 country trek to be here today.

13 MEMBER GARRICK: We know they are very
14 busy men, and we know you're a very busy lady. Thank
15 you very much.

16 (Whereupon, at 12:48 p.m., the
17 proceedings in the foregoing matter went
18 off the record.)

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CERTIFICATE

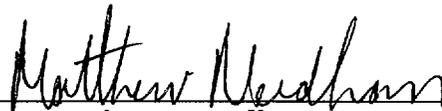
This is to certify that the attached proceedings before the United States Nuclear Regulatory Commission in the matter of:

Name of Proceeding: ACNW 133rd Meeting

Docket Number: (Not Applicable)

Location: Rockville, Maryland

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



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March 14, 2002

Dr. George M. Hornberger, Chairman
Advisory Committee on Nuclear Waste
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Dear Dr. Hornberger:

SUBJECT: LETTER FOR THE RECORD – NRC HLW RESEARCH: ASSURING NRC HLW DECISIONS ARE INFORMED BY SOUND SCIENCE - THE UNIQUE ROLE OF THE ACNW

My February 28, 2002 letter to the ACNW (Reference 1) transmitted a copy of a letter I sent to the NRC Commissioners on February 26, 2002 (Reference 2). Reference 2 presented concerns about the NRC HLW research strategy and its impact on the credibility and public acceptance of potential regulatory decisions made by the NRC for the proposed HLW repository at Yucca Mountain, Nevada (YM). In Reference 1 I requested that Reference 2 be included in the record at the next ACNW meeting, March 19, 2002. In addition, I request that this letter also be included in the record on March 19.

The purpose of this letter is to strongly emphasize the importance of the upcoming ACNW Annual Waste-Related Research Report and the unique role that the ACNW can play in helping to correct serious flaws in the current NRC HLW program strategy, which has overemphasized a compliance-based approach at the expense of underemphasizing research. Semantics and process appear to be substituting for the science and understanding required by the NMSS staff and NRC decision makers, which can only be obtained from a well planned, supporting research program with major involvement by RES. The transcript of the recent Commission briefing by NMSS on March 4, 2002 (Reference 3), in part, supports this conclusion.

As the only independent, oversight body to review the NRC HLW regulatory program, the ACNW can play a crucial role in altering the direction of the NRC HLW program from its current course and risk of likely failure, as the proposed Y M project proceeds towards the licensing stage. **I request that the following points receive special consideration and emphasis in the preparation of the final Annual Waste-Related Research Report, and at the ACNW meeting with the Commission, March 20, 2002.** Many of these points are not new, but merit inclusion as a frame-of-reference for this discussion.

1. As a starting point for the discussion, I fully understand that the DOE is responsible for providing the necessary technical and scientific bases for demonstrating the safety of the proposed YM repository. This guideline has also been true for reactor safety licensees and other areas of the nuclear industry regulated by the NRC.
2. Nevertheless, the NRC (RES) was also given the responsibility, in the 1974 ERA, to conduct and maintain a sufficient, independent confirmatory research program of its own. This mandate has allowed RES to provide the NRC licensing staff and senior decision makers with the necessary tools, data and scientific understanding to properly judge the work of licensees, and support decisions rendered by the staff. As a result, the NRC has been able to successfully address key issue challenges over the past 25 years, such as: ECCS performance and thermal-hydraulic code validation; severe accident source term and risk reassessment in response to the accident at TMI-2; pressurized thermal shock; and reactor license renewal.
3. **Is the ACNW confident that the NRC and CNWRA technical staff have sufficient independent supporting tools and data, and resources, to allow them to gain sufficient understanding of repository science and the associated complex issues they need, to do the job being asked of them?**
4. Is the ACNW confident that NMSS has a formal strategy, which integrates: YM key technical issues (KTIs); performance assessment methodology and its associated uncertainties and their PA sensitivities; data and information from the DOE YM program needed to 'close' the 293 'open' KTI 'resolution' agreements, which taken together provide much of the bases for NRC independent research and technical assistance to support the decisions the NRC will be confronted with over the next 3-5 yr? The next 5-10 yr? Such a strategy would also be useful for prioritization of research as well as technical assistance, and hence resource allocation. It is also interesting to note that the draft NRC YM license review plan posted on the NRC web site, is silent on the role of NRC research!
5. In their 2001 Annual Research Report (Reference 4), the ACNW recommended, "The HLW program needs to be expanded to have a modest long-term, 'anticipatory' research component, perhaps through collaboration between NMSS and RES." **What was the basis for the ACNW's judgment as to the size of the anticipatory research program? How can the ACNW understand the research needs of the HLW program without information of the type noted in Item 4? How can the ACNW call for an RES research plan, which includes HLW components, and a prioritization protocol, without an integrated plan and road map of the type described in Item 4?**
6. In Reference 4 the ACNW also noted, "Another aspect of the partitioning of HLW and non-HLW issues is the potential for ignoring anticipatory research needs in the HLW area. NMSS focuses on the relatively short-term goal of analyzing what DOE is doing. RES, on the other hand is prohibited from doing any work on HLW, even if it is anticipatory and arguably focused on the long term. There is a potential gap in the NRC program because of the separation of the NMSS and RES programs."

7. The ACNW, perhaps because of the current narrow, and shortsighted NRC HLW policy restrictions imposed on the NRC staff and the Committee, continues to address the NRC HLW research program as two distinct entities, confirmatory and anticipatory. This categorization is misleading. In the real world of nuclear regulatory research, especially with a first-of-a-kind geological repository and its complex technical and scientific uncertainties and challenges, research programs are most appropriately a continuum of closely integrated studies. **I believe the Committee needs to break out of the constraints imposed upon it and send a clear and unmistakable message to the Commission on the gravity of the current deficiencies in the NRC HLW research program, sooner, rather than later. How much research does the ACNW, in their legislatively mandated, expert advisory capacity, truly believe is sufficient to support the NMSS licensing staff's review?**
8. Several presentations at the ACNW Research Needs Workshop in November 2001(Reference 5) provided perspectives and advice, which support some of the issues and concerns discussed above.

The ACNW should give high priority, proactive attention to the issues presented here, many of which the Committee has touched upon in their recent letters to the Commission. The Committee must recognize that if the proposed YM HLW repository proceeds to the licensing phase, the ACNW will be called upon to review, and either reject or endorse, the findings of NRC decisions makers on the matter before it. **At that time, the ACNW will have at its disposal the same information resources available to the NRC staff, no more, no less, to render its crucial judgment.** The ACNW will have to evaluate and judge the acceptability and quality of the NRC staff review, as well as the adequacy of the science-informed rationale and treatment of uncertainties used by the staff to measure compliance and the margins for assuring safety. **Hence, the ACNW must rest assured that the NMSS staff and the Committee have sufficient science-informed resources at its disposal to render an adequate review. The NRC advisory committees are the guardians of sound science-based regulatory decisions.**

If the ACNW has any doubts or reservations about the current direction of the NRC HLW research program now is the time to express it, in the annual research report, and in the meeting on March 20, 2002 with the Commission. If not now, when? I am sure the ACNW has a clear vision of the needs of the NRC in the HLW arena. The Committee must take the necessary steps to see that vision come to fruition. If not the ACNW, who else?

Thank you for the opportunity to comment on NRC HLW research. Please let me know if I can be of further assistance to the Committee.

Sincerely,

(signature)
Mel Silberberg

cc: NRC Chairman and Commissioners

REFERENCES

1. Letter from Mel Silberberg to Dr. George M. Hornberger, Chairman, ACNW, dated February 28, 2002.
2. Letter from Mel Silberberg to The NRC Commissioners, dated February 26, 2002.
3. USNRC, Transcript of Commission Meeting on March 4, 2002, Rockville, MD.
4. Letter from Advisory Committee on Nuclear Waste to the Honorable Richard A. Meserve, Chairman, USNRC, dated February 5, 2001.
5. Advisory Committee on Nuclear Waste, Transcript of Meeting – Workshop on Research Needs, November 27-28, 2001.

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February 26, 2002

The Honorable Richard A. Meserve
Chairman
U. S. Nuclear Regulatory Commission
Washington, DC 20555-0001

The Honorable Nils J. Diaz
Commissioner
U. S. Nuclear Regulatory Commission
Washington, DC 20555-0001

The Honorable Greta J. Dicus
Commissioner
U. S. Nuclear Regulatory Commission
Washington, DC 20555-0001

The Honorable Edward McGaffigan, Jr.
Commissioner
U. S. Nuclear Regulatory Commission
Washington, DC 20555-0001

The Honorable Jeffrey S. Merrifield
Commissioner
U. S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Dear Chairman Meserve and Commissioners Diaz, Dicus, McGaffigan, and Merrifield:

**SUBJECT: RESTORING NRC HLW RESEARCH; IT'S ALL ABOUT CREDIBILITY,
BUILDING PUBLIC CONFIDENCE AND SCIENCE-INFORMED DECISIONS**

BACKGROUND, STATUS, AND SUMMARY OF CONCERNS

1. On January 16, 2001 I sent a letter to Chairman Meserve regarding my concerns about the flawed strategy and scope of the NRC HLW research program (Ref. 1).
2. I received a response to Reference 1 in a May 7, 2001 letter (Ref. 2) from Mr. Martin Virgilio restating the staff position on the current NRC HLW program strategy, judging it

effective and efficient, so that NRC is well positioned to support an independent review of any potential license application for a potential repository. I will address this assertion later.

3. Since May 7, 2001 the results of several relevant, timely, and substantive reviews by boards and special panels have been published. I have also found additional, related information in searching various agency documents.
4. Many of the conclusions and recommendations contained in these reviews provide convincing support for the need for change expressed in Reference 1. They not only serve to confirm and reinforce the concerns I outlined in Reference 1, but also more clearly reveal the program deficiencies. **Overall, these recommendations were sufficiently compelling for the Commission to take action, yet another year has passed, without visible changes to the program. Despite specific recommendations from these reviews, including several relevant Commission meetings in 2001, the Commission was silent, not even issuing a Staff Requirements Memorandum dealing with this policy issue.**
5. There is a perceptible absence of a viable NRC HLW research program, regardless of the semantics used by the NRC staff to categorize the research as confirmatory or anticipatory. **Even more alarming is the continuing lack of a viable role for the fundamentally important and valuable research arm of the NRC, the Office of Research (RES), in the regulatory process for a proposed HLW repository at Yucca Mountain, Nevada. The passing of another year has only magnified these concerns.**
6. **It is difficult to imagine how a program strategy that doesn't take advantage of all of the technical and scientific staff resources available in the NRC can be deemed effective and efficient.**
7. **If one summarizes the abovementioned concerns and the discussion to follow, I do not agree with the conclusion in Reference 2, that the NRC is well positioned to support an independent review of any potential license application for a potential repository.**

Critical decisions required to implement needed change to a flawed research strategy for the NRC HLW program are of such magnitude and importance to the credibility of the NRC HLW regulatory program, they can no longer be left to the NRC staff. **Based upon the record to date, I do not believe the senior management in NMSS and the EDO can be expected to render an objective judgment in this matter. In addition, the current NRC organizational structure no longer gives the RES Director an independent voice in waste-related matters, as was the case prior to ~1996, therefore, it is necessary to bring this urgent need for change involving NRC HLW research, directly to the attention of the entire Commission as a vital policy matter.**

In the following sections I will discuss further the rationale supporting the concerns and conclusions reached above.

INFORMING, BUILDING PUBLIC CONFIDENCE WITH CREDIBLE DECISIONS ASSURED BY SOUND SCIENCE: A MANDATE FOR THE NRC RESEARCH OFFICE

The institutional process driving a decision on the siting, licensing and operation of a proposed, potential geological repository at Yucca Mountain, Nevada, (YM) involves technical, scientific, and political issues. At the end of the day, if you can't build a consensus base in the scientific community for repository science, you will not be able to gain the confidence of the public. For example, recent concerns about the state of DOE scientific investigations (Ref. 3 and 4) can have serious implications for building public confidence in the potential licensing process for a possible repository. Since the current divisions over YM science will continue to exist for some time into the foreseeable future, we should not expect the licensing review to be a pro-forma process of compliance. **Regardless of the outcome of the NRC review of the license for a potential repository, the agency will have to defend the scientific basis for its decisions to all stakeholders, as well as to the world court of scientific opinion.** This issue is addressed later.

Over the course of NRC history (e.g. reactor system thermal-hydraulic performance, severe accident risk and source term, nuclear plant aging and pressurized thermal shock, to name a few) the public and other stakeholders have gained confidence in NRC decisions involving controversial, complex technical and scientific issues because of the coordinated support of a robust, independent research program carried out by the NRC, within RES. The scope and depth of the NRC research programs were of sufficient magnitude that NRC was able to independently defend its decisions based upon sound science, while assuring public health and safety. NRC was in effect the last word, literally and figuratively. The need for an adequate NRC HLW research program is not exempt from the tested lessons and wisdom derived from NRC's past. **NMSS regards the NRC HLW regulatory program as risk-informed, effective and efficient, but at the end of the day, success and credibility requires a comprehensive research effort, one that has not been evident in recent years.**

NRC HLW RESEARCH: A PRIORITY NEED FOR A PROGRAM STRATEGY

The NRC HLW research program was ostensibly terminated in 1996 owing to a severe reduction in funding for the NRC HLW program. Although funding for the NRC HLW program was restored in 1998, the NRC HLW research program per se was not restored. The chronology of these program decisions was discussed previously in Reference 1. **As a member of the public I have not found on the public record, the existence of a bona fide NRC HLW research program or strategy to support and confirm technical and scientific issues over the entire regulatory process.** The NRC Performance and Strategic Plans for the Nuclear Waste Safety Arena are silent about the role of research in the HLW program or program strategy. **By comparison, the role of research to provide the technical basis to confirm the adequacy of regulations and guidance to maintain safety in areas such as decommissioning and interim spent fuel storage are evident. How can the agency justify and defend such an incongruent policy in the application of research in the interest of safety and public confidence?**

Since 1996 the NRC HLW program at the CNWRA has been referred to sometimes (e.g. ACNW) as technical assistance, a part of which is considered to be 'research.' In their 2000 ACNW Performance Plan under Second-Tier Priorities – Research, reference is made to "technical assistance performed by the CNWRA. During presentations before the ACNW, NMSS and contractor staff noted that no research was actually being conducted under the NRC HLW program (Ref. 5 and 6). Nevertheless, in Reference 2, Mr. Virgilio states " Although some of the CNWRA's technical work might be deemed 'confirmatory research' by some, I do not believe the assignment of some research responsibilities to NMSS violates any prohibition in the ERA. The reason is that, under the ERA, the Commission has wide discretion in assigning work among its statutory offices." The first point about this assertion is that I cannot find evidence in the ERA to support it. **The second point is that if NMSS staff really believes it was given such a mandate by the ERA, why haven't they come forth, on the public record, with an integrated, confirmatory research plan and strategy to support even the current phases of their pre-licensing review.**

One explanation was offered in Reference 7 by former Commissioner Kenneth C. Rogers, who chaired an expert panel on the role and direction of NRC nuclear research: . . . "A considerable lack of understanding exists both outside and inside NRC of exactly what the words research, confirmatory research and anticipatory research mean at NRC. The Panel sought clarification from the staff on those questions with limited success . . . Further confusion in definitions arises because the Center for Nuclear Regulatory Analysis conducts studies entirely related to Yucca Mountain (which could either be short term or long term). Because they are carried out with the express approval of NMSS consistency would define them as Confirmatory Research. However the Commission has directed that all Confirmatory Research is to be conducted under RES. Perhaps this is the reason that Mr. Kane in his presentation to the Panel contended that NMSS does not do research." **Another possible explanation is that a planned, multi-year program, confirmatory or otherwise, does not really exist in NMSS, or if such a program exists it is inadequate to meet the needs of the HLW program.**

Since 1996 there has been little, if any, discernable participation by RES experts in the NRC HLW program. For example, one of the key technical and scientific challenges in HLW is the question of the corrosion of the Alloy 22 waste package material proposed by DOE. RES had on its staff internationally recognized expertise in materials corrosion science as one of its core research capabilities applicable to nuclear waste safety. NMSS, carrying out an ostensible NRC policy, failed to take advantage of this staff capability in RES. There are other examples of this deficiency. **The internal culture displayed in this case tends to promote a 'closed program,' indicative of a program operating 'inside the box.'**

INFORMING NRC HLW PROGRAM STRATEGY: ADVICE OF EXPERT PANELS AND REVIEW BOARDS SPEAK VOLUMES ON THE NEED FOR CHANGE

In its Annual Report on NRC Waste-Related Research (Ref. 8) the ACNW noted: . . . "Another aspect of partitioning the HLW and non-HLW issues is the potential for ignoring anticipatory needs in the HLW area. NMSS focuses on the relatively short-term goal of analyzing what the DOE is doing. RES, on the other hand, is prohibited from doing any work on HLW even if it is anticipatory and arguably focused on the long term. There is a potential for a gap in the NRC

Program because of the separation of the NMSS and RES programs.”

In one of his comments in Reference 7, former NRC Chairman John F. Ahearne, citing Reference 8 noted: “These are issues raised by the NRC group chartered to review the waste programs. I believe these comments should alert the Commission to a serious potential for the NRC becoming a major obstacle to moving forward with HLW disposition for reasons other than sound science. Rather, the NRC may be found unprepared to address issues which arise because of the exclusion of a research-perspective.”

In Reference 7, Robert J. Budnitz, a former Director of RES, expressing a similar concern noted: “I feel very strongly that the Commission made a serious mistake in its decision to allow NMSS to manage the research aspects of the overall program to support its regulatory decision concerning Yucca Mountain. NMSS is not suited to managing long-range research as a matter of culture, staff-incentive structures and management skills (neither is NRR) . . . But, looking ‘beyond the licensing offices headlights’ is RES’s Congressionally assigned role! I urge the Commission to revisit this decision, and in doing so to hear from people like me who can provide it with another view, to balance what I believe to be the distorted and incorrect view that now emerges from senior staff management in NMSS and at the EDO level, few if any of whom are researchers.”

A recent report (Ref. 9) issued by one of the committees of the National Research Council’s Board on Radioactive Waste Management (BRWM) presented a number of useful views and recommendations on regulatory issues related to geologic disposal. I have selected a few cogent excerpts from Chapter 6, entitled *Scientific and Technical Issues in Radioactive Waste Management*:

- In a section called ‘The Regulator’s Dilemma’ two roles of the regulator are defined, the first role is to decide on the rules for demonstrating compliance that the implementing agencies should follow. The second role of the regulator is to decide if the license application meets these requirements. The report then states: “Both roles require that the regulator has scientific credibility and that the same rules as described above for science at the implementing agencies apply also to regulators. This includes the need for scientists at the highest levels, sufficient scientific staff, publications, room and funding for independent scientific views.”
- From Sidebar 6.4 (1).... “A second corollary is that, in general, a ‘compliance’ attitude and philosophy is an inappropriate way for the regulator to approach the major yes-or-no decision; the regulatory yes-or-no decision for a geological repository will always require a good deal of judgment, not merely a cookbook compliance-type finding. At some very fundamental level, the implementer is always responsible for showing that the site is safe. Programs should be careful that a prescriptive regulatory approach does not induce a compliance attitude rather than a ‘safety’ attitude.
- From Sidebar 6.4 (5) “The regulatory body’s ability to adopt and utilize a less prescriptive system that involves relatively more judgment is very much tied up with how much trust that body enjoys with the broad public. The more trust, the more

deference is afforded the regulatory body to exercise judgment instead of relying on prescriptive yes-or-no findings, and the more likely is acceptance by the public of the regulator's decisions."

A statement in Reference 7 sums up the concerns and advice presented above: "Several panel members felt that regardless of the work being done by NMSS in evaluating the ability to license waste management programs, special research skills are required to review that work and verify its credibility. **Decisions regarding the ultimate safety of the Yucca Mountain Project, for example, will be carefully scrutinized by stakeholders and solid research data must be available to support the decisions made by the Commission.**" (Emphasis added)

REFLECTIONS ON NRC HLW CONFIRMATORY RESEARCH: GETTING OUTSIDE OF THE BOX

In a number of the reviews referenced above, many of the comments point to the need for anticipatory or long-term research in the NRC HLW program. The anticipatory, or so-called long-term, research needed has been referred to as a 'small' or 'modest' program. No basis is offered for the qualitative nature of these judgments and their meaning. The current situation regarding what HLW research is actually being done by the NRC is confusing and troubling. If the elusive scope and magnitude of the NRC research program is not clear or definitive, how can one start to define or bound the anticipatory research program? At its outset, the anticipatory program is a derivative of the confirmatory program, and for many years, both programs should be complementary. The first question that needs to be answered is: How much of the confirmatory research needed to credibly review a possible licensing application for a potential repository been completed or even identified? I believe the short answer to this question is we don't know. The NRC needs to be sure it is doing the research needed to support a credible licensing review now, before it can initiate a meaningful anticipatory program. The reasons for this answer follow.

The NRC has listed nine key technical issues (KTI) for their review of the YM project. There are many additional sub-issues related to these KTIs. Some of these issues would be influenced more by the assumption of a high-temperature repository design. The NRC is using a repository performance assessment (PA) code to project repository performance for thousands of years into the future. Large uncertainties exist in the processes and parameters for many of the models in the code, as well as the models themselves, and are closely related to many of the KTIs. Some NRC research related to these uncertainties is needed now just to understand and confirm the DOE PA code, its models and parameters, for the licensing review, and for many years to come. Such research is also essential to gain understanding and build confidence in the use of the NRC PA mode. **Risk-informed PA can be an important tool for HLW regulatory decisions, but unless the PA model is also sufficiently science-informed; it is much less useful and credible.**

Recent reports of the Nuclear Waste Technical Review Board (NWTRB) appear to be consistent with these views. In Reference 10 the NWTRB commented on the DOE performance assessment model and its related uncertainties: "The DOE uses a complex integrated performance assessment model to project repository performance. Performance assessment is a

useful tool because it assesses how well the repository system as a whole, not just the site or the engineered components, might perform. However, gaps in data and basic understanding cause important uncertainties in the concepts and assumptions on which the DOE's performance estimates are now based. Because of these uncertainties, the Board has limited confidence in current performance estimates generated by the DOE's performance assessment model.

... An international consensus is emerging that a fundamental understanding of the potential behavior of a proposed repository system is of importance comparable to the importance of showing compliance with regulations. The Board agrees that such fundamental understanding is important."

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CONCLUSIONS AND RECOMMENDATIONS FOR COMMISSION CONSIDERATION

Ample arguments, supported by a preponderance of testimonials by recognized experts and former regulatory decision-makers, have been presented for the Commission's policy consideration in the matter of NRC HLW program strategy and the urgent need to fill the current void in the science-informing role normally derived from NRC research. The current NRC HLW strategy is not sufficiently pro-active in the area of confirmatory research, lacks a role for traditional RES support, and appears to rely excessively on a compliance-based approach.

There is still time for the Commission to make needed changes in the HLW program strategy. The age-old adage about not 'changing horses in mid-stream' is not a sound or prudent justification. The case for change presented in this letter indicates that the 'horse may not make it across the stream.' The potential risk of delaying needed changes to the program increases with time with the consequence of a real potential for the NRC becoming a major obstacle to moving forward with HLW disposal. **This concern is not only about who manages the NRC HLW research program, expressed in Reference 1. It's also about serious concerns with the inadequacies of the research program strategy and its impact on the very credibility of the regulatory program.**

This Commission can leave an important policy legacy for the future of the NRC HLW regulatory program or it can defer the needed change to those who follow. Assuming the Congress decides to move forward with the YM Project on the current schedule, or with a likely scenario which delays the project several years (similar to the GAO finding) to obtain more data, it is incumbent upon the Commission to inform the Congress that the NRC finds it prudent to revise its HLW program strategy, and hence its budget request from the Nuclear Waste Fund, based upon the weight of considerable, expert advice from various panels and committees.

One thing is certain. The earlier needed program changes are made, the easier they are to implement, and with a lower potential risk for a regulatory impasse to HLW disposal. If the Commission decides to take no further action and if for some reason the NRC HLW strategy is

called into question in the future, a response, which in effect says, "we didn't have sufficient resources to do the job" will be unacceptable.

During a speech in 2001 Commissioner Merrifield used a quotation from Nathaniel Hawthorne, which is appropriate for the current discussion: "*Destiny is not a matter chance; it's a matter of choice. It is not a thing to be waited for, it is a thing to be achieved.*"

I trust the Commission will accept these comments with the same constructive and collegial spirit in which they are offered. If I can be of further assistance please do not hesitate to call on me. When appropriate, I would be pleased to appear before the Commission on the matters presented in this letter, as an informed stakeholder with extensive expertise in nuclear regulatory research for reactor safety and nuclear waste safety.

Sincerely,


Mel Silberberg

cc:

ACNW

NWTRB

DOE/OCRWM

NWPO

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REFERENCES

1. Letter from Mel Silberberg to The Honorable Richard A. Meserve, Chairman, USNRC, dated January 16, 2001.
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7. USNRC, Office of Nuclear Regulatory Research, "Role and Direction of Nuclear Regulatory Research - Expert Panel Report," May 2001.
8. Letter from Advisory Committee on Nuclear Waste to The Honorable Richard A. Meserve, Chairman, USNRC, dated February 5, 2001.
9. National Research Council, Board on Radioactive Waste Management, "Disposition of High-Level Waste and Spent Nuclear Fuel: The Continuing Societal and Technical Challenges," June 2001, National Academy Press.
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In the interest of time and space, selected passages were chosen from some of these References because of the importance of the comment, view, or discussion to the specific issue being emphasized in this letter. The reading of the full-text of the reference is also recommended.

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February 28, 2002

Dr. George Hornberger, Chairman
Advisory Committee on Nuclear Waste
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Dear Dr. Hornberger:

SUBJECT: STATEMENT FOR THE RECORD – NRC HLW RESEARCH

Enclosed for your information and use in your consideration of the ACNW Annual Waste-Related Research Report to the Commission is a letter I have sent to the Commissioners on NRC HLW Research. I request that it be entered into the record at the next ACNW meeting, March 19, 2002, with my November 23, 2001 letter to the ACNW, which does not appear to have been placed into the record for ACNW Research Needs Workshop, November 27-29, 2001.

Thank you for the opportunity to comment on NRC programs within the scope of review of the ACNW. Please do not hesitate to call on me if I can be of any assistance to the Committee.

Sincerely,


Mel Silberberg

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February 26, 2002

The Honorable Richard A. Meserve
Chairman
U. S. Nuclear Regulatory Commission
Washington, DC 20555-0001

The Honorable Nils J. Diaz
Commissioner
U. S. Nuclear Regulatory Commission
Washington, DC 20555-0001

The Honorable Greta J. Dicus
Commissioner
U. S. Nuclear Regulatory Commission
Washington, DC 20555-0001

The Honorable Edward McGaffigan, Jr.
Commissioner
U. S. Nuclear Regulatory Commission
Washington, DC 20555-0001

The Honorable Jeffrey S. Merrifield
Commissioner
U. S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Dear Chairman Meserve and Commissioners Diaz, Dicus, McGaffigan, and Merrifield:

**SUBJECT: RESTORING NRC HLW RESEARCH: IT'S ALL ABOUT CREDIBILITY,
BUILDING PUBLIC CONFIDENCE AND SCIENCE-INFORMED DECISIONS**

BACKGROUND, STATUS, AND SUMMARY OF CONCERNS

1. On January 16, 2001 I sent a letter to Chairman Meserve regarding my concerns about the flawed strategy and scope of the NRC HLW research program (Ref. 1).
2. I received a response to Reference 1 in a May 7, 2001 letter (Ref. 2) from Mr. Martin Virgilio restating the staff position on the current NRC HLW program strategy, judging it

effective and efficient, so that NRC is well positioned to support an independent review of any potential license application for a potential repository. I will address this assertion later.

3. Since May 7, 2001 the results of several relevant, timely, and substantive reviews by boards and special panels have been published. I have also found additional, related information in searching various agency documents.
4. Many of the conclusions and recommendations contained in these reviews provide convincing support for the need for change expressed in Reference 1. They not only serve to confirm and reinforce the concerns I outlined in Reference 1, but also more clearly reveal the program deficiencies. **Overall, these recommendations were sufficiently compelling for the Commission to take action, yet another year has passed, without visible changes to the program. Despite specific recommendations from these reviews, including several relevant Commission meetings in 2001, the Commission was silent, not even issuing a Staff Requirements Memorandum dealing with this policy issue.**
5. There is a perceptible absence of a viable NRC HLW research program, regardless of the semantics used by the NRC staff to categorize the research as confirmatory or anticipatory. **Even more alarming is the continuing lack of a viable role for the fundamentally important and valuable research arm of the NRC, the Office of Research (RES), in the regulatory process for a proposed HLW repository at Yucca Mountain, Nevada. The passing of another year has only magnified these concerns.**
6. **It is difficult to imagine how a program strategy that doesn't take advantage of all of the technical and scientific staff resources available in the NRC can be deemed effective and efficient.**
7. **If one summarizes the abovementioned concerns and the discussion to follow, I do not agree with the conclusion in Reference 2, that the NRC is well positioned to support an independent review of any potential license application for a potential repository.**

Critical decisions required to implement needed change to a flawed research strategy for the NRC HLW program are of such magnitude and importance to the credibility of the NRC HLW regulatory program, they can no longer be left to the NRC staff. **Based upon the record to date, I do not believe the senior management in NMSS and the EDO can be expected to render an objective judgment in this matter. In addition, the current NRC organizational structure no longer gives the RES Director an independent voice in waste-related matters, as was the case prior to ~ 1996, therefore, it is necessary to bring this urgent need for change involving NRC HLW research, directly to the attention of the entire Commission as a vital policy matter.**

In the following sections I will discuss further the rationale supporting the concerns and conclusions reached above.

INFORMING, BUILDING PUBLIC CONFIDENCE WITH CREDIBLE DECISIONS ASSURED BY SOUND SCIENCE: A MANDATE FOR THE NRC RESEARCH OFFICE

The institutional process driving a decision on the siting, licensing and operation of a proposed, potential geological repository at Yucca Mountain, Nevada, (YM) involves technical, scientific, and political issues. At the end of the day, if you can't build a consensus base in the scientific community for repository science, you will not be able to gain the confidence of the public. For example, recent concerns about the state of DOE scientific investigations (Ref. 3 and 4) can have serious implications for building public confidence in the potential licensing process for a possible repository. Since the current divisions over YM science will continue to exist for some time into the foreseeable future, we should not expect the licensing review to be a pro-forma process of compliance. **Regardless of the outcome of the NRC review of the license for a potential repository, the agency will have to defend the scientific basis for its decisions to all stakeholders, as well as to the world court of scientific opinion.** This issue is addressed later.

Over the course of NRC history (e.g. reactor system thermal-hydraulic performance, severe accident risk and source term, nuclear plant aging and pressurized thermal shock, to name a few) the public and other stakeholders have gained confidence in NRC decisions involving controversial, complex technical and scientific issues because of the coordinated support of a robust, independent research program carried out by the NRC, within RES. The scope and depth of the NRC research programs were of sufficient magnitude that NRC was able to independently defend its decisions based upon sound science, while assuring public health and safety. NRC was in effect the last word, literally and figuratively. The need for an adequate NRC HLW research program is not exempt from the tested lessons and wisdom derived from NRC's past. **NMSS regards the NRC HLW regulatory program as risk-informed, effective and efficient, but at the end of the day, success and credibility requires a comprehensive research effort, one that has not been evident in recent years.**

NRC HLW RESEARCH: A PRIORITY NEED FOR A PROGRAM STRATEGY

The NRC HLW research program was ostensibly terminated in 1996 owing to a severe reduction in funding for the NRC HLW program. Although funding for the NRC HLW program was restored in 1998, the NRC HLW research program per se was not restored. The chronology of these program decisions was discussed previously in Reference 1. **As a member of the public I have not found on the public record, the existence of a bona fide NRC HLW research program or strategy to support and confirm technical and scientific issues over the entire regulatory process.** The NRC Performance and Strategic Plans for the Nuclear Waste Safety Arena are silent about the role of research in the HLW program or program strategy. **By comparison, the role of research to provide the technical basis to confirm the adequacy of regulations and guidance to maintain safety in areas such as decommissioning and interim spent fuel storage are evident. How can the agency justify and defend such an incongruent policy in the application of research in the interest of safety and public confidence?**

Since 1996 the NRC HLW program at the CNWRA has been referred to sometimes (e.g. ACNW) as technical assistance, a part of which is considered to be 'research.' In their 2000 ACNW Performance Plan under Second-Tier Priorities – Research, reference is made to “technical assistance performed by the CNWRA. During presentations before the ACNW, NMSS and contractor staff noted that no research was actually being conducted under the NRC HLW program (Ref. 5 and 6). Nevertheless, in Reference 2, Mr. Virgilio states “ Although some of the CNWRA’s technical work might be deemed ‘confirmatory research’ by some, I do not believe the assignment of some research responsibilities to NMSS violates any prohibition in the ERA. The reason is that, under the ERA, the Commission has wide discretion in assigning work among its statutory offices.” The first point about this assertion is that I cannot find evidence in the ERA to support it. **The second point is that if NMSS staff really believes it was given such a mandate by the ERA, why haven’t they come forth, on the public record, with an integrated, confirmatory research plan and strategy to support even the current phases of their pre-licensing review.**

One explanation was offered in Reference 7 by former Commissioner Kenneth C. Rogers, who chaired an expert panel on the role and direction of NRC nuclear research: . . . “A considerable lack of understanding exists both outside and inside NRC of exactly what the words research, confirmatory research and anticipatory research mean at NRC. The Panel sought clarification from the staff on those questions with limited success . . . Further confusion in definitions arises because the Center for Nuclear Regulatory Analysis conducts studies entirely related to Yucca Mountain (which could either be short term or long term). Because they are carried out with the express approval of NMSS consistency would define them as Confirmatory Research. However the Commission has directed that all Confirmatory Research is to be conducted under RES. Perhaps this is the reason that Mr. Kane in his presentation to the Panel contended that NMSS does not do research.” **Another possible explanation is that a planned, multi-year program, confirmatory or otherwise, does not really exist in NMSS, or if such a program exists it is inadequate to meet the needs of the HLW program.**

Since 1996 there has been little, if any, discernable participation by RES experts in the NRC HLW program. For example, one of the key technical and scientific challenges in HLW is the question of the corrosion of the Alloy 22 waste package material proposed by DOE. RES had on its staff internationally recognized expertise in materials corrosion science as one of its core research capabilities applicable to nuclear waste safety. NMSS, carrying out an ostensible NRC policy, failed to take advantage of this staff capability in RES. There are other examples of this deficiency. **The internal culture displayed in this case tends to promote a ‘closed program,’ indicative of a program operating ‘inside the box.’**

INFORMING NRC HLW PROGRAM STRATEGY: ADVICE OF EXPERT PANELS AND REVIEW BOARDS SPEAK VOLUMES ON THE NEED FOR CHANGE

In its Annual Report on NRC Waste-Related Research (Ref. 8) the ACNW noted: . . . “Another aspect of partitioning the HLW and non-HLW issues is the potential for ignoring anticipatory needs in the HLW area. NMSS focuses on the relatively short-term goal of analyzing what the DOE is doing. RES, on the other hand, is prohibited from doing any work on HLW even if it is anticipatory and arguably focused on the long term. There is a potential for a gap in the NRC

Program because of the separation of the NMSS and RES programs.”

In one of his comments in Reference 7, former NRC Chairman John F. Ahearne, citing Reference 8 noted: “These are issues raised by the NRC group chartered to review the waste programs. I believe these comments should alert the Commission to a serious potential for the NRC becoming a major obstacle to moving forward with HLW disposition for reasons other than sound science. Rather, the NRC may be found unprepared to address issues which arise because of the exclusion of a research-perspective.”

In Reference 7, Robert J. Budnitz, a former Director of RES, expressing a similar concern noted: “I feel very strongly that the Commission made a serious mistake in its decision to allow NMSS to manage the research aspects of the overall program to support its regulatory decision concerning Yucca Mountain. NMSS is not suited to managing long-range research as a matter of culture, staff-incentive structures and management skills (neither is NRR) . . . But, looking ‘beyond the licensing offices headlights’ is RES’s Congressionally assigned role! I urge the Commission to revisit this decision, and in doing so to hear from people like me who can provide it with another view, to balance what I believe to be the distorted and incorrect view that now emerges from senior staff management in NMSS and at the EDO level, few if any of whom are researchers.”

A recent report (Ref. 9) issued by one of the committees of the National Research Council’s Board on Radioactive Waste Management (BRWM) presented a number of useful views and recommendations on regulatory issues related to geologic disposal. I have selected a few cogent excerpts from Chapter 6, entitled *Scientific and Technical Issues in Radioactive Waste Management*:

- In a section called ‘The Regulator’s Dilemma’ two roles of the regulator are defined, the first role is to decide on the rules for demonstrating compliance that the implementing agencies should follow. The second role of the regulator is to decide if the license application meets these requirements. The report then states: “Both roles require that the regulator has scientific credibility and that the same rules as described above for science at the implementing agencies apply also to regulators. This includes the need for scientists at the highest levels, sufficient scientific staff, publications, room and funding for independent scientific views.”
- From Sidebar 6.4 (1)... “A second corollary is that, in general, a ‘compliance’ attitude and philosophy is an inappropriate way for the regulator to approach the major yes-or-no decision; the regulatory yes-or-no decision for a geological repository will always require a good deal of judgment, not merely a cookbook compliance-type finding. At some very fundamental level, the implementer is always responsible for showing that the site is safe. Programs should be careful that a prescriptive regulatory approach does not induce a compliance attitude rather than a ‘safety’ attitude.
- From Sidebar 6.4 (5) “The regulatory body’s ability to adopt and utilize a less prescriptive system that involves relatively more judgment is very much tied up with how much trust that body enjoys with the broad public. The more trust, the more

deference is afforded the regulatory body to exercise judgment instead of relying on prescriptive yes-or-no findings, and the more likely is acceptance by the public of the regulator's decisions."

A statement in Reference 7 sums up the concerns and advice presented above: "Several panel members felt that regardless of the work being done by NMSS in evaluating the ability to license waste management programs, special research skills are required to review that work and verify its credibility. **Decisions regarding the ultimate safety of the Yucca Mountain Project, for example, will be carefully scrutinized by stakeholders and solid research data must be available to support the decisions made by the Commission.**" (Emphasis added)

REFLECTIONS ON NRC HLW CONFIRMATORY RESEARCH: GETTING OUTSIDE OF THE BOX

In a number of the reviews referenced above, many of the comments point to the need for anticipatory or long-term research in the NRC HLW program. The anticipatory, or so-called long-term, research needed has been referred to as a 'small' or 'modest' program. No basis is offered for the qualitative nature of these judgments and their meaning. The current situation regarding what HLW research is actually being done by the NRC is confusing and troubling. If the elusive scope and magnitude of the NRC research program is not clear or definitive, how can one start to define or bound the anticipatory research program? At its outset, the anticipatory program is a derivative of the confirmatory program, and for many years, both programs should be complementary. The first question that needs to be answered is: How much of the confirmatory research needed to credibly review a possible licensing application for a potential repository been completed or even identified? I believe the short answer to this question is we don't know. The NRC needs to be sure it is doing the research needed to support a credible licensing review now, before it can initiate a meaningful anticipatory program. The reasons for this answer follow.

The NRC has listed nine key technical issues (KTI) for their review of the YM project. There are many additional sub-issues related to these KTIs. Some of these issues would be influenced more by the assumption of a high-temperature repository design. The NRC is using a repository performance assessment (PA) code to project repository performance for thousands of years into the future. Large uncertainties exist in the processes and parameters for many of the models in the code, as well as the models themselves, and are closely related to many of the KTIs. Some NRC research related to these uncertainties is needed now just to understand and confirm the DOE PA code, its models and parameters, for the licensing review, and for many years to come. Such research is also essential to gain understanding and build confidence in the use of the NRC PA mode. **Risk-informed PA can be an important tool for HLW regulatory decisions, but unless the PA model is also sufficiently science-informed; it is much less useful and credible.**

Recent reports of the Nuclear Waste Technical Review Board (NWTRB) appear to be consistent with these views. In Reference 10 the NWTRB commented on the DOE performance assessment model and its related uncertainties: "The DOE uses a complex integrated performance assessment model to project repository performance. Performance assessment is a

useful tool because it assesses how well the repository system as a whole, not just the site or the engineered components, might perform. However, gaps in data and basic understanding cause important uncertainties in the concepts and assumptions on which the DOE's performance estimates are now based. Because of these uncertainties, the Board has limited confidence in current performance estimates generated by the DOE's performance assessment model.

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Sincerely,

A handwritten signature in cursive script that reads "Mel Silberberg". The signature is written in black ink and is positioned to the right of the typed name.

Mel Silberberg

cc:

ACNW

NWTRB

DOE/OCRWM

NWPO

REFERENCES

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